

Cambridgeshire and Peterborough Combined Authority Transport Model

Model Specification Report

Cambridgeshire and Peterborough Combined Authority

October 2022

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1. Introduction

1.1. Background

The Cambridgeshire and Peterborough Combined Authority (CPCA) has a long-term strategy to improve transport in their area; and have recently consulted on an updated Local Transport and Connectivity Plan which sets out their vision and a framework to deliver a modern integrated transport system for the residents and businesses in Cambridgeshire and Peterborough.

According to the 2021 Census, the usual resident population for Cambridgeshire and Peterborough was 894,300 with the two main cities growing faster than other districts over the past ten years. The aspiration is to make future growth more sustainable and to improve the transport system to provide travellers with choice, making it easier to access opportunities across the region using alternatives to the car. This is a significant challenge as the region is diverse including the cities of Peterborough and Cambridge, many towns of varying size and rural areas focused on agriculture with a high reliance on car for travel between communities.

To successfully meet its vision and goals, CPCA is looking to deliver an integrated transport network which includes the following¹:

- Integrated and seamless interchanges between modes
- Accessible travel and spatial planning
- High-quality and effective digital connectivity through the region
- Investment in high quality public realm
- Safe and attractive walking and cycling infrastructure
- Efficient highway network that accommodates the needs of all users
- Accessible, affordable, reliable, and frequent public transport and
- Innovative new transport modes.

The CPCA recognises the importance of having an up to date and robust evidence base and tools to allow them to stress test future transport plans which support economic growth aspirations, while balancing environmental concerns across Cambridgeshire and Peterborough.

Two transport models currently provide coverage of most of the CPCA area:

- Cambridge Sub Regional model represents travel to / from and within four districts of Cambridgeshire
- Peterborough transport model (PTM) provides detailed representation of highway travel for Peterborough.

To achieve the aims of a “good growth” and balanced assessment across the wider region, CPCA have approved the development of a new regional transport model to assess transport projects across the whole of Cambridgeshire and Peterborough area using one tool.

The new model will replace the existing Cambridge Sub Regional Model (CSRM), which is limited to four districts of Cambridgeshire, with a detailed model which covers the whole of the Cambridgeshire and Peterborough Combined Authority area. It will allow the costs and benefits of proposed transport schemes, and the transport impacts of new housing developments, to be fairly assessed for the whole area.

1.2. Client group

A Combined Authority working group has been set up to oversee the model development. This working group includes representatives from Cambridgeshire County Council, Peterborough City Council, and the Greater Cambridge Partnership.

1.3. Model suppliers

Atkins and WSP will collaborate and act as joint suppliers of the new transport model on the Cambridgeshire and Peterborough Joint Professional Services Framework. The management and governance of the supplier team, including our approach to quality assurance is provided in the Model Delivery Plan.

¹ Source: Draft Local Connectivity and Transport Plan: <https://yourltcp.co.uk/wp-content/uploads/2022/05/Draft-Regional-Section.pdf>

1.4. Model Name

The model is proposed to be formally named as CaPCAM, the **C**ambridge and **P**eterborough **C**ombined **A**uthority **M**odel. To avoid confusion, references to the regional model throughout this specification report refer to the new model.

3. Existing models and data

3.1. Models

3.1.1. Introduction

This section provides a brief overview of the range of existing modelling tools available to the stakeholders to answer these questions:

- What can existing models provide (data) that can be taken forward for the new model?
- Which features from existing models should be retained and any aspects to be dropped (more problematic than the value they add)?
- Where do the existing models fall short for foreseeable applications - gaps in existing model to be addressed by new model.
- How will / should the new model replace, complement and, if appropriate, interface with the existing model and implications for consistency.

The existing models considered in this section are as follows:

- Cambridge Sub Regional Model (CSRM2 F-series)
- Peterborough Transportation Model (PTM3)
- Wisbech Area Transport Model (SATURN and Vissim)
- March Area Transport Study Models (SATURN and Vissim)
- Ely Traffic Model – (SATURN)
- Regional Traffic Models (SATURN, National Highways)
- Cambridge CUBE PT assignment model; and
- Various microsimulation and local junction models within the Cambridgeshire and Peterborough area (Cambridge, Huntingdon and St Ives)

The section concludes by considering the questions posed above and highlights aspects to be addressed by CaPCAM.

3.1.2. Cambridge sub regional model (CSRM2 F-series)

The CSRM2 F-series model represents the demand for personal travel to, from and within the Cambridge sub region, defined as the four districts of Cambridge City, South Cambridgeshire, East Cambridgeshire and Huntingdonshire. CSRM2 comprises a variable demand model (VDM) integrated with assignment models for highway, public transport, walk and cycle modes.

The model has 313 zones for the four districts representing the internal model area and a further 161 external model zones. The zones are defined from the Middle layer Super Output Areas with some subdivisions relating to specific sites, eg separating major employment areas and to provide detail in the urban centres and some aggregation in rural areas.

The demand model is implemented for an average weekday and considers choices of mode, time period and destination. Travel demand is highly segmented to reflect travellers' education / working status, household income, size and car availability, as well as the trip purpose.

Highway matrices were developed for a 2015 base year from mobile phone data, 2011 Census data and synthetic matrices (from the VDM) for 12 user classes (8 purpose and income combinations, 4 goods vehicles to reflect restrictions in Huntingdon). The highway assignment model is implemented for the peak hours of 0800-0900 in the morning and 1700-1800 evening and an average hour (from 1000-1600) during the day.

The other assignment models operate for the morning, interpeak and evening periods of 0700-1000, 1000-1600 and 1600-1900 respectively and in each case the demand (trips) estimated by VDM is assigned.

Land use and trip end spreadsheet models are used to forecast personal travel demand based on land use activity (dwellings containing population, commercial development containing jobs). Trip rates for total travel derived from the National Travel Survey (NTS) akin to those used in DfT's NTEM dataset are applied to the forecast population to estimate future travel demand. Growth for goods vehicles and external (through) trips is derived from DfT's Road Traffic Forecasts.

The VDM estimates travel by mode in each time period. The base year highway matrices are updated by applying growth from the VDM (incremental approach). Matrices of light and heavy goods vehicle trips, and through trips are added to the car trips from the demand model.

The modelling system runs iteratively until demand estimates are in equilibrium with the levels highway congestion forecast.

CSRM F-series included a detailed representation of Park and Ride with car access to the city bus-based park and ride sites and the Cambridge Busway guided bus. Car access to rail is also explicitly modelled. The representation of cycling has been enhanced for the F-series, with varying perception of cycle facilities (on / off road) and modelling the ability to drive to Park and Ride sites then walk or cycle to the destination (Park and Active).

The model does not include any representation of public transport crowding (discomfort / delays to passengers due to standing / lack of capacity on the services). Parking costs are included, but no impacts of limited parking capacity on travellers' choices.

3.1.3. Peterborough Transportation Model (PTM3)

The current PTM3 model represents highway travel in the Peterborough Unitary Authority, with its detailed modelled area (simulation network) covering the City Council boundary bounded by the A1 in the west, Bourne and Yaxley to the north and south respectively, and to Guyhirn in the east. The model has 250 internal and 63 external zones. The zoning is based on Census Output Areas with additional zones to represent city car parks.

PTM3 is a three-stage model with trip generation and distribution for new developments carried out using spreadsheet models, and highway assignment in SATURN. An update to create PTM4 is being planned and will run in parallel with the new regional model development.

Highway matrices were developed for a 2019 base year from mobile phone data and synthetic matrices (from NTEM based trip ends and a gravity model) for 5 user classes (commute, business, other, LGV and HGV). The highway assignment model is implemented for the peak hours of 08:00-09:00, 14:00-15:00 and 17:00-18:00. Detailed networks represent the connectivity across the study area with signal timings provided by Peterborough City Council and checked against observed average timings. Level crossings are also included either as traffic signals based on observed barrier timings in the modelled hours, or link based time penalties.

Forecasts have been generated for the future years of 2026, 2031 and 2036. The trip generation spreadsheet model is used to forecast additional highway demand generated by developments in the modelled area. Trip rates derived from TRICS, count data and local studies are applied to land use units (dwellings, square metres of commercial floorspace). Background growth for car travel associated with existing land use activities, is determined from NTEM v7.2 applying alternative planning assumptions, and making allowance for changes in income and vehicle operating costs through time. Growth for HGVs and for through trips (external to external) is taken from the DfT's Road Traffic Forecasts.

3.1.4. Wisbech Area Transport Model

The Wisbech Area Transport model is a highway model that was updated for the Wisbech Area Transport Study in 2016/17 and has a base year of 2015. The model is implemented using the SATURN software and has a study area of Fenland district in Cambridgeshire and Kings Lynn and West Norfolk in Norfolk. Zones are defined from Output Areas with 34 zones representing Wisbech and its surrounds, and 61 external zones.

Highway matrices were developed for the 2015 base year from 2016 mobile phone data supplemented by earlier 2008 RSI data and information from SERTM. Matrices for HGV trips were derived from DfT's Base Year Freight Matrices (BYFM) for 2006 uplifted to 2015. The assignment model operates with 5 user classes (commute, business, other, LGV and HGV) and is implemented for the peak hours of 0800-0900 and 1700-1800, and an average interpeak hour (1000-1600).

Forecast highway matrices are developed using the same concepts as set out for PTM3. Growth in zones with developments is estimated using an Uncertainty Log with trip rates derived from TRICS data and distribution patterns taken from the existing zones. For zones without development, background growth is derived from NTEM forecasts with income and fuel adjustment factors applied. The final stage is constraining overall growth to NTEM levels.

Results from the strategic highway model were fed into a microsimulation model in Vissim for use in the Wisbech Access Study.

3.1.5. March Area Transport Study (MATS) Model

This strategic highway model was developed for the March Area Transport Study (MATS) to assess the impact of new developments on future traffic growth, and evaluate the impact and benefit of a number of proposed highway improvement schemes.

The MATS model is implemented in SATURN with two spreadsheet models to provide trip generation / land use and trip distribution modelling for developments, similar to the implementation of the current Peterborough transport model (PTM3). Outputs from the model are used with the DfT's Transport User Benefit Appraisal (TUBA) software for the cost-benefit analysis of highway schemes.

The study area focuses on the town of March and with network representation of connectivity to Wisbech in the North, Chatteris in the South and Whittlesey in the West. To the East the detailed modelling covers the area towards the A1101. The detailed modelling is focused on the town centre and the A141 to the west. Zoning in MATS is based on the Lower layer Super Output Areas (LSOAs) with some sub divisions to represent car parks in the town centre, and comprises 38 internal and 8 external zones.

The base year is 2018 with the highway demand matrices developed from automatic number plate recognition (ANPR) and car park surveys, allocated to journey purposes (commuting, business and other) using National Travel Survey, 2011 Census and the car park survey data. Three separate hours are modelled for an average weekday 08:00-09:00, 14:00-15:00 and 17:00-18:00. Signal timings were provided by Cambridgeshire County Council and checked against observations to provide best representation of dynamic signals under prevailing conditions. Four level crossings are included in the model and represented using traffic signals taking into account the time the barriers were closed during the one hour periods modelled.

Forecasts were generated for the years of 2026 and 2031. An uncertainty log was used to identify development sites to include, and trip rates derived from TRICS applied to the planned developments using the spreadsheet models. Background traffic growth is derived from DfT's NTEM and Road Traffic forecasts.

3.1.6. Ely Traffic Model

The Ely Traffic Model (ETM) is a highway assignment model developed originally for the AM and PM peak hours, using SATURN software with a 2009 base year. The model was built to allow tests to be conducted for the East Cambridgeshire District Council LDF proposals for Ely. The network covers the built-up area of Ely City and the local hinterland network enclosing Ely as far south as the A1123 from Soham to Stretham. Forecast years were established for 2017 and 2031. The forecasts were controlled to TEMPRO 6.2 levels of household and employment growth, although there was evidence that the employment growth in Ely anticipated by the local district council may be significantly higher than the reported TEMPRO 6.2 level.

The ETM was updated in 2021 using the 2031 Do Something network as it included the Southern Bypass which is now open and the 2017 matrix, with a Present Year Validation to 2019 data. A limited amount of manual matrix estimation was required and the inclusion of signals to represent level crossings, and an hgv ban added at the north end of Queen Adelaide Way where there is a height restriction. Calibration of link speeds and speed flow curves resulted in a good fit to 2019 count data, and further checks were carried out against routing and journey times for OD pairs against data derived from Google Maps.

3.1.7. Regional Traffic Models

National Highways have a suite of five regional traffic models (RTMs) covering the whole of England. The original development of the models in 2015 was to enable National Highways to progress schemes identified in the Road Investment Strategy (RIS). As the models were designed to provide the base for multiple highway schemes the geographical coverage is broad, with no one centre of focus. The suite of models were developed for a 2015 base year to a common design, with a consistent set of standards and utilised common datasets. The RTMs are currently being updated to a 2019 base year.

Cambridge and Peterborough are both within the area covered by the South East Regional Traffic model (SERTM), though Peterborough is fairly close to the edge. Peterborough is also in the area covered by the Midlands RTM, though Cambridge lies just outside.

The RTMs comprise a highway assignment model implemented in SATURN, and a variable demand model using DfT's DIADEM (Dynamic Integrated Assignment and Demand Modelling) software.

The primary data source for the development of the base year trip matrices was mobile phone data processed into the Trip Information System dataset, supplemented with information from Trafficmaster and DfT's Base Year Freight Matrices. Rail trip matrices are also developed for the base year to enable demand changes to / from rail when forecasting. Highway networks were developed from Ordnance Surveys ITN (Integrated Transport Network) again supplemented with traffic signal data and information from existing traffic models.

The assignment models operate for average hours in each of three time periods (morning, interpeak and evening peak) for an average weekday. Five user classes are defined for car commute, business and other trips and for light and heavy goods vehicles.

Forecast demand is developed using NTEM data for car growth and DfT's Road Traffic Forecasts for LGV and HGV trips. Specific development sites are not considered in these large-scale strategic models.

3.1.8. Cambridge CUBE PT assignment model

The Cambridge CUBE public transport assignment model is derived from the CSRM2 D-series public transport assignment model with some refinements related to specific GCP corridor schemes. The 2015 base year public transport matrices have been taken from CSRM2 base year and modified to improve the validation for the schemes being considered. The public transport network and service representation was taken largely from CSRM2, with improvements to zone connectors, non-transit legs utilising CUBE functionality.

The CUBE PT model does not include any specific forecasting functionality, with demand changes taken from CSRM2 forecasts and applied in CUBE.

CSRM2 has been updated to the F-series since this model was implemented. Many of the enhancements made for the CUBE PT model relating to zoning, highway detail for bus stops and routing, have been incorporated into the CSRM2 F-series networks.

3.1.9. Microsimulation and local junction models

For more detailed operational assessment relating to scheme proposals and design, micro simulation models are often used for smaller areas than the models outlined above. Junction specific models are also created for key locations. The main micro simulation modelling packaged used are Paramics, Aimsun and PTV Vissim. Several micro-simulation models exist for areas within Cambridgeshire and Peterborough including:

- Paramics based models for Cambridge, St Ives, A14 Huntingdon
- Aimsun – within Peterborough
- Vissim – Wisbech, March and corridors in Peterborough

Many of the micro simulation models were developed from the more strategic SATURN highway models, and thus provide similar network detail, though they could provide supplementary junction information where it is still up to date.

Detailed junction models are developed to provide operational assessments and look at specific details of scheme design. The focus of these models is very different to the proposed strategic model, however if sufficiently up to date, they could provide detailed junction geometry and signal phasing and timings. The transfer of such information already coded for the purposes of transport modelling will be considered should this be more efficient than collating the data from alternative sources.

3.1.10. What can existing models provide?

The models described above provide a large collection of information which could be utilised when developing the new model. However much of the data underlying the models is now quite dated, and hence the appropriateness of this data in terms of coverage and age will need to be considered. In particular, demand data from traffic surveys is pre Covid and hence its usefulness will be limited.

CSRM2, PTM3, MATS and the Wisbech area transport model provide coverage for most, if not all, of the study area being considered and could potentially provide highway network information for the new model.

The local microsimulation and junction models will be considered as a source for junction coding and signal timing, depending on the age of the data and whether junction changes mean the data is no longer valid.

In addition, these models could provide the basis for model zoning.

Recent data collated for forecast scenarios is also directly relevant. Uncertainty logs (where they exist) should be pooled, and form the basis for development and infrastructure logs for the wider area.

Public transport network data could be taken from CSRM, however contemporary PT modelling software (such as PTV Visum and CUBE Voyager) has functionality to process timetable information and hence this approach will be more efficient.

More importantly where existing models are expected to continue in use due to their more detailed, local coverage, consistency in definitions should be considered carefully to facilitate the sharing of data or transfer of information between modelling tools in the future.

For consistency, definitions should be the same or compatible wherever possible with simple one to one, many to one aggregations.

- Same highway assignment hours (including definition of average weekday)
- user classes – same or simple aggregations
- definition of modes – “car”, van and HGV – same or simple aggregations
- same price base
- zoning – nested across models
- Classification of road types

Network coding rules will be required for the new regional model, and these might be taken from an existing model, particularly where consistency is desirable between models in the longer term.

3.1.11. Shortcomings in existing models and functionality to adopt

Table 3 sets out some of the functionality in the existing models that has been identified as desirable for including in CaPCAM to provide the range of tools required for the likely scenario applications.

Table 3-1 - Functionality options

Existing Model	Desirable	Debatable (sufficient value added?)
CSRM	P&R modelling Cycle modelling LU / trip end growth based on local uncertainty logs or constrained to NTEM Representation of area licence for Cambridge City	Income segmentation - should be useful – but limited application to date Treatment of bus v guided bus (HQPT) – was useful – but more important now to differentiate off road dedicated track versus on road running Macro time of day choice – limited use to date, important for time period specific charging. Assigning walk (cycle is desirable).
PTM, MATS	Clarity of trip generation for future developments	Representation of individual car parks – too much detail for strategic model though data potentially useful.
SERTM	Goods vehicle demand Strategic road network	

The existing models provide a wide range of functionality across the CPCA area, particularly for highway modelling. The main shortcomings identified with the existing models are:

- Area of coverage and consistency across tools
- Demand data underpinning models are now quite dated (eg 2011 Census) and require updating to remain valid
- Multi modal modelling limited to Cambridge sub region only
- Limited / time consuming graphical outputs for presentation
- Bespoke and complex approach to represent Park and Ride
- Transparency of planning inputs
- Modelling constraints imposed on car travel by restricted parking capacity
- Changes in traveller behaviour due to emerging technology and post Covid

The proposed approach to developing CaPCAM seeks to address these shortcomings.

3.1.12. Interaction between CaPCAM and existing models

The outline specification of CaPCAM has highlighted some areas of consistency in terms of geographical building blocks for zone definitions, time periods and segmentation (user classes) across the existing models. Some of the definitions are slightly different (eg for the inter peak highway assignment hour). The definitions will be finalised for CaPCAM based on analysis of data and in discussion with the existing model owners to

maximise consistency in definition across the existing models which are expected to be used in future applications. The most relevant model is PTM where the proposed update provides the opportunity to align definitions with CaPCAM.

Having maximised consistency in definitions, some of the potential benefits of sharing information between modelling and assessment tools are as follows:

- Single maintained Uncertainty log for all developments across the CPCA area to maximise consistency in forecast growth assumptions for alternative scenarios;
- Derivation of modal (expected to be primarily highway) growth factors from CaPCAM for application in existing models in a variety of ways: as background growth, for longer distance movements not captured in the local model or to create a reference scenario;
- Single maintained Uncertainty log for potential transport schemes across the CPCA area;
- Sharing of scheme coding for potential highway schemes across relevant models – with adjustments required for appropriate level of detail in each application;
- Ability to develop new detailed assessment tools from CaPCAM, eg by cordoning the highway model, extracting a subset of the demand matrices for a local micro simulation, cycling or public transport and adding additional detail for local applications.

It must however be noted that each model or assessment tool will be focused on meeting specific objectives, with more local models intended to provide more detail than the strategic CaPCAM. While inconsistency can be minimised and information can be shared between the various tools, this does not ensure consistency in forecasts outputs. The most appropriate tool should be used for the relevant application and the validity of the tool confirmed at the outset.

3.2. Data

3.2.1. Introduction

This section briefly outlines existing data sources we are aware of, and in many cases have previously used for models and studies within the CPCA area. The datasets fall into two main groups:

- National datasets providing information for the CPCA area which are published or can be made available for applications such as transport modelling.
- Locally collected data collected regularly (e.g. annually) or as a one-off for a specific purpose.

The data requirements for the model development are covered in Chapter 8 of this report, covering both data which exists (as summarised here) and datasets which would need to be collected.

The following sections provide a brief summary of the existing data relating to the different components of the proposed model and stages of development.

3.2.2. Planning data and demand model

Planning statistics are published by the Local authorities on levels of development and growth in their area. Many of the development assumptions are already collated for the CSRM and PTM models. The existing data would need confirming with the relevant local authorities, with data expected to be available for 2022.

Statistics are published at least annually, by the Office for National Statistics, and freely available relating to population, households and employment at a district level and in some cases for more spatially disaggregate areas. Again data for 2022 is or will be available for use in the base year model development. Data is also collated by various government departments on housing developments (Live tables) and school places (School Census)

Commercial datasets such as the Ordnance Survey AddressBase relate postcodes to geographic locations and enable more spatial detail to be incorporated into models. This dataset, and some others, are freely available to public authorities. Where such data is required, we will request access to the data via the relevant client authority.

The Census of Population carried out every ten years provides a wealth of spatially detailed information on the population and households living in each area. Data from the 2021 Census is now being published, with more information due out by Spring 2023. The 2021 Census will provide an excellent dataset from which to derive 2023 segmented population data, with more aggregate growth statistics being applied.

Trip rates are required to determine the amount of travel made people living, working, shopping etc in the study area. Trip rates can be obtained from two sources:

- travel diaries recording every trip made by a set of individuals for a defined period (usually a day or a week).
- Counts at specific facilities (eg retail parks, science parks, specific development areas).

The National Travel Survey is an excellent source of information on travel behaviour and available for all recent years. The survey is however a very small sample of people, sampled across England and hence cannot be reliably applied for spatially detailed areas. It does however provide robust information on trends and can be used to provide statistics at a more aggregate spatial level (while ensuring sample sizes are sufficient). A limited amount of data is published and freely available. A licence can be obtained to access more detailed NTS data for specific purposes, such as transport modelling.

The TRICS database is a widely used system for trip generation analysis particularly in relation to Transport Assessments. The database provides access to a wide range of traffic and multi-modal transport surveys for different development types.

Changes in behaviour have also been monitored by ONS, with a variety of datasets collected from lifestyle surveys such as the Living Costs and Food survey, and Opinions and Lifestyle survey. These data are not specific to the study area, but can provide useful insights for the demand model on the factors influencing the ability / desire to work from home.

3.2.3. Base year trip matrix and distributional data

The Census of Population also records information on the usual workplaces and methods (mode) of travel to work for employed people, and has historically been widely used in transport modelling. This data is unlikely to be reliable for 2021 due to restrictions on movement imposed due to the Covid-19 pandemic at the time the Census was completed. Data from 2011 is available, but now very dated so of limited use meaning existing data on commuting patterns across the CPCA area is limited and will need to be addressed.

Public transport ticketing information can provide information on volumes and patterns of movement on public transport. Ticketing data from Stagecoach has been used for analysis of bus travel patterns for CSRM. Similar data is likely to be available from other bus operators, though restrictions are usually imposed to ensure the commercial sensitivity of patronage data is respected.

Annual rail ticketing data is available via LENNON which holds the vast majority of national rail tickets purchased in Great Britain. The MOIRA model makes extensive use of LENNON to predict the number of people who travel on each service. MOIRA is the rail industry standard source of information on rail patronage and can provide information on station to station movements (based on ticket sales). There are limitations with the data particularly in major conurbations covered by travel cards where the stations used are not defined. Times of travel are not determined for some tickets, and it is not clear how accurately the MOIRA information reflects variations across the year and throughout the day at local stations.

Mobile phone or other mobile device data, collectively known as mobile network data (MND) can also be used to obtain information on patterns of movement. Mobile phone datasets have been used for CSRM, PTM and the Wisbech transport models. This data ranges from 2015 to 2019 and is sourced from different providers.

Various companies collate and sell information on vehicle movements through fleet tracking systems using GPS devices in a sample of vehicles. These include INRIX, Teletrac Navman and TomTom. The sample sizes for the data vary and the bias of the sample is not known. These datasets are often used to provide data for vans or heavy goods vehicles.

3.2.4. Network data

Many sources of geo-coded network data for alternative modes are widely available. Opensource datasets such as OpenStreetMap are available and provide some of the information required. Commercial datasets provide more attributes for the networks which can be valuable for transport modelling. OS Mastermap and HERE maps are examples of networks where additional detail can be purchased.

As outlined in Section 3.1, the existing models provide good coverage of the proposed CaPCAM study area and already contain detailed network information appropriate for modelling.

Signal timing information could be taken from existing models, but the age of the data means it should be verified or updated with current information from the local authorities.

3.2.5. Highway model

The highway model development requires information on the volumes of traffic using the network, observed speeds of travel and journey time routes to calibrate and validate the model. Count data is used to help scale

and shape the matrices of demand with additional (independent) data then used to validate the resulting traffic flows across sets of links.

Ideally the data will be collected close to the date being used to validate the model. Adjustments can be made to the data to account for monthly variations due to seasonality, though the aim to represent travel for an average weekday during (school and university) term time.

National Highways continuously monitor traffic flows and speeds on the strategic road network and this data is available via WebTRIS. There are approximately 1,400 permanent traffic sensors on the strategic road network within Cambridgeshire and Peterborough. This dataset is expected to be key data source for the strategic road network, managed by National Highways.

The Department for Transport also collect data from 300 automatic traffic counters and approximately 8,000 manual classified traffic counts across the country each year. There are many sites in Cambridgeshire and Peterborough. Data is collected between 7am and 7pm between March and October excluding public and school holidays. Major roads are surveyed regularly with the interval between counts being 1, 2, 4 or 8 years depending on the traffic level. A sample of minor roads are counted each year. Traffic estimates are derived for all years based on the data collected.

Cambridgeshire County Council have a series of permanent sensors to provide count data and the annual traffic monitoring surveys (7am-7pm). The surveys include:

- Annual town monitoring sites in March, Wisbech, Chatteris, Whittlesey, Ely, Huntingdon, Ramsey, St Ives, and St Neots.
- Annual Cambridge radial sites on routes to / from Cambridge City.
- Annual Cambridge river screenline sites.

The annual town monitoring sites and Cambridge radial are one-day surveys in October / November counting pedestrians, cyclists and motorised vehicles by type at half hourly intervals. The same information is collected for the Cambridge river screenline during two-day counts carried out in April / May each year. Information on the surveys is geocoded with GIS layers of information on the counts available.

In addition to these regular counts, adhoc surveys are undertaken for individual projects with data potentially available to CCC. The relevance and availability of any such data will be investigated when defining the new data collection programme in collaboration with CCC.

To update the PTM model to a 2019 base year (PTM3), Peterborough resurveyed many of the earlier 2015 traffic count sites in September / October 2019 to provide link and turning count data. Weekly ATC counts were carried out for the links, with one day video surveys for classified turning counts. A further programme of traffic surveys is being planned for the update to PTM4 and should be available for CaPCAM.

As well as this more traditional data, both Cambridgeshire and Peterborough have a number of permanent Vivacity sensors counting pedestrians, cycles and motorised vehicles in 5-minute, 15-minute, hourly and daily intervals, with more sites proposed. Both authorities have been analysing data and comparing results with more traditional data forms to better understand the robustness and reliability of the data. We will engage with the relevant users of the data at Cambridgeshire and Peterborough to explore the extent this data can be reliably used to supplement traditional count data for model calibration and validation.

Journey time information is now typically derived from vehicle tracking devices and available from a number of providers as noted in Section 3.2.3 for GPS based distributional data. Historic journey time information has also been collated for the existing models, though this is now too dated to be relied on for CaPCAM. CCC have access to Trafficmaster journey time / speeds data pre-2021 and CTrack/Inrix data from 2021 onwards.

3.2.6. Public transport model

The Bus Open Data Service (BODS) is a portal providing access to bus timetable, vehicle location and fares data ([Bus Open Data Service \(dft.gov.uk\)](https://bods.dft.gov.uk)). Vehicle location information can be used to calculate speeds of travel and journey times. The data is in GTFS format (which can be now read by leading public transport modelling software packages). Rail timetable information can be obtained from the Associate of Train Operating Companies in the equivalent GTFS format.

The national public transport access nodes (**NaPTAN**) is a national dataset of all public transport 'stops' in England, Scotland and Wales.

These publicly available datasets are now national standards and widely used for transport modelling applications.

3.2.7. Park and ride

Passenger journeys using the Cambridge Park and Ride sites were counted annually as part of the CCC Rolling Count programme until the Covid-19 pandemic. From the induction loops on the entry and exit of each city P&R site it has historically been possible to obtain vehicle entry and exit counts for each site. Differences in data collection and the ability for travellers to park at the site and not use the bus, or walk or cycle to the site to access the bus services has made these two datasets difficult to combine.

Additional surveys carried out in November 2018 provided supplementary information on cycle parking, those arriving and leaving the site by active mode and interview surveys providing information on the ultimate origin and destination of the park and ride trips. This data is now dated, with major developments occurring in close proximity to some of the P&R sites making it less reliable for continued use.

3.2.8. Car parking

Daily car park usage data by length of stay is available from Cambridge City Council for the public multi-storey and surface access car parks in Cambridge. The multi-story car parks provide daily data by length of stay, while the surface access car parks provide monthly totals.

The availability of similar data for other districts, particularly Peterborough, will be investigated.

Information is also available from the internet for Cambridgeshire and Peterborough on the number of spaces at each car park and their usage charges.

3.2.9. Active modes

CCC carry out annual one-day surveys each April / May counting pedestrians and cycling at half-hourly intervals between 7am and 7pm on a set of Cycle routes.

Additional data collection is being planned as part of the Greenways count programme.

To calibrate the varying perception of different types of cycle facilities for CSRM F-series enhancements data on cycling was obtained from Strava. This data is a relatively small sample of data from “members” who tend to be focused on fitness / exercise. How well this data represents the range of cyclists across the study area is not known.

No existing data has been identified beyond the Cambridge area.

3.2.10. Summary of existing data sources

Table 3-2 provides a brief summary of the existing data sources identified and discussed in the previous sections.

Table 3-2 - Existing data sources

Associated model component	Identified existing datasets
Planning data and travel demand	Census of Population: 2021 and 2011 Local authority records of developments Government collated tabulations on dwellings, school places ONS statistics – mid year population estimates, Business register and employment survey AddressBase: geocoding of residential and commercial addresses Trip rates: National Travel Survey (NTS) and TRICS database Behavioural / lifestyle surveys: Living costs and food survey
Trip matrices / patterns	Census travel to work: 2011 (old), 2021 (unreliable due to Covid-19) Electronic ticketing data from bus operators LENNON / MOIRA station-to-station rail data Mobile phone data used for CSRM/PTM and Wisbech – old
Network data	Existing models Open source: OpenStreetMap Commercial data: OS Mastermap, HERE maps

Associated model component	Identified existing datasets
Highway model	CCC annual traffic monitoring 2019 data collection for PTM3 Data from Vivacity sensors for Cambridgeshire and Peterborough National Highways WebTRIS data DfT traffic counts
PT model	Bus Open Data System: timetables, fares, location (speeds / journey times) Rail timetables and fares (ATOC)
Park and Ride	Historic CCC rolling count programme P&R passenger counts P&R site vehicle entry / exit counts Interview surveys (November 2018)
Car parking	Cambridge City Council – multi-storey and surface car park usage records Car park capacities and charges from websites
Active modes	CCC annual cycle route monitoring surveys Strava data obtained for CSRM2 F-series

4. Model scope

4.1. Model overview

The proposed CaPCAM model will incorporate four main elements as follows:

- A trip generation model to estimate the demand for personal travel from land use activities;
- A variable demand model (VDM) to consider the choice of mode, macro time period and destination faced by travellers;
- A highway assignment model (HAM) with a representation of the road network; and
- A public transport assignment model (PTAM) representing bus and rail public transport services, and the ability to walk and cycle.

Multi-modal trips, for example park and ride (P&R) will be explicitly modelled, with the car and public transport legs of the journeys included in the relevant assignment model. The demand model would be implemented for an average weekday with assignment models for specific times of the day.

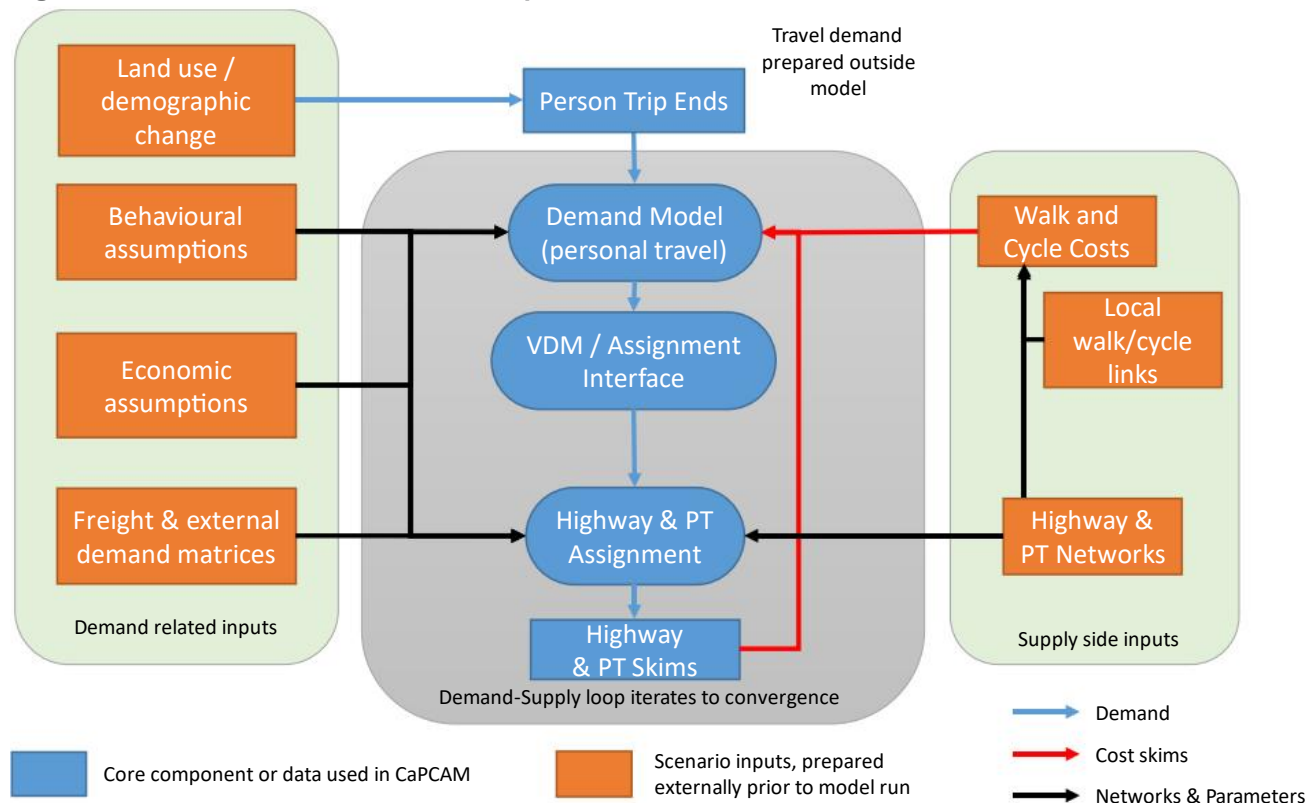
The attractiveness of car is heavily influenced by the availability and cost of parking which will be reflected in the model. The CaPCAM model will also be able to represent alternative road pricing policies such as the Making Connections package of measures currently under consideration by the Greater Cambridge Partnership.

The initial implementation of CaPCAM will not include real time modelling or be an activity-based model. The proposed design and implementation is intended to facilitate (not create obstacles to) additional functionality being added at a later stage if it becomes appropriate for the model applications.

4.1.1. Model structure

The design and structure of the model is intended to remain as close as practical to a conventional TAG design for a four-stage transport demand and assignment model. A simple summary of the structure proposed is shown in Figure 4-1.

Figure 4-1 - Overview of core model components and structure



There would be no difference between the structure used for 'Base' and 'Forecasting' model runs, with model forecasts or scenarios being created simply by altering the appropriate demand or supply-side inputs.

The basic structure and principles of the model can be summarised as follows:

- **Person trip ends:** In the Base Year model, trip productions and attractions by zone will be calculated, separated by trip purpose and person type. These trip ends are used as the basis for any model scenario tests, with changes input either as scalar growth or additive changes. These trip ends, and all the demand modelling, is carried out for a 24-hour weekday;
- **Demand model (VDM):** A logit based variable demand model (VDM) will be used to determine personal choices of travel mode and destination. These choices are informed by the generalised cost for each possible journey, calculated based on journey time, distance and money costs (red arrows);
- **VDM/assignment interface:** The "synthetic" personal travel information calculated by the VDM is converted into public transport passenger trips and highway vehicle trips by time period, and used to apply changes to the Base Year assignment matrices for each mode;
- **Freight and external matrices:** The highway assignment matrices include matrices of road freight (goods vehicles) trips in the Base Year. Similarly those trips which pass through the study area without stopping (eg on the A1, A14, A47 etc) are included as "external matrices". Forecast growth or other changes in freight and external trips would be determined externally and applied within runs of the model;
- **Assignment models (HAM and PTAM):** Network assignment is carried out for highway and PT to determine routing and links flows, and to extract highway costs (distance, time and any toll charges) and PT costs (fares, journey times, wait times and interchange) for O-D zone pairs by time period;
- **Active mode costs:** Walk and cycle costs are estimated from travel distances extracted from the public transport network, which includes highway pavements and additional links where walk or cycle only links are known to exist. A fixed speed of walking and cycling is assumed.
- **Behaviour assumptions and economic assumptions:** These can be altered during scenario tests to determine the impact e.g. of changes in fuel costs or values of time; and
- **Model iteration:** For scenario testing the model includes a supply-demand loop which allows for iteration of VDM choices and highway congestion levels.

Additional features not shown in figure:

- **Highway / PT interaction:** The highway assignment network includes pre-loads of scheduled public transport services (bus and coach) based on the timetabled services, and on-road bus times responding to road congestion;
- **Parking Capacity Function (PCF):** parking penalties will be applied for "parking districts" in urban areas and park and ride sites where parking capacity is known to be limited. This will act to limit personal car trip destinations, and will not operate as a hard-constraint but as a deterrent function limiting growth in parking. The penalty will be calculated alongside the highway costs after each iteration and included in the generalised time for car mode).

Key components and features of the model are discussed in the following sections. The model system will be designed such that, to the greatest extent possible, information is coded only once and is available to all components which either directly or indirectly make use of it. For example, economic assumptions determining vehicle operating costs available to VDM and assignment models, and network information used by the HAM and PTAM.

Note that it will be possible to use the HAM, PTAM and VDM components independently from each other, for example to carry out fixed-demand assessments of infrastructure and service options.

4.1.2. Travel demand linkages

The travel demand in the model will at the highest level be derived via trip rates from the land use and economic activity assumptions, and act as an input to the demand model. The VDM and assignment models operate with different forms of demand: the VDM having what is termed a 'synthetic 24-hour person matrix of productions and attractions', and the assignment models requiring separate matrices of trips by time period on an origin-destination basis, which in the HAM are measured in vehicle trips not persons. To link these, the VDM / assignment model interface will comprise several data transformations carried out as part of a model run. These include:

- Transforming the 24-hour production-attraction person trips output by the VDM into matrices of origin-destination personal trips for the time periods represented in the assignment models;
- Conversion of VDM person car trips to vehicle trips via occupancy factors;

- Mapping of the VDM travel demand segments into assignment user classes;
- A 'pivot' process to adjust the base year assignment matrices based on forecast changes in personal trips from the VDM;
- Freight and external-external movements, calculated outside the main model, will be added to the pivoted vehicle matrices before assignment.

4.2. Geographical coverage

The geographic scope of the model is to focus on the two authorities making up the CPCA area (Cambridgeshire and Peterborough), and will cover all travel movements within, to and from the area shown in in Figure 4-2.

Figure 4-2 - Model coverage



Two factors require further consideration: the extent of the model coverage, and the spatial detail or granularity within each area. Note that the exact coverage and level of detail will be agreed early in model development in collaboration with CPCA through creation of a network topology in GIS.

The approach proposed is outlined in Table 4 with the definitions to be finalised early during model development. Analysis of the Census travel to work homes and workplaces and the patterns of travel in the proposed mobile network data will be carried out prior to finalising the definition of the different areas of coverage and associated levels of detail in the network and zoning.

Table 4-1 – Geographical areas of coverage

	Area type	Areas Covered	HAM	PTAM	Demand Model
Fully Modelled Area (FMA)	Area of Detailed Modelling (AODM)	Cambridge, South Cambridgeshire, Peterborough, A14/A1/A10 corridors (including Ely, Huntingdon, St	Coded with junction delay represented where significant. Network to include most roads (e.g. all motorways, trunk roads, primary, secondary roads) Tertiary and unclassified roads	PT network representing all rail and bus services routing through the areas.	Internal Area: Full trip representation across all modes.

	Area type	Areas Covered	HAM	PTAM	Demand Model
		Ives, March and Wisbech).	included where strategic routing occurs or where required for zone loading). Note, in rural areas, detail will be necessarily focussed on strategic (e.g. inter-urban and other important route) corridors.	Walk and cycle network to include primary, secondary, tertiary and unclassified roads which provide walk access from zones to wider network, as well as major walk/cycle only link such as off-road cycle routes.	
	Rest of Internal Area	Rest of Cambridgeshire plus Royston, Haverhill, Newmarket and Mildenhall	Motorway, trunk road, primary and secondary roads. Some tertiary roads where required for zone loading. Primarily speed flow curves on links but with key junctions coded in detail.		
External Area	Immediate External Area	Extending into Bedfordshire, Norfolk, Essex and Lincolnshire, precise detail to be agreed during network development.	Major routes (motorways and A roads) sufficient to join external zones into model. Link representation only with fixed speeds.	Rail services which pass through the CPCA region coded in full within region and simplified on external parts.	Representation of trips to/from the internal area, including mode choice
	Wider External Area	Rest of GB	Skeletal network of key motorways sufficient to link zones defined at the County or Regional level. Link representation only with fixed speeds.	Public transport trips passing through internal area included	

The terminology typically adopted varies for the different model components (demand and assignment), though a high level of consistency is required between the components for the modelling system as a whole.

For the demand model, coverage is split between trips produced (i.e. made by residents / employees) in internal and external areas, defined as follows:

- **Internal area:** All trip ends for person trips are included, and all travel choices within scope are determined in the model. This means that for each trip production in the internal area, the mode and distribution choice apply fully.
- **External area:** For these areas, only trips with production or attraction end in the internal area are considered in the demand model. This means that the model considers only a proportion of the trip productions and attractions in the external area, and moreover this proportion is determined as an input to the model.

These definitions have some implications for the application of the model and are therefore worth considering carefully. Key considerations are:

- While movements between external areas (external-external) will be included as exogenous assumptions in assignment matrices, and hence may re-route, they will not be variable within the demand model even where these cross the study area and are potentially influenced by travel conditions within the model. Growth in external-external highway movements will need to be input to the model for each assignment mode and segment.
- Internal to external movements, such as out-commuting to work and for shopping and leisure, will be subject to mode and destination choice in an identical manner to internal trips. As commuting is doubly-constrained (in line with guidance), the number of out-commuting trips to each external zone will need to be specified as an input to the model for each scenario;

- Conversely, for external-internal movements, the trip productions in each external zone will be input to the model, which corresponds (for example) to determining the number of workers in each external zone whose jobs are in the internal area and similarly how many people travel in to shop. The demand model will determine the travel mode and destination choice within the model area.

4.3. Zoning

It is important to consider the levels of spatial detail or granularity required within the model. A very large number of model zones will increase model running times and make the model unwieldy, whereas a lack of detail can limit the ability to represent walking and cycling, reflect where people board bus services, join the main road network and make the model less responsive to policy tests.

Table 4 shows the number of zones representing the internal area of the existing transport models. In comparison the Cambridgeshire and Peterborough area comprises approximately 2,500 Output areas which aggregate to 98 MSOAs as shown in Table 4.

Table 4-2 - Comparison of zones

Model / ONS	CSRM2-F	PTM3	WATS	MATS
Number of "internal" zones	304	250	38	34

Table 4-3 – MSOAs, LSOAs and Output Areas (OAs) in each local authority

Local Authority	MSOA	LSOA	OA
Peterborough	22	112	604
Cambridge	13	69	372
South Cambridgeshire	20	96	473
Huntingdonshire	22	105	537
East Cambridgeshire	10	50	265
Fenland	11	55	290
Cambridgeshire & Peterborough	98	487	2,541

A reasonable number of zones for a highway model of this type is in the range 500 to 800 including both internal and external areas. It may however be appropriate to better represent access to PT stops to use more detailed zoning for the PT assignment. For simplicity of operation, the zoning used in the demand and assignment models would be identical, so any additional zoning required for PT would ideally be included throughout the model. The levels of detail will be confirmed early in model development based on experimentation with model run times.

For demand modelling purposes, the basic units used for zoning should be taken from Census geography and administrative boundaries, and nest within these at all times. By preference this would mean model zones are grouped from output areas (OAs), lower super output areas (LSOAs), middle super output areas (MSOAs) and Local Authority Districts (LADs), and should nest within this hierarchy. It appears from the numbers of zones in Table 4 that a basic building block of LSOAs would be appropriate, with some aggregation and splitting to provide appropriate detail for the policy areas of interest.

Urban zoning will be determined by the granularity of the highway and PT networks, and the locations of bus stops and routing options to be considered. The existing CSRM and PTM3 model zoning will be used as a guide, but zone structure will be developed bottom-up from Census geography and bus stop catchment areas. The zone system will be reviewed with the client prior to adoption.

4.4. Model years

The model will be prepared with a base year of 2023, which means that all model inputs will be developed based on this year, including calibration of the highway and PT assignment models. The decision to use 2023 is based on the possibility of collecting data representative of the 'post-Covid' period.

As specified by TAG, the model will represent a neutral period during 2023, nominally a typical working weekday outside the school holidays. The precise time period will be determined following data collection and during base matrix building, guided by availability and quality of data.

It will be possible to implement CaPCAM for any forecast year after the 2023 base year, and potentially create historic years as a back-casting exercise. For the initial model development, we propose implementing three forecast years to demonstrate the operation of the model and provide a set of outputs. The proposed forecast years are 2041 (end of Local Plan period) and 2031, with an interim year of 2036. These years will then be consistent with PTM (which currently uses 2031 and 2036).

4.5. Time periods

The base year model will represent a 24-hour average weekday in a neutral period in 2023. The VDM will consider choices at the average weekday level. The HAM and PTAM will each be divided into AM, interpeak (IP) and PM models, representing the average conditions during those time periods, based on differences in travel demand, road congestion and service schedules.

Table 4 illustrates the out and return time period combinations which will be considered in the model. The VDM will produce 24-hour P/A which for home-based trips implicitly include all trips which travel out and back in a single 24-hour period. Hence any combination of trip travelling from home in the morning pre-peak period (midnight until the start of the AM period) and returning during a later period is included. This would include trips entirely within the pre-peak or post-peak.

The assignment models will include only trip legs in the defined AM, IP or PM periods, which will include return legs in those periods for journeys starting in the pre-peak, and outward legs of journeys ending in the post-peak.

The AM, IP and PM periods for highway and PT assignments will be considered and defined during the matrix build and data collation. The main choice will be whether the AM and PM peaks are represented as single peak hours (e.g. 8-9am and 5-6pm), or as full periods (e.g. 7-10am and 4-7pm). This will be dependent on the proposed linkages with existing models and their definitions, the profile of demand across the peaks, the variation in journey times, and for PT the variation in service schedules. Time period conversion factors will then be derived to allow the 24-hour VDM production/attraction trips to be split into the required assignment time periods. Both exercises will make use of NTS data and directly observed data sources including mobile network data, traffic counts and ridership numbers for PT where available.

Table 4-4 – Out and return time periods in VDM and assignment models (home-based trips)

		Return time period (same day)					Key
		Ante-peak	AM	IP	PM	Post-peak	
Outward Period	Ante-peak						VDM and Assignment
	AM						VDM only
	IP						
	PM						
	Post-peak						

4.6. Modes

Following designs previously adopted successfully, and in consideration of DfT guidance, the model would represent a full range of private, public and active travel modes. A 'main mode' choice would divide trips first between private car, public transport, walk and cycle trips. These four main modes represent very different trip lengths and characteristics and separating them initially improves the next step of destination choice.

The model would also include sub-mode choice covering bus, rail, bus park & ride and rail park & ride. The intention is to represent the improved quality of guided bus services through the coding associated with dedicated (off-road) infrastructure, rather than a separate mode (as is currently the case in CSRM). Taxi travel may be included separately but is not currently considered a core requirement and would by default be assumed to be part of the car mode.

The main mode and sub-mode choice are determined explicitly within the VDM, determining a ‘dominant mode’ for each O-D trip as input to the assignment models. Within the assignment model the journey may be split into journey legs with interchanges modelled and access legs using appropriate access/egress modes. For example, a rail trip may include access/egress legs by walk, cycle and bus. The bus and rail modes will allow interchange between services, with appropriate interchange penalties to address the inconvenience of this.

Table 4-5 – Main modes and constituent modes by stage for access / egress

Demand Model		Assignment models			
Main mode	Sub-mode	Dominant mode	Access/Egress modes		
Car	Car	Car			
	Bus P&R	Car	Bus	Cycle*	Walk*
PT	Bus	Bus	Walk	Cycle*	
	Rail	Rail	Bus	Walk	Cycle
	Rail P&R/car access	Rail	Car	Bus*	Walk*
Walk	Walk	Walk			
Cycle	Cycle	Cycle			

* Park & Ride modes will allow egress to the final destinations by walk, cycle and bus as appropriate. Cycling should be an access mode to specific bus stops with designated cycle parking, though normally not an egress mode.

The model will aim to consider the most common set of mode choices for journeys, in a manner which is applicable to the travel trends and policy choices faced by CPCA. However, there are some travel combinations explicitly excluded or only implicitly included. These include:

- Return journeys where the outward and return legs use radically different modes, e.g. walk or bus in the morning, and then train home;
- Lift sharing will be represented via a car occupancy factor only, a fixed input by travel purpose derived from TAG databook or local data;
- Kiss & Ride will be considered as part of Park & Ride, with the onward journey by the driver not explicitly considered.

The Base Year model will not include any ‘new modes’ such as e-scooters, autonomous vehicles or mobility as a service. However, it is anticipated that these can be added as a future enhancement should the need arise and suitable definitions of the travel modes and their characteristics become available.