North West Cambridge Retail Transport Study

Final Report
June 2010

Plan Design Enable

ATKINS

North West Cambridge Retail Transport Study

Final Report

June 2010

Notice

This document and its contents have been prepared and are intended solely for *Cambridgeshire County Council's* information and use in relation to *the North West Cambridge Retail Transport Study*.

Atkins Transport Planning & Management assumes no responsibility to any other party in respect of or arising out of or in connection with this document and/or its contents.

Document History

JOB NUMBER: 5092812			DOCUMENT REF: Final Report-v11.docx			
4	Final Draft	NP	-	-	RSB	30/6/10
3	Second Draft	NP	-	JML	RSB	11/6/10
2	Draft Report for issue	NP	SA	JML	RSB	14/5/10
1	First Draft	NP		RSB, JML	-	10/5/10
Revision	Purpose Description	Originated	Checked	Reviewed	Authorised	Date

Plan Design Enable

Contents

List of Tables

List of Figures

Appendices

List of Tables

List of Figures

ATKINS

List of Abbreviations

CCC	Cambridgeshire County Council
CCRG	Cambridgeshire County Research Group
CO_2	Carbon dioxide
CSRM	Cambridge Sub-Regional Model
DfT	Department for Transport
GFA	Gross Floor Area (measured in square metres)
NLP	Nathaniel Lichfield and Partners
NWC	North-West Cambridge (consisting of University, NIAB, NIAB Extra and Orchard Park sites)
PCA	Primary Catchment Area (as defined in the SRS)
PCU	Passenger Car Unit
RFA	Retail Floor Area (measured in square metres)
SCA	Secondary Catchment Area (as defined in the SRS)
SCDC	South Cambridgeshire District Council
SOLUTIONS	Sustainability Of Land Use and Transport In Outer Neighbourhoods
SRS	Supplementary Retail Study
TIF	Transport Innovation Fund
TRICS	Trip Rate Information Computer System
WebTAG	Web-based Transport Analysis Guidance

Glossary

Base case	The "starting position" for modelling. In this study, the base year is 2008 and the base case includes everything that had been built by that year (roads, houses, etc.).
CSRM	The Cambridge Sub-Regional Model is a transport and land use interaction model that was originally built for the TIF study according to the latest DfT guidelines. It has a base year of 2006 and forecast years of 2011, 2016, 2021, 2026 and 2031, with the predicted interim/complete states of all developments fed into each forecast year.
Generalised cost	Generalised cost is a combination of travel time and distance, expressed as a monetary cost in pence based on DfT valuations of the cost of time for personal travel as well as fuel and non-fuel elements of travel costs.
Gravity model	In transport modelling, a gravity model provides a means of distributing trips between origins and destinations, based on the 'production potential' of origins, the attractiveness of destinations, and the cost of travelling between the two. As its name suggests, it is based on an analogy with the law of gravity in physics, whereby the gravitational 'pull' of an object decreases with distance from it, and is dependent on the size of the object. In the context of this study, the 'production potential' of origins describes the number of households and their propensity to go shopping in the study area; the attractiveness of destinations is based on the store size; and the cost of travel is expressed in generalised cost (see above).
Major food store	A food store of 2800 m^2 GFA or more.
Minor food store	A food store of less than 2800 m^2 GFA.
Mode share	Mode share describes the proportion of trips travelling by each mode of transport. For example, the car mode share is the proportion of trips that are made by car.
Pass-by trip	A pass-by trip is one that is made en route between two other places. For example, somebody might call in at a supermarket on their way home from work. These trips in themselves do not cause additional traffic to enter the road network (although they may involve a detour).
PCU	Vehicular data from the SATURN models is in Passenger Car Units, rather than pure vehicles. For example, an HGV is counted as 2.3 PCUs, while a car is 1 PCU. This is due to the way the SATURN model represents the additional road space required by larger vehicles on the network.
Planned Development Only	This describes the future year scenario when only the development that is currently planned in NWC has been put in place. This is as opposed to the

	Test Scenarios, when additional food store floorspace is included to test the effects of these changes.
SATURN	The SATURN software suite is used for highway modelling. The models include roads, junctions and the traffic that uses them. In assigning vehicles to the highway network, it considers likely routing and takes congestion into account. Additional roads and traffic can be added to the model, and the resulting predicted change in traffic flows can be observed.
Transport Assessment	A Transport Assessment is a required part of the planning process for any commercial development with transport implications. It sets out the existing conditions of the site (including transport/access provision) and considers the impacts of the proposed development. Measures to improve travel in/to/from the proposed development are identified and refined in an iterative process, which may then result in conditions being placed on the planning approval to ensure that these measures are put into place.
TRICS	The TRICS database has been built up over many years, and contains traffic survey information from thousands of sites across the UK. These sites are categorised in detail according to their purpose – including supermarkets, offices, swimming pools, places of worship, etc. Within each purpose category, locations are also categorised (such as town centre, edge of town, rural, etc.) as well as different areas of the country (e.g. London, or the Scottish Highlands). For each site, rates of arrivals and departures are given by hour.
Trip cost distribution	The cost of a trip is calculated in terms of generalised cost (see previous page). The trip cost distribution is a graph that describes the spread of costs in the model. The peak of the graph represents the mode (average) cost, i.e. the most frequently observed trip cost.
Vehicle hours	This is the total number of hours that all vehicles spend travelling in the model.
Vehicle kilometres	This is the total number of kilometres that all vehicles travel in the model.

Executive Summary

Outline

The North West Cambridge Retail Transport Study was commissioned by Cambridgeshire County Council on behalf of Cambridge City Council and South Cambridgeshire District Council in response to emerging developer proposals for a major food store to be located in North West Cambridge (NWC). This study is designed to complement the Supplementary Retail Study (SRS), which has been investigating the potential for retail provision in terms of trading levels and viability, but not from a transport perspective.

The key requirements of the study have been to:

- Understand the transport implications arising from the location of a new major food store in one or more of the local centres, with reference to the wider City and South Cambridgeshire areas;
- Understand the ability of a new major food store in one or more of the main development sites to contain trips within NWC relative to a base of the small supermarkets currently envisaged in each local centre, consistent with current planning policy and;
- Produce a range of transport data outputs for each option including impacts on travel times, distances and carbon emissions.

The three development sites that make up NWC are known as the University site, the NIAB site (consisting of NIAB 1 and NIAB Extra) and Orchard Park. The proposals are that by the time the sites are fully developed in 2021 there may be a need for either a single large store of approximately 5,500 m^2 Gross Floor Area (GFA) located on one of these sites, or alternatively two smaller stores of approximately 3,000 m^2 GFA on two of the three sites. The purpose of this study has been to investigate the traffic impacts arising from food store provision in NWC in a number of different scenarios as summarised in the table below.

Scenario	University	NIAB	Orchard Park
Planned Development Only	Current Policy Provision Only	Current Policy Provision Only	Current Policy Provision Only
Test 1	5,500 m^2 store	Current Policy Provision Only	Current Policy Provision Only
Test 2	Current Policy Provision Only	5,500 m^2 store	Current Policy Provision Only
Test 3	Current Policy Provision Only	Current Policy Provision Only	5,500 m^2 store
Test 4	3,000 m^2 store	3,000 m^2 store	Current Policy Provision Only
Test 5	3,000 m^2 store	Current Policy Provision Only	3,000 m^2 store
Test 6	Current Policy Provision Only	3,000 m^2 store	3,000 m^2 store

In undertaking this work, a wide range of indicators have been considered including the ability of a store in NWC to source a large proportion of its custom from the immediate vicinity; the car and non-car mode shares of trips to a new store; the carbon impacts of a new store both locally and across the wider

Cambridge City and South Cambridgeshire areas; and the impacts on traffic delays at junctions in the area surrounding NWC.

Key Findings

At a wide geographical area (covering Cambridge City and South Cambridgeshire), the inclusion of additional new food store(s) in NWC results in an overall reduction in traffic impacts as indicated by carbon dioxide emissions and distance travelled. However, at a more localised level (NWC and its immediate surroundings), the traffic impacts are slightly worse; this is because the provision of a new store in NWC draws in traffic from the surrounding area causing an increase in delays and emissions as it converges on the new store, but in doing so it reduces travel distances and delays for many more wider trips and thus overall trip lengths and carbon impacts are reduced.

In terms of travel time and travel distance, stores in any of the locations are more accessible than the existing stores, and the introduction of one or more new stores leads to a bigger reduction in average travel times and distances across the whole modelled area. An analysis of the impacts on key junctions in the local area shows that the access points to each site are put under greater stress as a result of a new store and more detailed junction design work will be required to determine whether these impacts can be satisfactory mitigated.

The proposed mix and density of land use at each site is a key determinant in the relative performance of each test scenario; the University site has the highest density of proposed dwellings (owing in part to the provision of student accommodation), which enables a store on this site to have the lowest car mode share in comparison to the other scenarios tested. However, the non-car mode shares of trips to any of the proposed new stores in NWC are at least as high as those to the best existing stores (in terms of highest non-car mode shares), indicating high levels of walking and cycling trips to the proposed new stores. The test scenarios all measure the impacts of additional retail provision over and above the policy baseline, which varies across the different sites; however the University site has the smallest proportionate increase in retail provision and this contributes in a large part to tests with a store on the University site performing better.

Provision of a major new food store in NWC also allows a large proportion of food shopping trips to be internalised; the new store locations are all able to draw a high proportion of their custom from the local area, which contributes towards the higher share of non-car modes. New stores in any of the proposed locations also have the potential for intercepting “pass-by trips”, i.e. traffic which would have been travelling along Madingley Road, Huntingdon Road or Histon Road and which could link a shopping trip to another journey purpose. The stores located nearer to Huntingdon Road will tend to benefit most from this effect.

The analysis also shows that the test scenarios with two smaller stores perform better than those scenarios which consider a single larger store; stores on two sites achieve better mode share for non-car modes, attract their custom from a smaller area of influence and are able to provide a ‘local’ facility to a greater number of dwellings.

When considered from the perspective of a wider geographical area, the analysis of an additional major food store in North West Cambridge indicates that the scenario with two smaller stores on the University and NIAB sites performs better in transport terms, given the data gathered in the SRS. This is because the new stores are well located to maximise non-car mode shares, attract their custom from a smaller area of influence and are best placed to attract pass-by trips from Huntingdon Road.

Basis of Analysis

The transport modelling work has been carried out in the context of existing planning policy and the SRS, ensuring consistency with both and by using robust, validated models.

A bespoke retail gravity model was created for the purpose of this study, taking its input data from sources that have been used in the SRS and ensuring consistency with previous work. This model considers the relative size and accessibility (in terms of travel distance and travel time) of existing convenience retail supermarkets and each proposed store, in order to determine the shopping trips that take place under each test scenario. The model was calibrated and validated against observed data from the SRS, prior to forecasting to 2021 assumptions (which include the addition of a major new food store in Northstowe).

Mode shares for major food shopping trips in Cambridge have been sourced from the SOLUTIONS study (a five year research programme which surveyed actual shopping trips in Cambridge), which provides a mode share for shopping trips according to shopping trip distances. The car-based shopping trips were then assigned to the road network in Cambridgeshire using the County Council's sub-regional land use and transportation model (known as CSRM), which has been constructed to latest DfT standards and guidelines for transport modelling. The 2021 forecasts of this model includes the full policy baseline land use assumptions for NWC, along with other background assumptions such as the A14 upgrade, major new developments such as Northstowe and other committed pipeline and expected developments. This provided a robust context for the traffic impacts of these retail tests to be assessed, and enabled the carbon impacts to be analysed taking into account road speeds and delays as well as the distance travelled.

1. Introduction

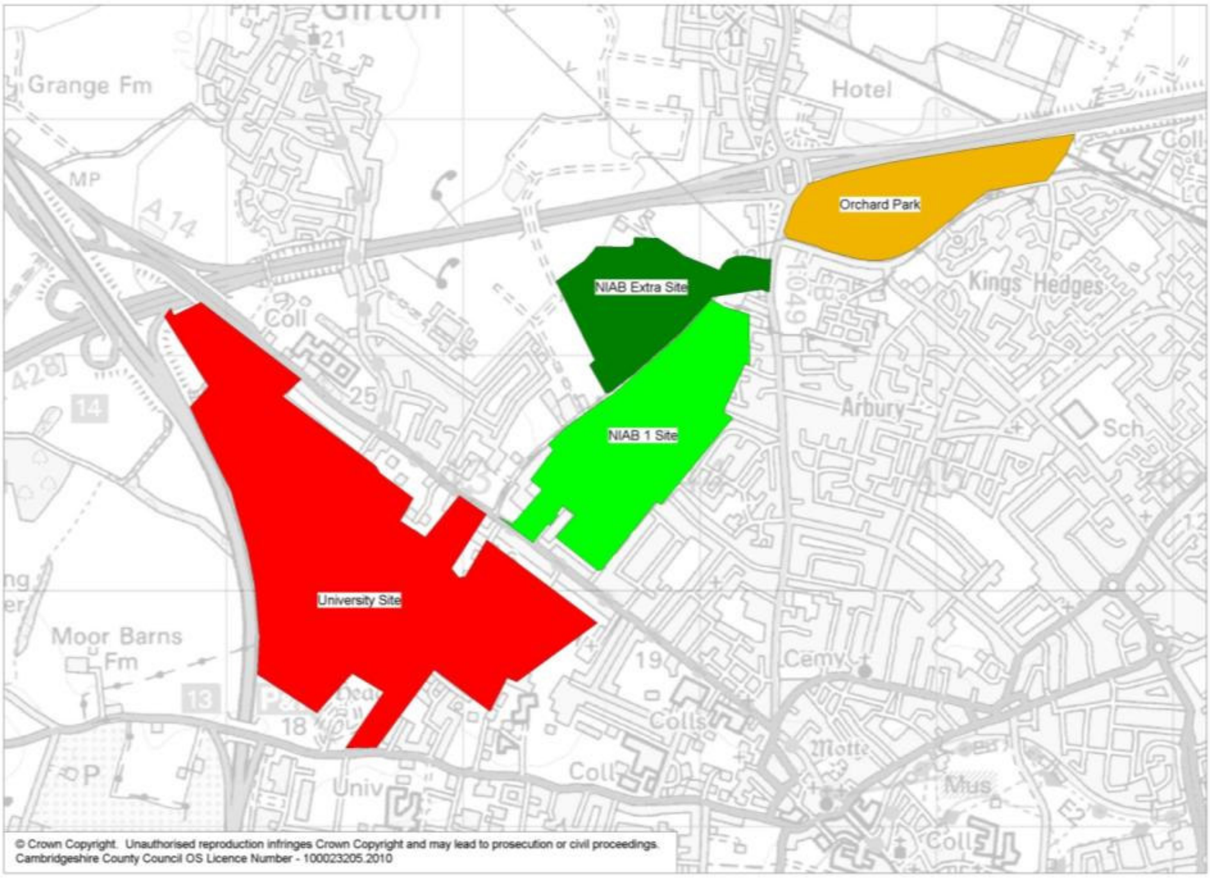
Background

1.1 Several large-scale developments are planned for the north-west quadrant of Cambridge, bringing thousands of homes and jobs to the area. The development of the North West quadrant of Cambridge is supported by planning policy as contained in:

- Cambridge Local Plan (2006) (policies saved in July 2009) – Policy 9/3 (Development in the Urban Extensions) and in relation to the NIAB site Policy 9/8 (Land between Huntingdon Road and Histon Road);
- South Cambridgeshire Local Development Framework – Core Strategy 2007 and Site Specific Policies Development Plan Document (DPD); and
- North West Cambridge Area Action Plan (2009), which covers the University Site.

1.2 North West Cambridge (NWC) is composed of developments at three main sites: the University site (between Madingley Road and Huntingdon Road), NIAB (between Huntingdon Road and Histon Road on the NIAB 1 and NIAB Extra sites) and Orchard Park (immediately east of Histon Road and south of the A14). These locations are shown in Figure 1.1.

Figure 1.1 – Development Site Locations



1.3 The nature and extent of development planned at each location is as follows:

- **The University Site** – a mixed-use development providing a new University quarter. This will provide approximately 3,000 dwellings with a priority on providing for University needs and approximately 2,000 units of student accommodation. There will also be academic facilities and associate research and development, and a local centre.
- **NIAB 1** – a new urban extension including housing and community facilities. The current plan is for 1,780 dwellings and a local centre including a primary school.
- **NIAB Extra** – this is allocated in the South Cambridgeshire District Council (SCDC) Site Specific Policies DPD. This will be a sustainable housing led urban extension of Cambridge, integrating with NIAB 1 and providing approximately 1,100 dwellings. A secondary school to serve the whole North West quadrant and a primary school will be provided within the development. An appropriate level of services, facilities and infrastructure will be provided either on the site or elsewhere in NW Cambridge, including local shopping and community facilities. It is likely that the local centre on the NIAB 1 site will be expanded to accommodate some of these facilities.
- **Orchard Park** – a permitted mixed use development of 900 dwellings with a local centre. A third of the housing is affordable and over half of the dwellings are now occupied. The SCDC Site Specific DPD provides for the change of some of the commercial parcels of land to residential which would result in approximately an additional 220 dwellings.

1.4 Local centres are planned for the main three sites – these will include an element of food store provision, but developer proposals have emerged for a major food store at one or more of the sites. A Supplementary Retail Study (SRS)[1] has been jointly commissioned by Cambridge City Council and South Cambridgeshire District Council (the Districts),in order to provide a more detailed retail planning evidence base for North West Cambridge to inform a view on the potential emerging proposals for food store development at one or more of the three proposed Local Centres. The SRS indicates that that all three locations have merit, with University and NIAB ranked similarly and Orchard Park ranked a close third. However, an assessment of the transport implications of the proposals was also needed to help inform the client team in making a judgement about the relative merits for locating one or more new convenience stores on one or more of these sites (if at all).

This Study

1.5 The purpose of this Retail Transport Study is to assess the transport and carbon implications arising from the inclusion of a major new convenience provision in NWC over and above existing allocations in policy as well as the case for no increase in provision (known as the Planned Development Only scenario). It has been commissioned by Cambridgeshire County Council (CCC) on behalf of the Districts.

1.6 The key requirements of the study are to:

- Understand the transport implications arising from the location of a new major food store in one or more of the local centres, with reference to the wider City and South Cambridgeshire area;
- Understand the ability of a new major food store in one or more of the main development sites to contain trips within NWC relative to a base of the small supermarkets currently envisaged in each local centre, consistent with planning policy and;
- Produce a range of transport data outputs for each option including impacts on travel times, distances and carbon emissions.

[1] North West Cambridge Supplementary Retail Study, Nathaniel Lichfield and Partners (NLP), February 2010

1.7 An important aspect of this study is that it should complement the SRS: for this reason, as far as has been possible, information from the SRS has been used as an input to this study. Data has been provided from the SRS by Nathaniel Lichfield and Partners (NLP) and The Cambridge Sub-Regional Retail Study 2008 undertaken by GVA Grimley This study has been carried out in conjunction with the client team and has benefited from inputs from the Officers of all three clients as well as direct contact with NLP.

1.8 The base year of this study is 2008, to tie in with the GVA Grimley interview data. The forecast year for this work is 2021; this was determined by the client team as the most appropriate forecasting horizon by which time all planned development at the sites was assumed to be complete. Details of the seven modelled scenarios (plus the base) which were provided by the client team can be found in Appendix A, including the number and average density of dwellings on each development site and the sizes of the proposed food stores in each scenario.

1.9 It is beyond the scope of this study to consider the phasing of any developments, or how any delays in other schemes (such as the A14 improvements) would impact on the forecast situation. However, phasing is discussed and considered in the “Further Work” section at the end of this report.

Structure of the Report

1.10 Following the Introduction, this report is structured as follows:

- Chapter 2 – Technical Approach – outlines the need for a Gravity Model, the construction and calibration of the Base Year Gravity Model and the forecasting to produce a detailed transport analysis;
- Chapter 3 – Gravity Model Forecasts – analyses the outputs from the Gravity Model across the whole study area and begins to build up a picture of which scenarios perform better than others;
- Chapter 4 – Cambridge Sub-Regional Model Forecasts – looks at the detailed transport outputs and draws together further analysis of the strengths and weaknesses of the different scenarios from a transport point of view; and
- Chapter 5 – Summary and Findings – collates the evidence from both the Gravity Model and the Cambridge Sub-Regional Model (CSRM), and considers how the different Tests perform against key planning objectives for development of the NWC quadrant.

1.11 In addition, Appendix A contains the detailed inputs to the forecasting information as provided by the clients.

2. Technical Approach

Introduction

2.1 This chapter discusses the availability of existing traffic and land use models and their suitability and limitations in relation to the transport modelling requirements for this study as the basis for developing a bespoke retail gravity model. It then sets out the basis of developing the Gravity Model and provides more details about the inputs and processes involved in using this model.

Applicability of Existing Models

2.2 The developers of each site have undertaken broad transport assessments of their developments as a whole, but there is insufficient detail in this modelling to allow full investigation of the retail options, and the modelling for the different developments has not been carried out in a consistent manner. Although transport modelling would be carried out for individual proposals (e.g. food stores, hotels, etc.) at each of the sites, this would be on a case-by-case basis and as such would not provide for a comparison to be made between the options being considered in the SRS and this study.

2.3 Strategic modelling was carried out by Atkins on behalf of CCC for input into the planning policy documents. Whilst this was useful in assessing the overall potential for development in the NWC area, it does not contain enough detail for this study. It has also been superseded by more recent and more detailed strategic modelling, described below (see paragraph 2.5).

2.4 The analysis that was carried out for the SRS was from a retail perspective, rather than a transport perspective: it was for this reason that a separate transport study was commissioned.

2.5 CCC has in its possession a transport and land use interaction model, which was built according to the latest DfT guidelines for the Transport Innovation Fund (TIF) bid and the A14 improvement scheme. This is known as the Cambridge Sub-Regional Model (CSRM). The transport highway network element of this model was built by Atkins using the SATURN software suite, while the land use element was constructed using bespoke software developed by WSP. The transport and land-use elements feed information back to each other and transport forecast outputs are available at five year intervals from 2006 (the base year) to 2031 inclusive. The basic road structure of the NWC developments as indicated in the planning policies and masterplans is included within the transport element of the model, with a 20mph speed limit for internal site roads in the NIAB and University sites. However, since the model encompasses much of Cambridgeshire, the representation of the NWC quadrant in land use terms is much less detailed. Consequently, there are several issues with using CSRM on its own for the purposes of this study:

- The development plots in NWC are in different CSRM transport zones but the model structure offers limited scope for modelling internalisation of trips within developments;
- The CSRM cannot readily model the effects of the precise location of stores within a transport zone;
- The CSRM land use zones are larger aggregations of the transport zones, and therefore allow even less precise location of developments within the model; and
- The CSRM also does not distinguish food shopping trips in isolation; these are encompassed within a general retail trip making function which includes non-food shopping trips. As a result, the number of shopping trips in the CSRM 2021 Planned Development Only scenario[2] in this study could be lower than would be expected if these developments were considered

[2] The Planned Development Only scenario describes the situation in 2021 as is currently envisaged in planning policy. See paragraph 3.2 for further details on the scenarios being tested in this study.

in isolation. This may mean that the localised base line levels of congestion may not be fully reflected and this would impact on the absolute results from the Test scenarios. Whilst acknowledging this, the performance of each Test *relative to each other and to the Planned Development Only scenario* is still valid for comparative purposes, and this limitation has been borne in mind during the analysis of results.

2.6 For these reasons, as well as a need to make best use of the SRS analysis and GVA Grimley survey data in this transport study, it was necessary to construct a bespoke retail Gravity Model which would be informed by both the wider predictions of land use and transport interaction from the CSRM, but which could in turn more accurately inform an assessment of the highway implications arising from the inclusion of a major new convenience store using the SATURN highway networks developed for CSRM. The following sections provide a more detailed explanation about the construction of the retail Gravity Model and how it interacts with CSRM.

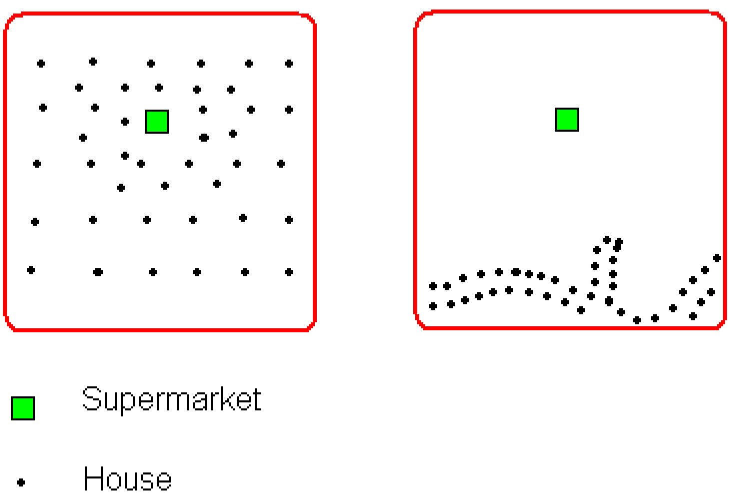
Gravity Model

2.7 As discussed in the previous section, none of the existing transportation models fulfils the requirements of this retail study. For this reason, a bespoke Gravity Model has been created, drawing information from the SRS and the CSRM wherever possible in order to create a consistent modelling base whilst also being able to provide outputs at the level of detail required by this study.

2.8 In transport modelling, a gravity model provides a means of distributing trips between origins and destinations, based on the 'production potential' of origins, the attractiveness of destinations, and the cost of travelling between the two. As its name suggests, it is based on an analogy with the law of gravity in physics, whereby the gravitational 'pull' of an object decreases with distance from it, and is dependent on the size of the object. In the context of this study, the 'production potential' of origins describes the number of households and their propensity to go shopping in the study area; the attractiveness of destinations is based on the store size; and the cost of travel is determined by a combination of the time and distance between the origin and destination.

2.9 The Gravity Model is built at an 'Address Point' level, giving a fine level of detail and enabling the model to differentiate between different store locations within the same development, and to represent the actual locations of dwellings in relation to stores. So, for example, if the red box in the diagrams below represents a CSRM zone, the two situations will be treated differently by the Gravity Model, whereas they would have been assumed to be the same in the CSRM. This finer level of detail allows the behaviour of the local trips to be more accurately assessed including the representation of mode choice.

Figure 2.1 – Illustration of Different Housing Distributions

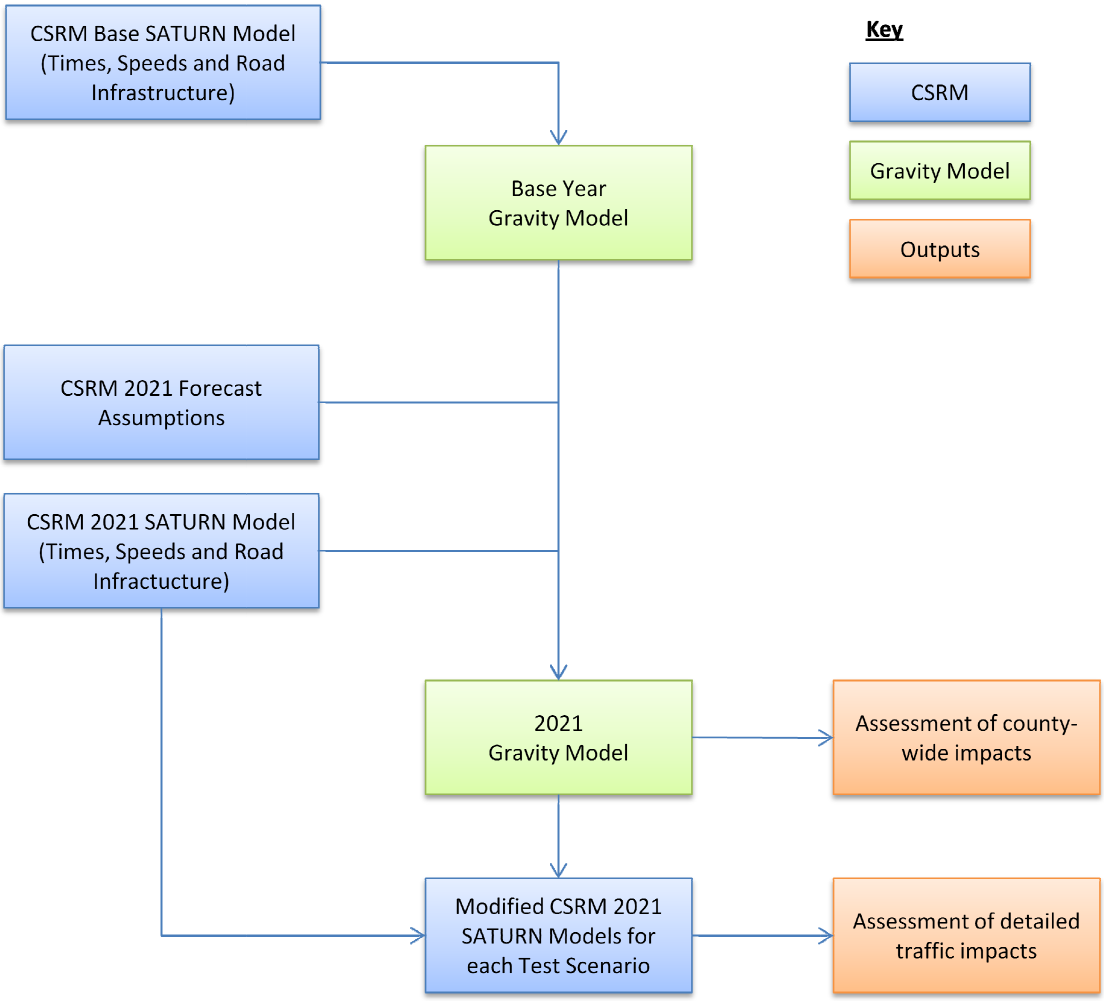


2.10 The Gravity Model was created and calibrated for the GVA Grimley survey base year (2008), and includes trips to all major food stores that the SRS determined to service the NWC area. (This list of stores can be found in paragraph 2.17.) The resulting catchment area of the Gravity Model can be found in Figure 2.4. Future year (2021) forecasts have been created by adding to the Gravity Model forecast dwellings across the whole study area and the new major food stores that are proposed to serve NWC under six scenarios.

2.11 In addition to the changes to the Gravity Model for the future year, inputs have been taken from the CSRM 2021 forecasts (including changes to the road network, growth in general traffic levels and major developments in other areas of the Cambridge Sub Region). For the purpose of this study, the CSRM forecasts have been updated by WSP on behalf of the client team to reflect the most up-to-date position with respect to the expected committed pipeline of developments in NWC. This includes information about dwellings, key worker accommodation, student accommodation, education (school pupils and employment of staff), research floorspace, retail floorspace and commercial floorspace. The details of this update (inputs and results) have been presented separately by WSP in their technical note "TN001 CSRM Updates for NW Cambridge ISSUED Rev 1.pdf", issued on 9th April 2010.

2.12 The detailed modelling outputs from the Gravity Model were then fed back into the 2021 CSRM (updated to reflect the latest development and infrastructure assumptions in NWC) in order to assess the wider traffic and carbon impacts of each scenario. The interactions between the CSRM and the Gravity Model, both in the base year and in the future year are illustrated in Figure 2.2.

Figure 2.2 – Flow Diagram showing CSRM and Gravity Model Interaction



Inputs and Assumptions

2.13 Table 2.1 lists the data that was gathered together for input into the Gravity Model, along with its source, any limitations noted and compatibility with the SRS and CSRM.

Table 2.1 – Input Data

Source	Description	Compatibility / Limitations
Ordnance Survey Address Points	The locations of all address points in Cambridgeshire	This provides a fine level of detail that can be aggregated for compatibility with both the SRS and CSRM.
2001 National Census, Table UV62	Households per ward, by car availability	Ward-level data is compatible with the CSRM and other forecasting data.
Cambridgeshire County Research Group (CCRG)	Population growth factors from 2001 to 2008, by ward	Ward-level data is compatible with the CSRM and other forecasting data.
GVA Grimley Household Survey interview data	Shopping pattern data: part of home postcode (e.g. CBx x), and usual destination for (i) main shopping and (ii) small-scale 'top-up' shopping	This very coarse data is not directly compatible with Ward boundaries or the CSRM, but has been converted to the Address Point level to give a 'smoothed' estimate of home addresses which can then be aggregated to Ward or CSRM level. **It should be noted that** this data has very low sample sizes[3], and that the survey does not reveal the shopping trip origin, or the frequency of main and top up shopping trips.
SRS (NLP)	Sizes of stores in m^2 GFA (except where unknown, when net has been converted to gross floor area based on a 65% net: gross ratio).	The list of stores included in the Gravity Model has been selected to ensure compatibility with the SRS.
TRICS database	Person trip rates for different categories of store	The categories of store have been taken from the SRS to maintain compatibility.
CSRM SATURN models	Time and distance values between each origin and destination for base and future years, along with corresponding generalised cost parameters	Perceived travel costs (in terms of Generalised Cost – see paragraph 2.21) in the Gravity Model maintain compatibility with the CSRM by using these inputs.
SOLUTIONS study[4]	Modal split information	For trips under 4.4 km in length, the modal split has been derived from the information provided; for trips longer than this, the car share has been assumed to stabilise at 98%.

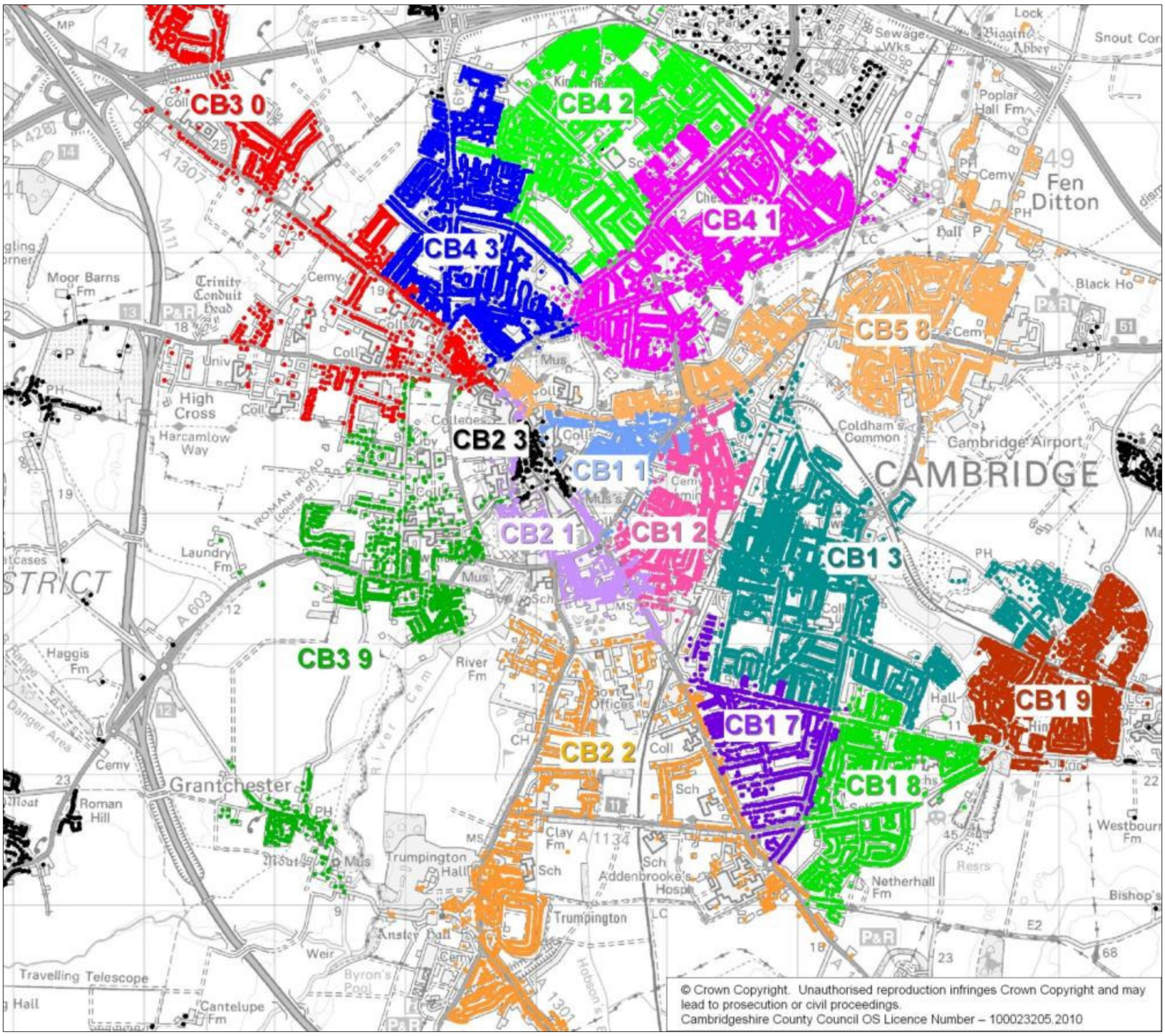
[3] The sample size of interviews to minor food stores within the SRS Primary Catchment Area was 42 in total, of which 32 originated within the SRS Secondary Catchment Area (with some of the remaining 10 interviews being from as far afield as Milton Keynes and Bury St Edmunds). The sample size of interviews to the major food stores that service NWC was 425, which reduced to 412 when the most extreme results were discarded. See paragraph 2.18 for details of these catchment areas.

[4] The SOLUTIONS (Sustainability Of Land Use and Transport In Outer Neighbourhoods) study was a five year research project conducted by academics from five universities, which focused on four cities – Cambridge, London, Tyne and Wear and Bristol. It was funded by the Engineering and Physical Research Council (EPSRC) with support from central and local authorities including Cambridgeshire County Council. http://www.suburbansolutions.ac.uk

Source	Description	Compatibility / Limitations
CSRM land-use model	2021 dwelling, by CSRM transport zone	CSRM transport zones are easily converted to wards to provide ward-level forecasting
The Districts	Detailed information about the locations of dwellings and stores proposed in NWC	Information was provided directly by the client team at the finest level of detail currently available, with information about relative densities of different parts of each development to enable estimation of 2021 Address Points

2.14 As indicated in Table 2.1, the GVA Grimley interview data only recorded part of the home postcode for each interview, which does not give a fine level of detail about the origin of shopping trips. Figure 2.3 below shows the Address Points within some of these postcode areas in Cambridge, giving an indication of the coarseness of the data.

Figure 2.3 – Postcode Areas in Cambridge



Details of the Gravity Model

2.15 As indicated above, the Gravity Model draws data from the SRS and feeds back into the CSRM, so compatibility with both models had to be maintained as closely as possible. Although the Gravity Model works at an address point level (which is finer in detail than either the SRS or the CSRM), its data ultimately has to be aggregated to CSRM zones, which are based closely on the ward structure of the county. Also, population estimates and forecasting are available at a ward level. For these reasons, the study area and any other aggregations made in the Gravity Model are based on wards, rather than the coarse postcode areas that were used in the SRS.

2.16 The Gravity Model concentrates on major food stores (greater than 2800m^2 GFA) only. The categorisation of different sizes of store is based on the breakdown used in Map 2: Catchment Area and Foodstores, Appendix 1 of the SRS: namely, Small stores are those up to 1000m^2 Retail Floor Area (RFA) (~1500m^2 GFA); Medium stores are 1000-2500m^2 RFA (~1500-2800m^2 GFA); Large stores are 2500-5000m^2 RFA (~2800-7700m^2 GFA); and Very Large stores are greater than 5000m^2 RFA (~7700m^2 GFA). Small and Medium stores are classified as 'minor'; Large and Very Large are 'major'. There are several reasons for not including minor stores in the Gravity Model:

- The minor stores (both existing and pipeline) are already included in the CSRM: this study needs only to investigate the traffic impact of increasing the size of one or more of these stores, or opening a new store, not the baseline impact of the minor store itself;
- The sample size of the GVA Grimley interview data to the minor stores in the SRS Primary Catchment Area is very small and does not provide a reliable basis for calibrating a Gravity Model of minor stores;
- The GVA Grimley interview data does not include any indication of the frequencies of 'main shop' or 'top-up shop';
- The GVA Grimley interview data gives only part of the home postcode and the shopping destination, not the actual origin of the trip: in practice, many 'top-up' shopping trips are combined with another journey (e.g. on the way home from work) and therefore should not be modelled as a full trip to and from their place of residence;
- The traffic impact of trips to minor stores is expected to be much less than for a major store because they are more dominated by localised trip making which are less reliant on cars and also because they have a greater propensity for 'pass-by' linked trips (the SOLUTIONS study found car mode share for top up shopping in Cambridge to be substantially less than for major food stores); and
- The SRS has already investigated the quantitative and qualitative need for additional main food store provision, so there is no need to repeat this analysis in the transport work.

Base Year Construction

Coverage of the Model

2.17 It was agreed with the client team that the following existing major food stores should be included within the Gravity Model:

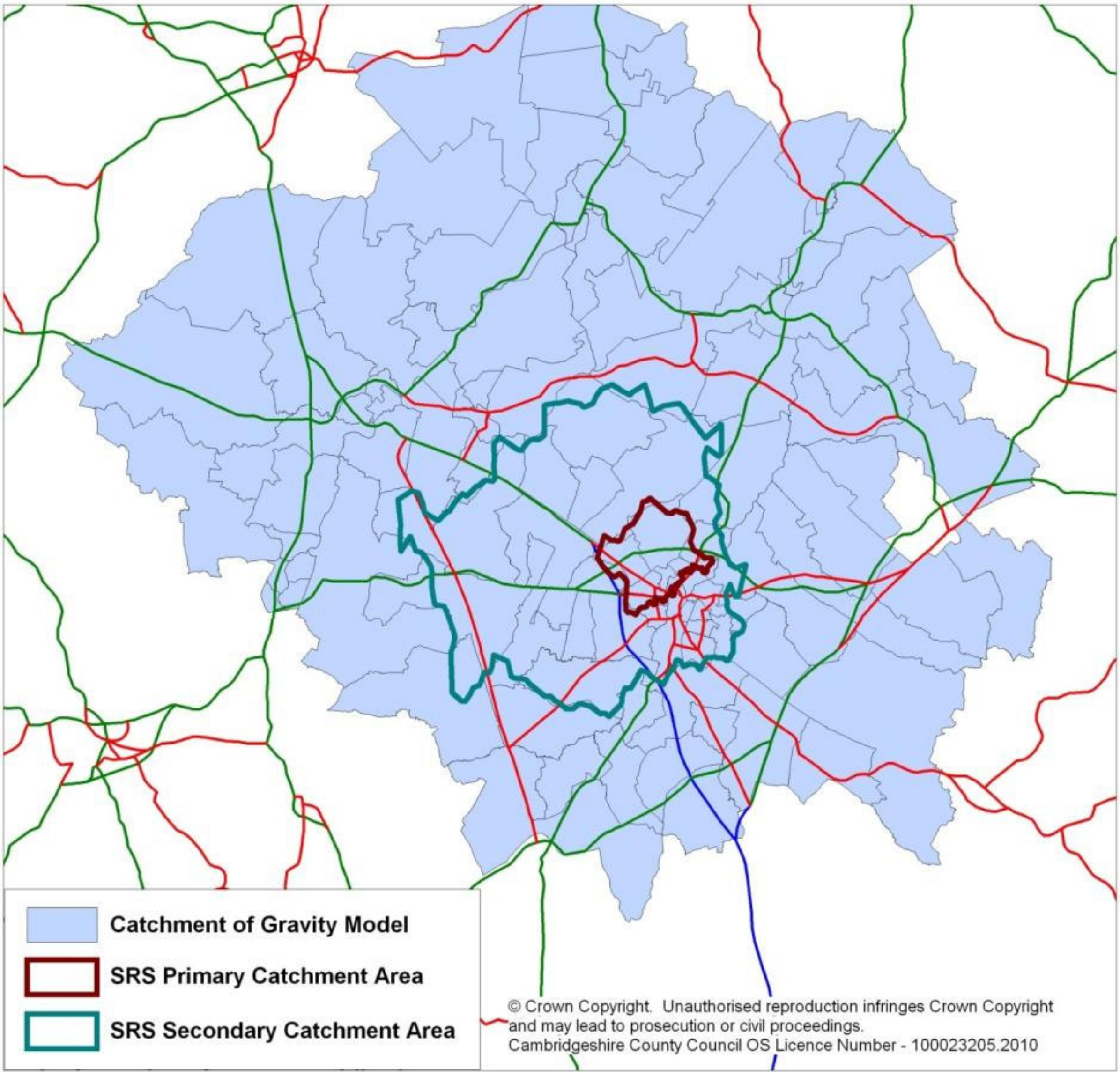
- Bar Hill Tesco Extra;
- Milton Tesco;
- Newmarket Road (Cheddars Lane) Tesco;
- Cherry Hinton (Yarrow Road) Tesco;
- Beehive Asda;

- Coldham's Lane Sainsbury's;
- Trumpington Waitrose; and
- Cambourne Morrisons.

2.18 Milton Tesco is on the borderline between the major and minor food store categorisations: it was agreed that this store should be classified as 'major' due to its proximity to NWC and its behaviour as studied in the SRS. It is also relatively unusual for a store of this size to have a petrol station. In addition, Milton Tesco is known to be easily accessible and visible from the A14, but this is not represented in the GVA Grimley observed data since information about 'pass-by' trips cannot be derived from home postcodes.

2.19 The study area of the Gravity Model is defined as the wards from which at least 95% of the trips to these stores originate; this area covers most of Cambridgeshire, excluding 19 wards in the north and one in the south-west and this has been derived directly from the GVA Grimley survey data. This catchment of the Gravity Model is illustrated in Figure 2.4 (with the boundaries of the wards it is made up of), along with the Primary and Secondary Catchment Areas determined by the SRS.

Figure 2.4 – Study Catchment Area



Gravity Model Formulation

2.20 The basic gravity model takes the following formulation, known as the combined power and exponential function:

$$F(C_{ij}) = C_{ij}^{X_1} e^{X_2 C_{ij}}$$

where *Cij* is the generalised cost between each origin and destination, and X_1 and X_2 are calibration parameters.

2.21 Generalised cost is a combination of travel time and distance, expressed as a monetary cost in pence based on DfT valuations of the cost of time for personal travel as well as fuel and non-fuel elements of travel costs. DfT guidelines recommend that generalised cost be used in preference to pure time or pure distance in transport modelling. Using generalised cost as opposed to distance means that the ease of access to more distant retail locations (such as Bar Hill Tesco Extra) can reflect the higher speeds attainable on dual carriageway or de-restricted non urban routes.

2.22 The process of the Gravity Model is as follows:

- For each origin to destination (address point to store) movement, the value of the function F given above is calculated.
- Use the Furness process[5] to refine the outputs of the function F to give a matrix of trips whose total trips per address point match the expected values and whose total number of trips to each major food store match the target values from TRICS.

2.23 This is a doubly-constrained gravity model, meaning that both the origin and destination trip end totals are matched to predetermined totals. To implement this, the Furness process is employed to calculate factors to match each origin total to its target, then match each column total to its target total, and iterate repeatedly until a converged answer is reached (i.e. each row total and each column total matches its target). However, there are often many solutions to this problem (different arrangements of numbers within the table that still give the same row and column totals), so it is important that the input function F is of a robust form. This is achieved by calibrating the parameters X_1 and X_2 to give the closest match to the Trip Cost Distribution of the GVA Grimley observed data.

2.24 The TRICS database has been built up over many years, and contains traffic survey information from thousands of sites across the UK. These sites are categorised in detail according to their purpose – including supermarkets, offices, swimming pools, places of worship and many other categories. Within each purpose category, locations are also categorised (such as town centre, edge of town, rural) as well as different geographical areas (London, rural, Scotland). For each site, rates of arrivals and departures are given by hour.

2.25 In the context of food store trip rates, the dataset can be further refined according to the size of the store, allowing different trip rates to be extracted for the different sizes of store (see paragraph 2.16) – though a careful balance needs to be struck between specifying the exact nature of the site required and maintaining a large enough sample to give accurate estimates of trip rates. In practice, the food store trip rates extracted for this study were done according to the size categorisation of the store, though there was little variance between the categories.

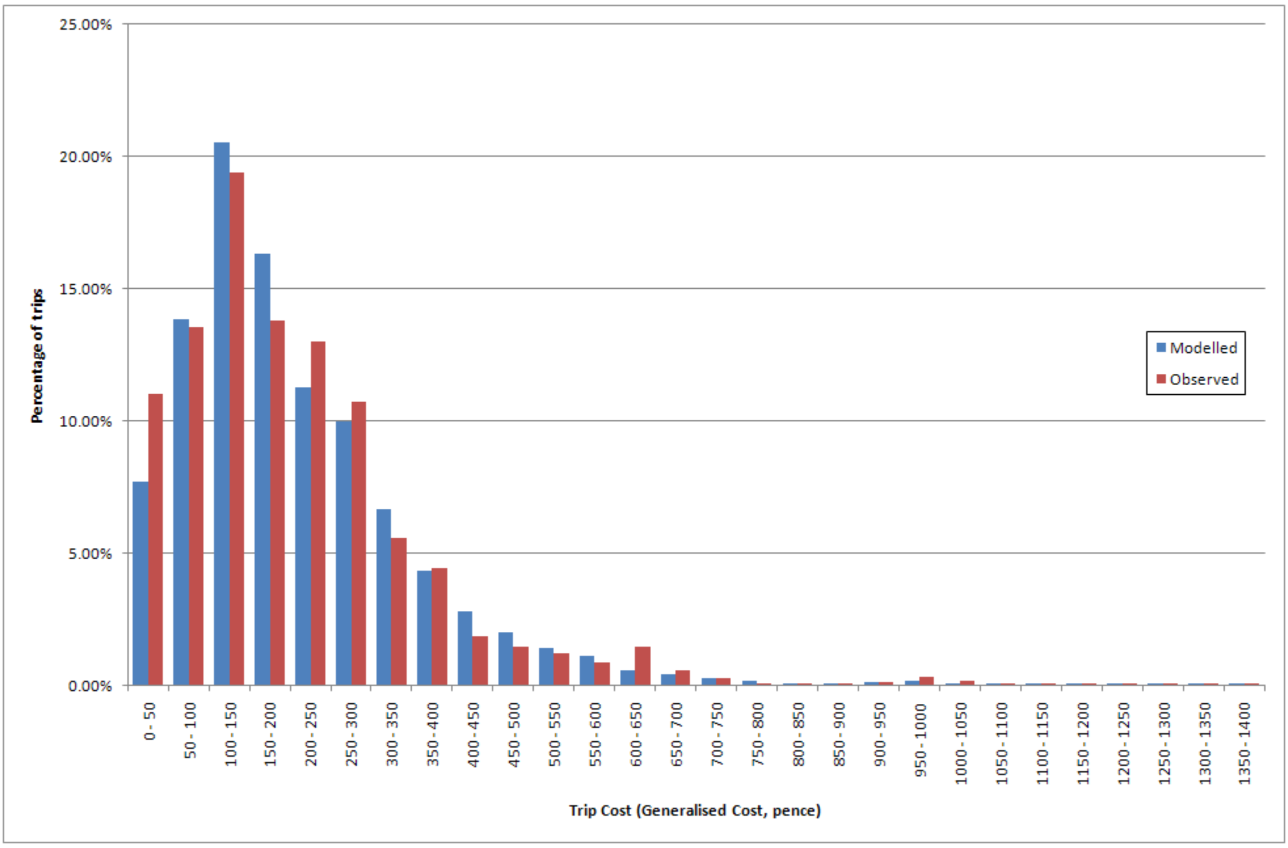
Gravity Model Calibration/Validation

2.26 Figure 2.5 shows the Trip Cost Distributions of the Observed (red) and Modelled (blue) data. The R^2 coefficient of variation is 0.971, indicating that the observed and modelled data is very well correlated. (The R^2 value is a measure of statistical fit between two sets of data: a value of 1

[5] The Furness process works by factoring each row to its target total, then factoring each column to its target total, and iterating repeatedly until a converged answer is reached.

would indicate a perfect match.) The analysis shows that a good degree of confidence can be placed on the ability of the gravity model to forecast responses to changes in the provision of major retail food stores.

Figure 2.5 – Modelled and Observed Trip Cost Distributions



2.27 Figure 2.5 shows the tendency towards longer-distance trips being recorded in the observed data, and that the Gravity Model is able to replicate this. Figure 2.5 also shows that there is a shortfall in the number of modelled lowest cost (shortest distance) trips, which causes the Gravity Model's average trip cost to be greater than that of the observed data. This means that the Gravity Model will tend to overestimate slightly the costs of trips and therefore predict a more pessimistic (high cost) outcome.

2.28 Table 2.2 displays the GVA Grimley observed data, the TRICS predictions and the Gravity Model outputs in terms of the number of trips to each major food store. The GVA Grimley observed data has been expanded from a sample of 412 interviews to a total of 61,659 trips as estimated by TRICS. A small discrepancy in the interview data can therefore cause a much larger difference when scaled by this amount. The fourth column shows the outputs from the Gravity Model, which match the TRICS estimates exactly. The final column gives an indication of the 2008 trading levels of each of these food stores (based on the GVA Grimley household survey) relative to their company average, derived from data provided in the SRS Report appendices (apart from the Cherry Hinton Tesco which is based on an NLP assessment). In this column, the = symbol means a store is trading within ±10% of its company average; ↑ and ↓ represent over and under trading by between 10% and 50%, respectively; and ↑↑ and ↓↓ represent over and under trading by more than 50%, respectively.

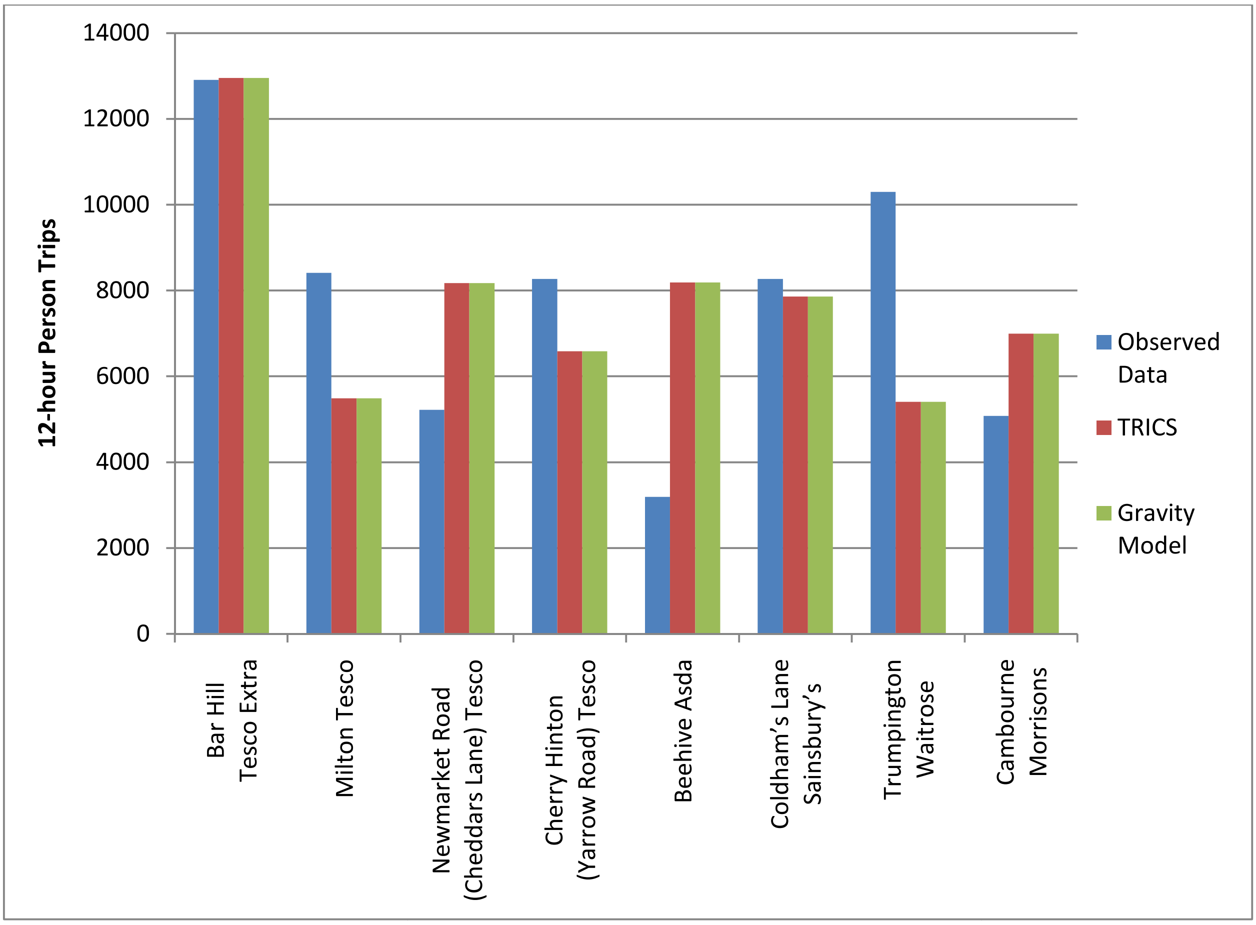
2.29 Following the table, Figure 2.6 shows the observed and estimated 12-hour person trips in a bar chart format.

Table 2.2 – Number of Trips to each Major Food Store

Store	Observed Data (Sample of 412 expanded to 61,659)	TRICS Estimated 12-hour Person Trips	12-hour Person Trips from Gravity Model	Trading Performance Relative to Company Average
Bar Hill Tesco Extra	12,912	12,956	12,956	=
Milton Tesco	8,415	5,488	5,488	↑↑
Newmarket Road (Cheddars Lane) Tesco	5,223	8,171	8,171	↓
Cherry Hinton (Yarrow Road) Tesco	8,270	6,586	6,586	↑
Beehive Asda	3,192	8,188	8,188	↓↓
Coldham's Lane Sainsbury's	8,270	7,861	7,861	↑
Trumpington Waitrose	10,301	5,409	5,409	↑
Cambourne Morrisons	5,078	6,999	6,999	↓
Total	*61,659*	*61,659*	*61,659*	

NB: The numbers displayed in this table do not add up due to rounding.

Figure 2.6 – Number of Trips to each Major Food Store



Summary of Gravity Model Performance

2.30 Figure 2.5 shows that the Gravity Model is functioning very well on overall trip cost distributions. Table 2.2 and Figure 2.6 show that the Gravity Model is also matching the TRICS estimates of the number of trips to each store, but that this does not always agree with the GVA Grimley survey data. This is particularly witnessed in the discrepancies for Milton Tesco, Newmarket Road (Cheddars Lane) Tesco, Beehive Asda and Trumpington Waitrose. Potential reasons for this are:

- The small sample size of the GVA Grimley interview data, meaning that a small discrepancy in the interviewed sample would cause a large discrepancy when scaled up to the total number of trips visiting these eight major food stores;
- Potential issues of brand loyalty and personal choice (e.g. Waitrose versus Asda), which cannot be picked up in this modelling;
- Some stores are over or under trading (as indicated in the SRS) – for example, Milton Tesco is known to be overtrading and so the GVA Grimley observed data suggests a higher number of trips to this store than the TRICS database does, while Beehive Asda is undertrading and so the observed data suggests fewer trips than the TRICS database; this cannot be replicated in the Gravity Model; and
- The method of collection of the GVA Grimley survey data – being collated by phone during the working day would impact on the socio demographics of the survey profile.

2.31 This shows that there is some limitation in the accuracy of the Gravity Model results, but there is no further empirical survey data that can help us refine our model to better replicate the trips for certain stores in the model.

2.32 The Gravity Model will be used to estimate the *differences* in trips to each store that are caused by the presence of a new store(s) in the future year scenarios, and therefore these discrepancies in the base year will not have a major impact in terms of the wider changes in travel patterns caused by the new store.

Future Year Construction

2.33 The Future Year Gravity Model is identical to the Base Year model in its operation. The calibrated values of X_1 and X_2 have been carried forward into all of the Future Year scenarios. The only differences between the Base and the Planned Development Only Gravity Models arise in the input data; these are:

- The list of address points has been expanded to take account of the new dwellings in NWC as accurately as possible;
- The number of dwellings elsewhere in the model has been increased in line with CSRM by increasing the assumed density of dwellings per address point: developments such as Cambridge East and Northstowe are not close enough to NWC for the exact locations of their dwellings to be required;
- An additional major food store has been included in Northstowe;
- The number of trips to major food stores has been increased to a level that is commensurate with the additional development between the Base Year and the Future Year; and
- Local centres have been included in the NWC developments as indicated in the information provided by the Districts (see Appendix A, Table A.3).

2.34 These changes are consistent with the inputs used in deriving the CSRM forecasts (see paragraph 2.11).

2.35 Each Test scenario has additional changes to reflect the situation being tested. Since there is already some level of retail provision in each location in the Planned Development Only scenario, the number of trips to the additional stores in the Test scenarios have been calculated only from the additional retail floorspace required to make up the total size. The differences between the Planned Development Only scenario and each Test are detailed in Appendix A. The trip rates and 'gravitational pull' for each store has been calculated using its full size – only the number of trips has been reduced to account for those already modelled in the Planned Development Only scenario.

2.36 It should be noted that the trip rates used in the CSRM are not consistent with those from TRICS that have been used in the Gravity Model; the CSRM makes no distinction between food shopping trips and other shopping trips. Consequently, the number of trips in the Planned Development Only scenario is likely to be an underestimate, and this shortfall would be carried through to all Test scenarios. This would not affect the comparisons between the Planned Development Only scenario and the Tests, but it does have an impact on any absolute trip numbers.

2.37 Whenever a new store is opened, there is more competition for the existing stores in the area. The number of major shopping trips made by residents of NWC is not dependent on a major food store being provided within NWC, and therefore remains constant throughout all of the 2021 scenarios. To analyse which stores are in competition with the new store(s) in a Test, the following steps are taken:

- The Gravity Model is run with a larger total number of trips than the Planned Development Only scenario, to identify the catchment area of the new store(s). This means that each household is temporarily making more shopping trips to maintain the target levels to each store.
- Any individual movements to an existing store that have increased in size are then reset to the Planned Development Only values, as those trips do not change their destination when the new store(s) are added.
- All other movements are identified as those whose destinations are affected by the opening of the new store(s). These movements are then scaled down so that the total matrix size for the Test is the same as the Planned Development Only scenario. In this way, the model determines how the new store(s) abstract trips away from the existing stores.

Feedback to the CSRM

2.38 The Gravity Model outputs 12-hour person trips. These trips are allocated to different modes (car or non-car) according to their distance and the mode share for "Food – Superstore" trips in Cambridge derived from the SOLUTIONS study (see footnote 4 on page 7). These car mode shares are given in Table 2.3.

Table 2.3 – Car Mode Shares for Major Food Stores in Cambridge based on SOLUTIONS Study

Distance (km)	Percentage by Car
0	0%
0.5	27%
1	49%
1.5	62%
2	72%
2.5	79%
3	85%

Distance (km)	Percentage by Car
3.5	90%
4	94%
> 4.4	98%

2.39 The numbers of people travelling by car are then converted to the number of car trips using occupancy data from the DfT's WebTAG documentation. These are then split further into AM Peak, Inter Peak and PM Peak using the time of day profile from the TRICS data, to be compatible with the CSRM SATURN model.

2.40 The above procedure is carried out for the Gravity Model outputs from the Planned Development Only scenario and all Test scenarios. The difference in trips is then calculated between the Planned Development Only scenario and each Test, and this difference is applied to the CSRM SATURN highway models, replacing existing shopping trips with the new pattern of trips as predicted by the Gravity Model.

2.41 The highway structure of the SATURN models does not change between the Test scenarios; the basic access to each site is not affected by the inclusion of a food store. As discussed in paragraph 2.5, the highway representation of each development site has the main infrastructure coded as 20mph roads.

2.42 The highway model then enables analysis of vehicle kilometres, carbon impacts, junction performance, etc. to be undertaken for each Test and the Planned Development Only scenario. For each Test scenario, the impact of the additional food store related car trips on the network is examined, highlighting issues of congestion and network performance in the wider modelled area.

Summary of the Technical Approach

2.43 In summary:

- None of the existing transport models were found to be suitable for the purposes of this study for a variety of reasons (for example, inconsistent modelling approaches across the different sites, or lack of detail in the NWC quadrant). Whilst CSRM has a land use model attached to it, it does not provide detailed enough coverage of NWC and thus it was necessary to construct a gravity model which would take information from the CSRM land use model and in turn inform testing of the various scenarios using the CSRM SATURN highway models for the future forecast year.
- A bespoke Gravity Model has been developed for this study using information supplied by the districts and that acquired by GVA Grimley in their survey of shoppers. The base year (2008) model has been shown to accurately replicate the spread of retail trips found in the survey, although at a individual store level there are some discrepancies resulting from wider factors including sample sizes of the data, brand loyalty and personal preferences, actual over/under trading of the stores, and the socio-demographic survey profile.
- The Gravity Model has been used to forecast the situation in 2021, taking into account planned development across the county including expected retail provision within the NWC sites' planning policy as well as a new major food store at Northstowe. The model has then been used to inform changes to the future 2021 highway models in the CSRM so that the impacts of each scenario can be analysed at a more detailed network level and produce forecasts of travel distance, time and emissions.

3. Gravity Model Forecasts

Introduction

3.1 Chapters 3 and 4 provide information on the outcome of the testing of the six scenarios for locating a major food store in NWC (and including information on the 'Do-Nothing' case where no additional major food store is provided). This chapter concentrates on analysis of the Gravity Model outputs, while Chapter 4 provides more detailed transport related information extracted from the SATURN highway model. A qualitative discussion of the implications of these results can be found in Chapter 5.

3.2 The six test scenarios, plus the Planned Development Only scenario, are detailed in Appendix A. In summary, these are:

- **Planned Development Only:** Defined as being all development sites as currently planned including provision of local stores but no new major food store. This provides our 'baseline' traffic networks for 2021 against which each of the tests below have been appraised; the SATURN models are unchanged from those produced by CSRM.
- **Test 1:** Minor store on University site upgraded to a major store (5,500 m^2 GFA)[6] and included in Gravity Model with appropriate adjustments made to the SATURN models; other sites unchanged.
- **Test 2:** Minor store on NIAB site upgraded to a major store (5,500 m^2 GFA) and included in Gravity Model with appropriate adjustments made to the SATURN models; other sites unchanged.
- **Test 3:** Minor store on Orchard Park site upgraded to a major store (5,500 m^2 GFA) and included in Gravity Model with appropriate adjustments made to the SATURN models; other sites unchanged.
- **Test 4:** Minor stores on University and NIAB sites upgraded to (smaller) major stores (3,000 m^2 GFA each)[7] and included in Gravity Model with appropriate adjustments made to the SATURN models; Orchard Park store remains unchanged.
- **Test 5:** Minor stores on University and Orchard Park sites upgraded to (smaller) major stores (3,000 m^2 GFA each) and included in Gravity Model with appropriate adjustments made to the SATURN models; NIAB store remains unchanged.
- **Test 6:** Minor stores on NIAB and Orchard Park sites upgraded to (smaller) major stores (3,000 m^2 GFA each) and included in Gravity Model with appropriate adjustments made to the SATURN models; University store remains unchanged.

3.3 Figure 3.1 shows the locations of the 2021 modelled major food stores for the Planned Development Only and Test scenarios and the locations of the proposed new major food stores. Figure 3.2 shows the locations and sizes (m^2 GFA) of the stores in NWC that are modelled in the Planned Development Only scenario: these are all minor stores and are not included in the Gravity Model as they are present in the CSRM forecasts. Figure 3.3 shows the locations and sizes of stores in each Test scenario. Note that the store on the Orchard Park site changes location, depending whether it is minor or major: these two locations are labelled C1 and C2, respectively.

[6] 5,500 m^2 GFA is equivalent to approximately 3,800 m^2 RFA or 2,500 m^2 net convenience floorspace.
[7] 3,000 m^2 GFA is equivalent to approximately 2,000 m^2 RFA or 1,500 m^2 net convenience floorspace.

Figure 3.1 – Major Food Store Location Plan

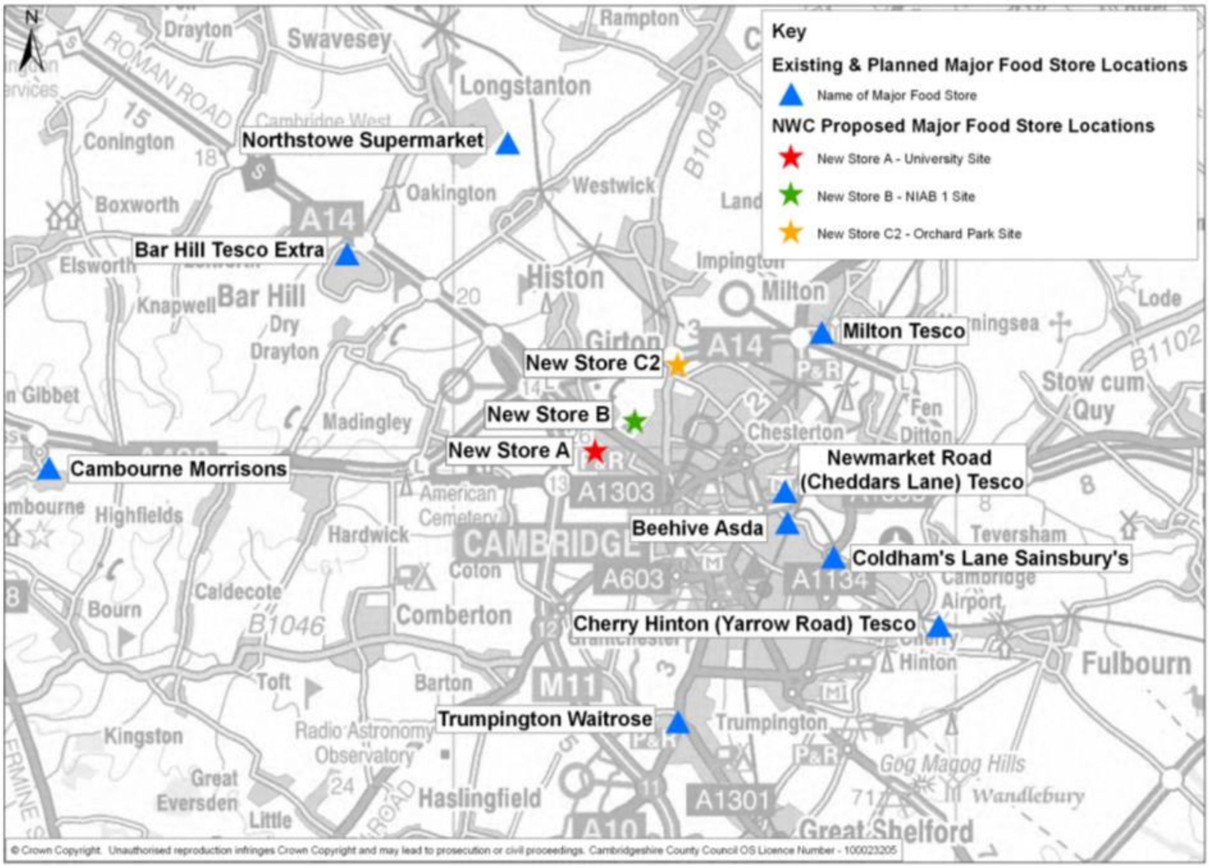


Figure 3.2 – Food Store Locations and Sizes (m^2 GFA), Planned Development Only

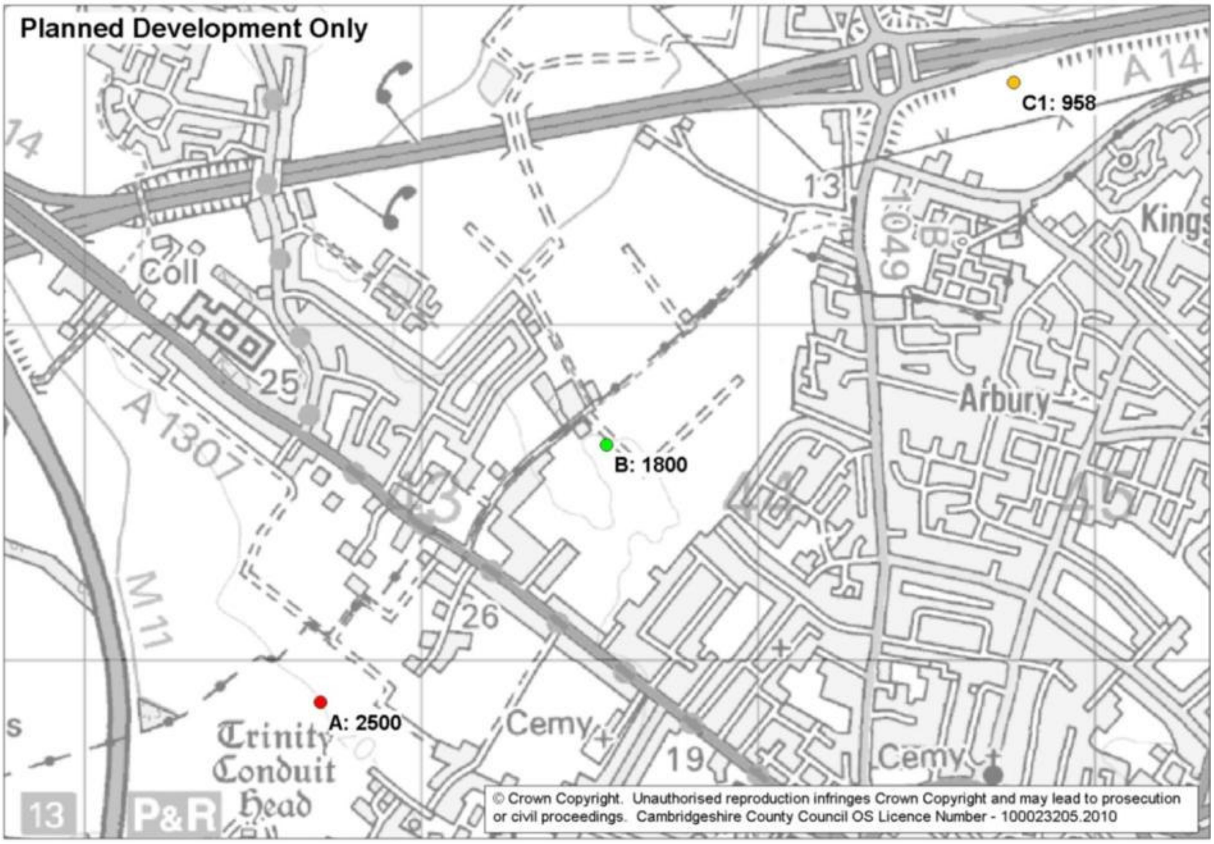
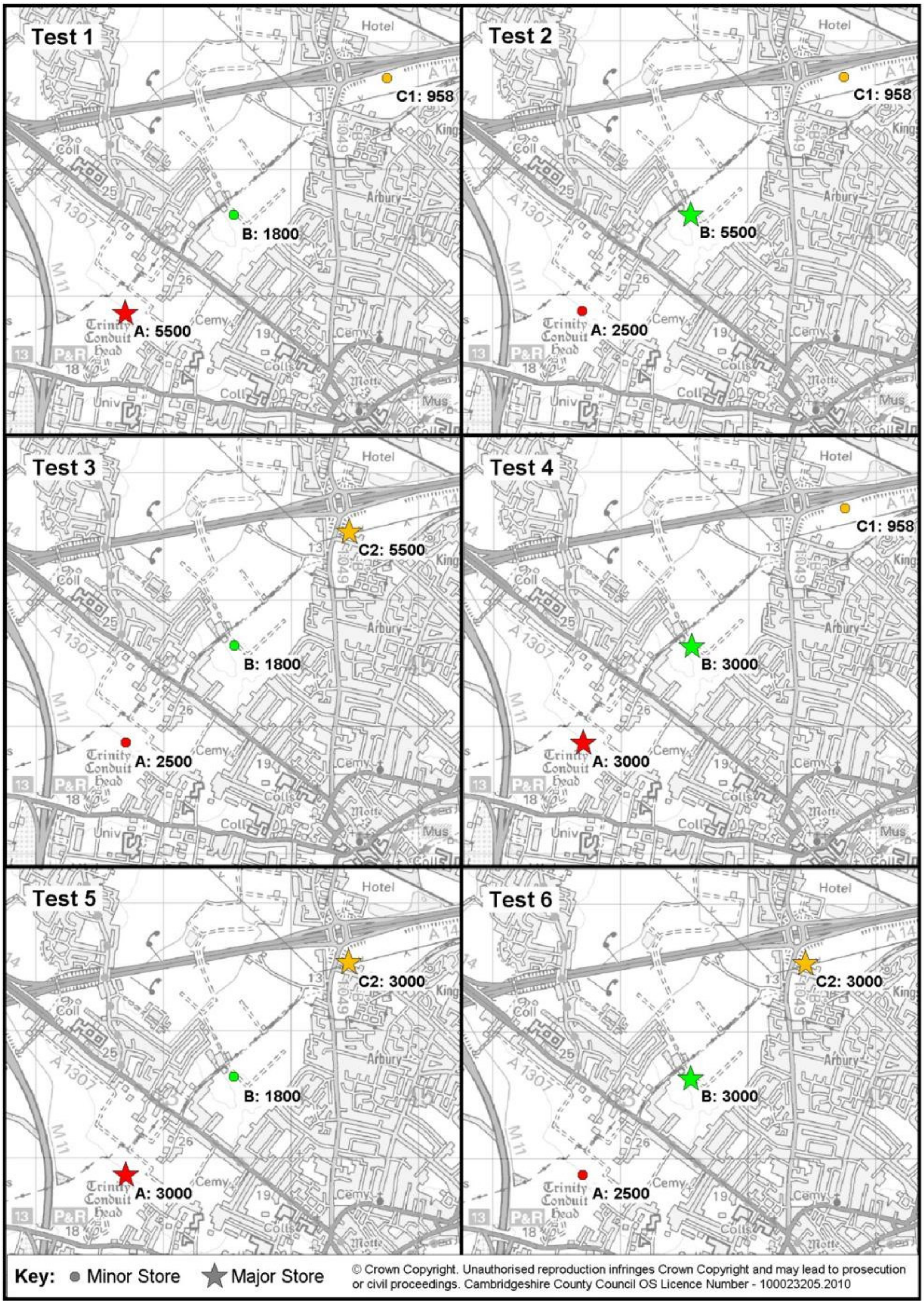


Figure 3.3 – Food Store Locations and Sizes (m^2 GFA), Test Scenarios



3.4 The remainder of this chapter deals with the analysis of the Gravity model forecasts of changes in trip patterns arising from the inclusion of a major new food store in each of the six scenarios. This includes:

- Mode share by car for each major food store location for all scenarios;
- Analysis of changes in the generalised cost of shopping trips (giving an indication of changes in travel time and distance across the County);
- How a new store in NWC will abstract retail trips from other major food stores in the modelled area;
- The level of internalisation achieved in the various scenarios; and
- The shopping destinations of trips from all wards in the Gravity Model catchment area, giving an indication of how far people are drawn to the modelled major food stores.

3.5 All results from the Gravity Model are presented in terms of 12-hour person trips, across the whole catchment area of the Gravity Model. They are converted later to car trips by time period for input into the CSRM SATURN model – this is addressed in the following chapter.

Mode Share

3.6 Mode shares were applied to each trip according to its distance, using the information derived from the SOLUTIONS study for main food shopping trips in Cambridge (see Table 2.3). The resulting mode share to each store is therefore determined by the distribution of short- and long-distance main shopping trips to that store.

3.7 Table 3.1 shows the percentage of trips to each major food store that are made by car, for main shopping purposes (not top-up shopping). A lower percentage indicates that fewer car trips, and therefore more trips by other modes (such as walking and cycling) are taking place. In addition, for the stores in NWC only, the number of people travelling in cars is provided (referred to as car-person trips). These are for a 12 hour day which has been generated by the additional food store provision over and above that contained in the Planned Development Only scenario.

3.8 For the existing stores, there is very little variation between the Planned Development Only scenario and any of the Tests. The results for the Northstowe supermarket are affected due to a less accurate distribution of the future year dwellings in that area, resulting in a decreased potential for short-distance non-car trips which would not be the case in practice.

3.9 The car mode share is clearly lower in areas that have greater population close by. The new store locations are all situated close to major housing developments, giving them all favourably low car mode shares. New Store A, on the University site, achieves the lowest car mode share since it has the densest population nearby; particularly the inclusion of student accommodation. It has since been noted that too many student accommodation units (see Appendix A) were included, but even when this number is reduced to the correct level, the University site still has the highest number of dwellings.

3.10 In Tests 4, 5 and 6, where there are two smaller stores, the car mode shares are lower (and therefore the non-car mode shares are higher) than when there is a single larger store as in Tests 1, 2 and 3. This is partly due to the better penetration of stores into the populated areas when the retail provision is split over two sites. The size of the store also plays a part in its mode share, since a smaller store has a smaller 'gravitational pull' and therefore draws its trips from shorter distances, which have lower car mode shares (see Table 2.3).

3.11 Note that this modelling covers only a household's main food shopping trips, not any top-up shopping. It is reasonable to expect that any top-up shopping that takes place at the new store(s) would also be sourced from the local area or from pass-by trips (see paragraphs 4.19 to 4.22).

Table 3.1 – Percentage Mode Share by Car and Car Person Trips for NWC Stores

Scenario	Beehive Asda	Cambourne Morrisons	Coldham's Lane Sainsbury's	Bar Hill Tesco Extra	Milton Tesco	Newmarket Road (Cheddars Lane) Tesco
Planned Development Only	85%	95%	85%	94%	92%	83%
Test 1	85%	95%	84%	94%	91%	83%
Test 2	85%	94%	84%	94%	91%	82%
Test 3	85%	94%	84%	94%	92%	82%
Test 4	85%	95%	84%	94%	91%	83%
Test 5	85%	95%	85%	94%	92%	83%
Test 6	85%	95%	84%	94%	92%	83%

Scenario	Cherry Hinton (Yarrow Road) Tesco	Trumpington Waitrose	Northstowe Supermarket	New Store A (University Site)	New Store B (NIAB Site)	New Store C2 (Orchard Park)
Planned Development Only	88%	86%	94%	-	-	-
Test 1	87%	85%	94%	77% (2,460)	-	-
Test 2	87%	85%	94%	-	82% (3,170)	-
Test 3	87%	85%	94%	-	-	85% (4,050)
Test 4	87%	86%	94%	74% (380)	81% (1,060)	-
Test 5	88%	86%	94%	74% (370)	-	84% (1,950)
Test 6	87%	85%	94%	-	81% (1,020)	85% (1,920)

Note: The actual number of car person trips to each of the new stores is provided in addition to the percentage car mode shares in this table, to provide additional context (see paragraph 3.7).These numbers specifically relate to the number of car person trips generated over a 12 hour day by the additional food store provision above that contained in the Planned Development Only scenario.

Shopping Trip Costs

3.12 As described in paragraph 2.21, Generalised Cost is the DfT's preferred measure of trip cost: rather than pure time or pure distance, it is a combination of the two and represents the monetary cost of a trip to an individual person. For this reason, the Gravity Model has been built using Generalised Cost in pence and its results are also presented in this way. Reductions in average travel costs across the whole Gravity Model (relative to the Planned Development Only scenario with no new store provided) indicate that the average travel distance and time have reduced, and as a consequence there would be a beneficial impact on emissions when viewing the model catchment area as a whole.

3.13 Table 3.2 shows the average cost of trips to the new store(s) in each test location labelled A, B and C2 in Figure 3.1 above, and the total average trip cost across the whole Gravity Model catchment area. This table indicates that the average shopping trip cost across the whole catchment area decreases when a new major food store is included, and the costs associated with visiting the new stores themselves are lower still.

3.14 In the Planned Development Only situation, when there are no major food stores in NWC, the average generalised cost of travel to all modelled major food stores is 214p. Whenever a new store is added, this average cost decreases (for example, in Test 1, it decreases to 211p), indicating that shopping trips in general are shorter in distance and/or time. In all Test scenarios, those trips to the new stores themselves have a lower average trip cost than the whole (for example, in Test 1, the average cost of travel to New Store A is 194p). The trips to the existing stores still account for the majority of the trips in the model, and hence these much lower average costs to the new stores have a relatively small impact on the overall average cost to all stores. These trends are true, to a greater or lesser extent, across all the Tests.

3.15 This indicates that stores situated in NWC are well located to draw most of their custom from a more local area than the existing modelled major food stores, and that the overall effect on the whole Gravity Model catchment area is also beneficial. The store location that performs best in terms of lowest trip costs is store B (NIAB site), especially when this is taken in combination with store A (University site) in Test 4. This, again, partly relates back to the density of dwellings on the development sites: a greater number of dwellings nearby leads to a greater number of low-cost trips, which in turn reduces the average trip cost.

Table 3.2 – Daily Average Trip Costs (pence), All Modes

Trip Destination	Planned Development Only	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
New Store A only	-	194	-	-	183	182	-
New Store B only	-	-	182	-	177	-	180
New Store C2 only	-	-	-	190	-	185	187
All Stores	214	211	211	211	212	212	212

Abstraction from Existing Major Stores

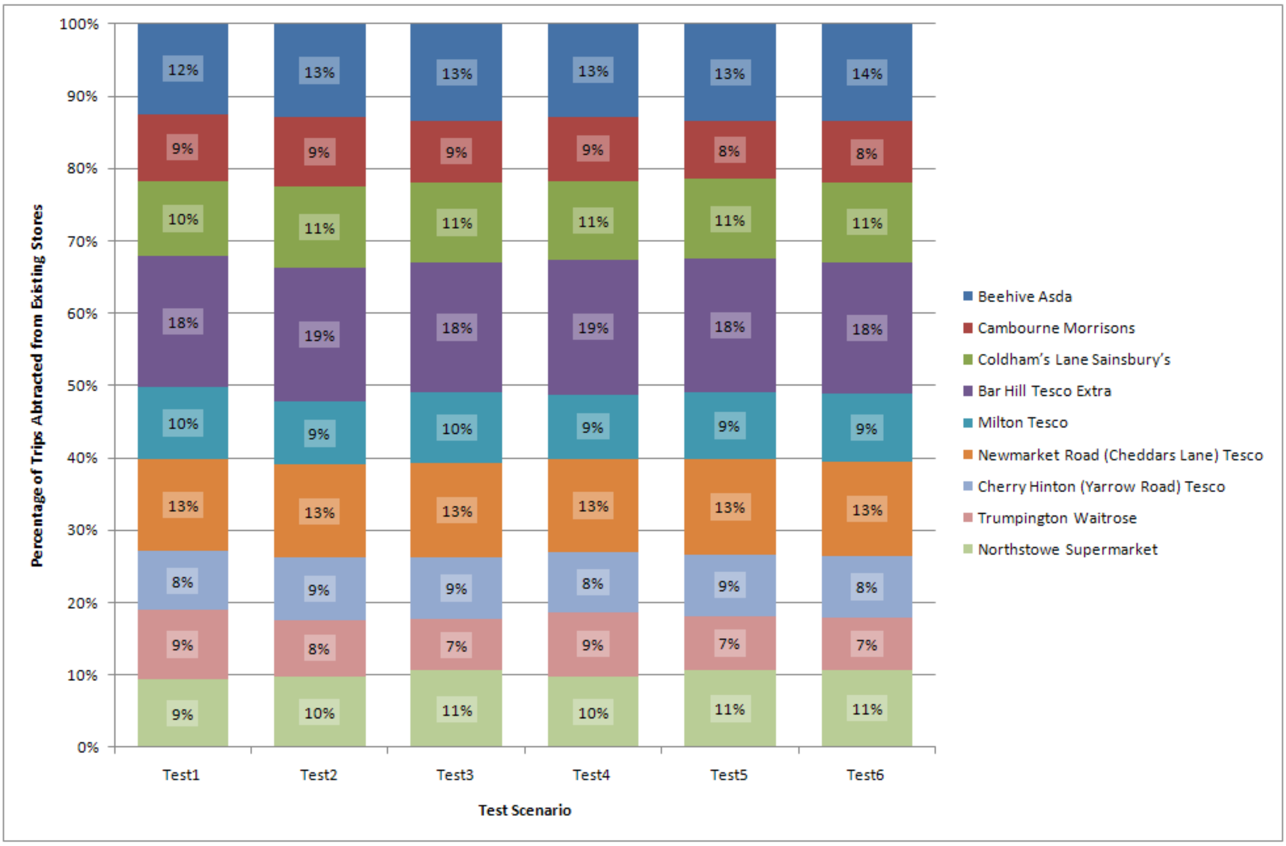
3.16 The bar chart in Figure 3.4 shows, for each Test scenario, the proportion of trips to the new major store in NWC which previously patronised existing stores elsewhere in the Planned Development Only scenario. The labels on the bar chart show the percentage of trips that are abstracted from each existing store: for example, 12% of custom to the new store in Test 1 previously patronised Beehive Asda, while 18% previously used Bar Hill Tesco Extra.

3.17 The variations between each test are very small, suggesting that the exact location of the new store(s) as tested in the Gravity Model has only a marginal effect on the levels of abstraction from other existing major stores across the catchment area.

3.18 For NWC, the Gravity Model predicts that abstraction of shoppers from Bar Hill Tesco Extra will make up proportionally the largest share of abstracted shopping trips. This is intuitively correct given that it is the closest store in competition with the proposed new store(s). The model predicts that Asda at the Beehive Centre and Tesco on Newmarket Road (Cheddars Lane) are the next most affected stores in terms of abstraction.

3.19 The SRS predicted that Milton Tesco would have been affected more than the Gravity Model outputs suggest, due to its proximity to NWC. As discussed in paragraph 2.18, this store is on the borderline between the minor and major classifications and therefore has only a relatively small 'gravitational pull'. Other factors that may make it more popular than its size suggests (such as its visibility from the A14 and a petrol station facility) cannot be readily incorporated in the Gravity Model. Whilst the Milton store is relatively close to NWC, the Gravity Model does incorporate the costs of travelling through the Cambridge road network to each of the major store locations in its calculations meaning that accessibility by road is part of the calculations. Nonetheless, the levels of abstraction from Milton Tesco may be underrepresented in the Gravity Model outputs.

Figure 3.4 – Abstraction from Existing Stores



Level of Internalisation

3.20 Table 3.3 shows, for each Test, the percentage of trips to the new store(s) that originate within the SRS Primary Catchment Area. A higher percentage indicates that more trips are being sourced locally and therefore that fewer trips originate from outside the SRS Primary Catchment Area.

Table 3.3 – Percentage of Trips to New Stores from within SRS Primary Catchment Area

Test Scenario	Store Location A	Store Location B	Store Location C2
Test 1	52%	-	-
Test 2	-	51%	-
Test 3	-	-	46%
Test 4	55%	53%	-
Test 5	55%	-	48%
Test 6	-	52%	47%

3.21 The store at location C2 (Orchard Park) always draws the lowest proportion of its custom from the SRS Primary Catchment Area, since its location is relatively near the catchment boundary and existing stores (such as Milton Tesco) are closer and therefore in greater competition. Store location B is the most centrally located in the SRS Primary Catchment Area, but store location A performs slightly better due to the higher density of dwellings on the University site.

3.22 This same analysis has also been performed for trips originating within the new developments in NWC to give a further indication of the level of trip containment within NWC. These results are presented in Table 3.4. Again, store location A (University site) gives the highest levels of trip internalisation and location C2 (Orchard Park) the lowest.

Table 3.4 – Percentage of Trips to New Stores from within NWC

Test Scenario	Store Location A	Store Location B	Store Location C2
Test 1	30%	-	-
Test 2	-	20%	-
Test 3	-	-	13%
Test 4	34%	21%	-
Test 5	34%	-	13%
Test 6	-	21%	13%

Shopping Destinations across the Wider Catchment Area

3.23 Figure 3.5 to Figure 3.16 on the following pages show for each Test scenario the proportion of main (weekly) shopping trips that are predicted to visit a major new food store in NWC as compared to the other existing stores. These cover the whole of the Gravity Model catchment area. The size of each pie chart is directly related to the actual number of shopping trips from the relevant ward, with smaller pie charts indicating fewer trips to any of the major food stores (new or existing) in the study area – either due to smaller population levels in that ward, or due to other (not modelled) shopping opportunities outside the SRS Secondary Catchment Area.

3.24 Note that this analysis looks at the shopping *destinations* from each ward, whereas Table 3.3 in the section above looks at the *origins* of the shopping trips that use the new store(s).

3.25 These results show, as expected, that those Wards closer to NWC have a greater share of trips going to the new store(s) than those Wards further away. The pie charts in the NWC area show that residents of Wards near NWC still do a large proportion of their shopping at existing external stores. This is supported by the long-distance nature of the observed data that has been replicated by the Gravity Model (see paragraph 2.27). This is also partly due to the size of the Wards covering a greater area than NWC itself; some parts of the Wards are closer to existing stores than to the new NWC stores.

3.26 Tests with two smaller stores (Tests 4, 5 and 6) draw a smaller number of trips from wards further away than tests with a single larger store (Tests 1, 2 and 3), because the smaller individual store size has a smaller 'gravitational pull'. Illustrating this (using existing stores as an example), shoppers travel further to Bar Hill Tesco Extra because it is larger and has a wider range of goods than their more local alternatives. This effect can be seen in the following figures because the total share of each pie chart for NWC stores in Tests 4, 5 and 6 is smaller than the NWC share in Tests 1, 2 and 3.

3.27 These figures also give an indication of the sphere of influence of the stores in each test. For example, Figure 3.6 shows very few trips to NWC stores originating from the eastern side of Cambridge in Test 1, while Figure 3.8 shows more in Test 2 and Figure 3.10 shows the most in Test 3. Similarly, store location C2 in Test 3 draws a much greater number of trips from the Histon and Impington ward than store location A in Test 1, because the Orchard Park location is more attractive to shoppers from that ward than the University location is.

3.28 As indicated in paragraph 3.26, the tests with two smaller stores have a smaller sphere of influence than the tests with one larger store. Again, the tests with stores located further east draw more custom from the eastern part of Cambridge, although this relates to a smaller number of trips than the tests with a single larger store.

Figure 3.5 – Test 1 Shopping Destinations, Wide Area

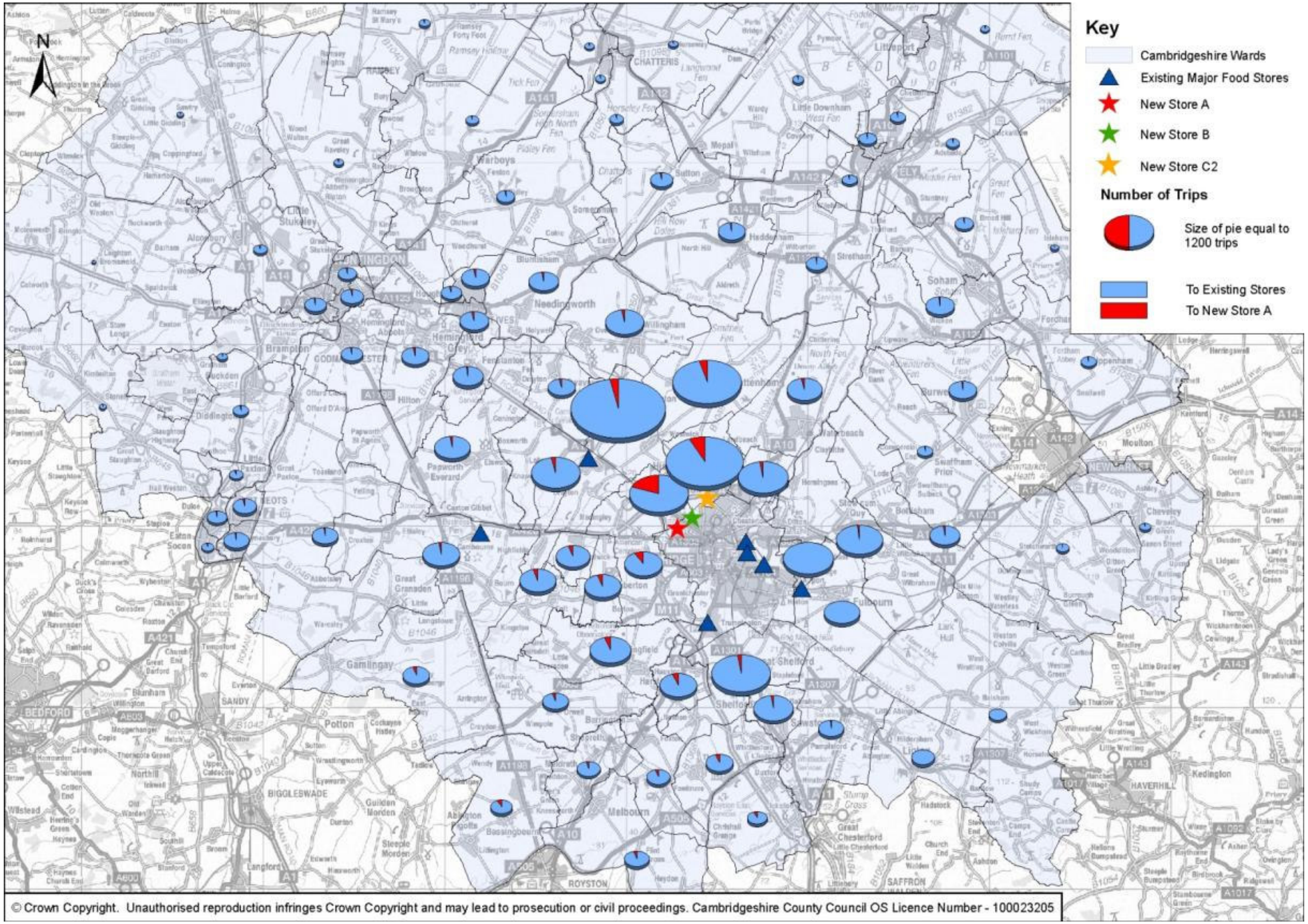


Figure 3.6 – Test 1 Shopping Destinations, Local Area

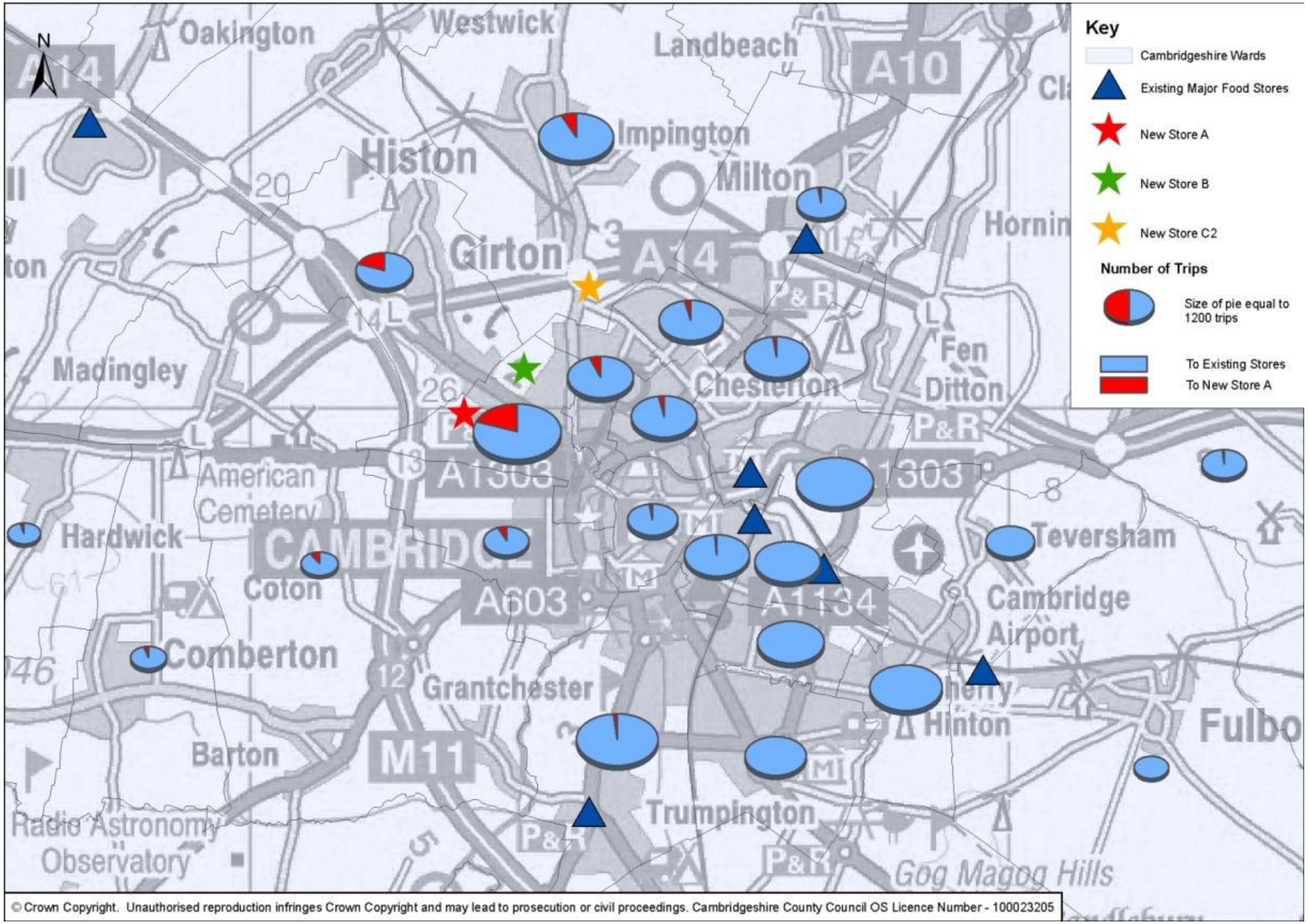


Figure 3.7 – Test 2 Shopping Destinations, Wide Area

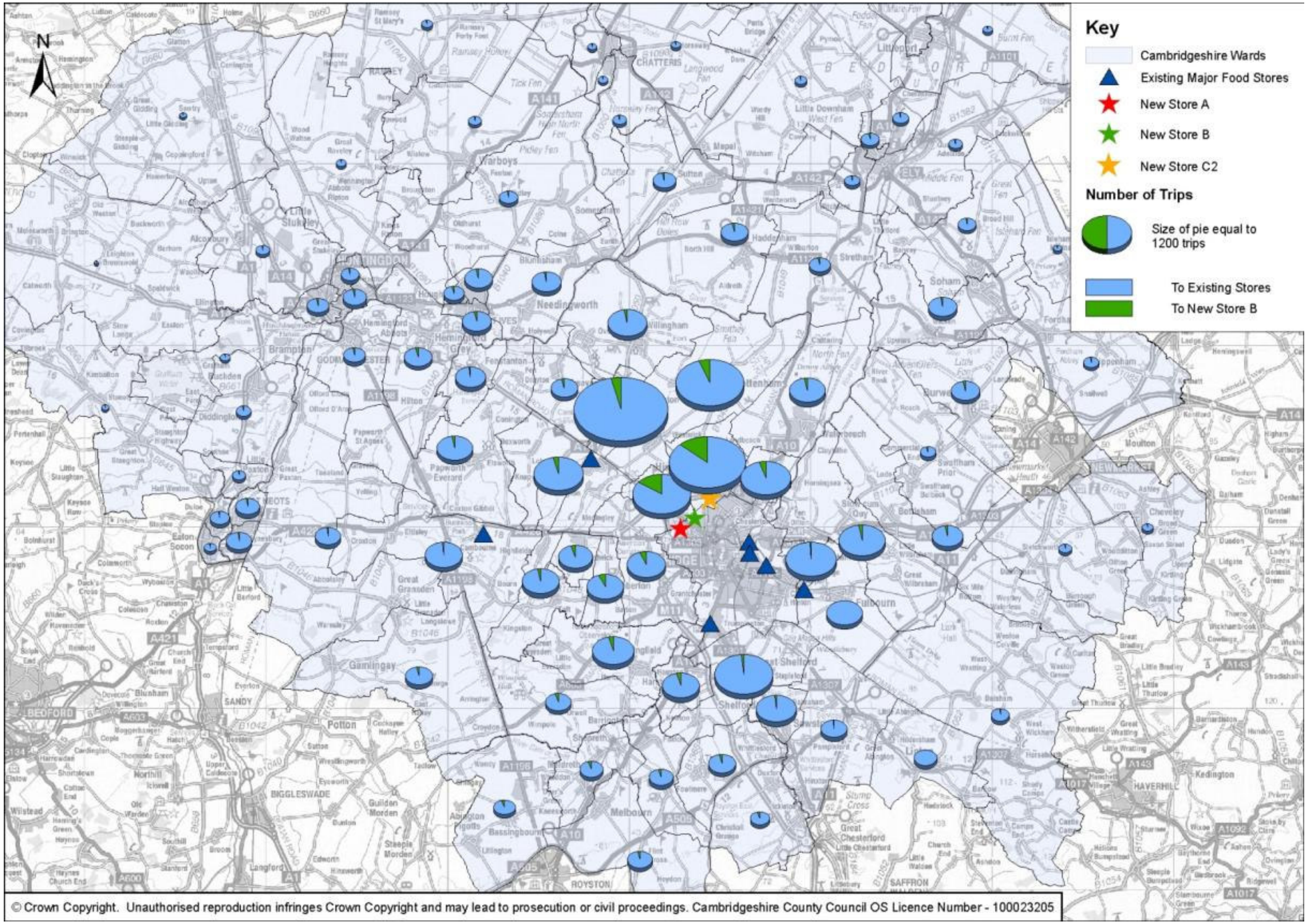


Figure 3.8 – Test 2 Shopping Destinations, Local Area

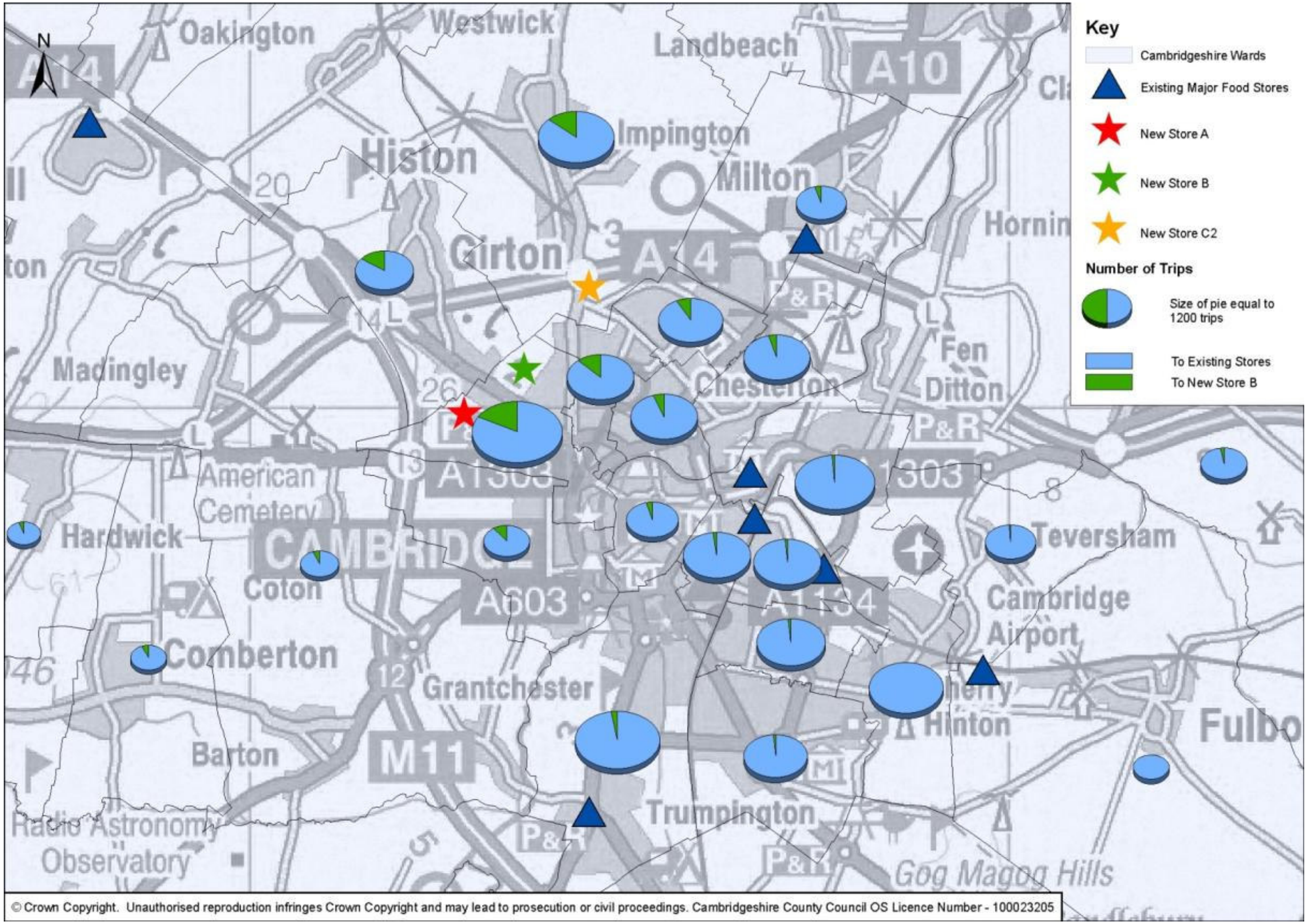


Figure 3.9 – Test 3 Shopping Destinations, Wide Area

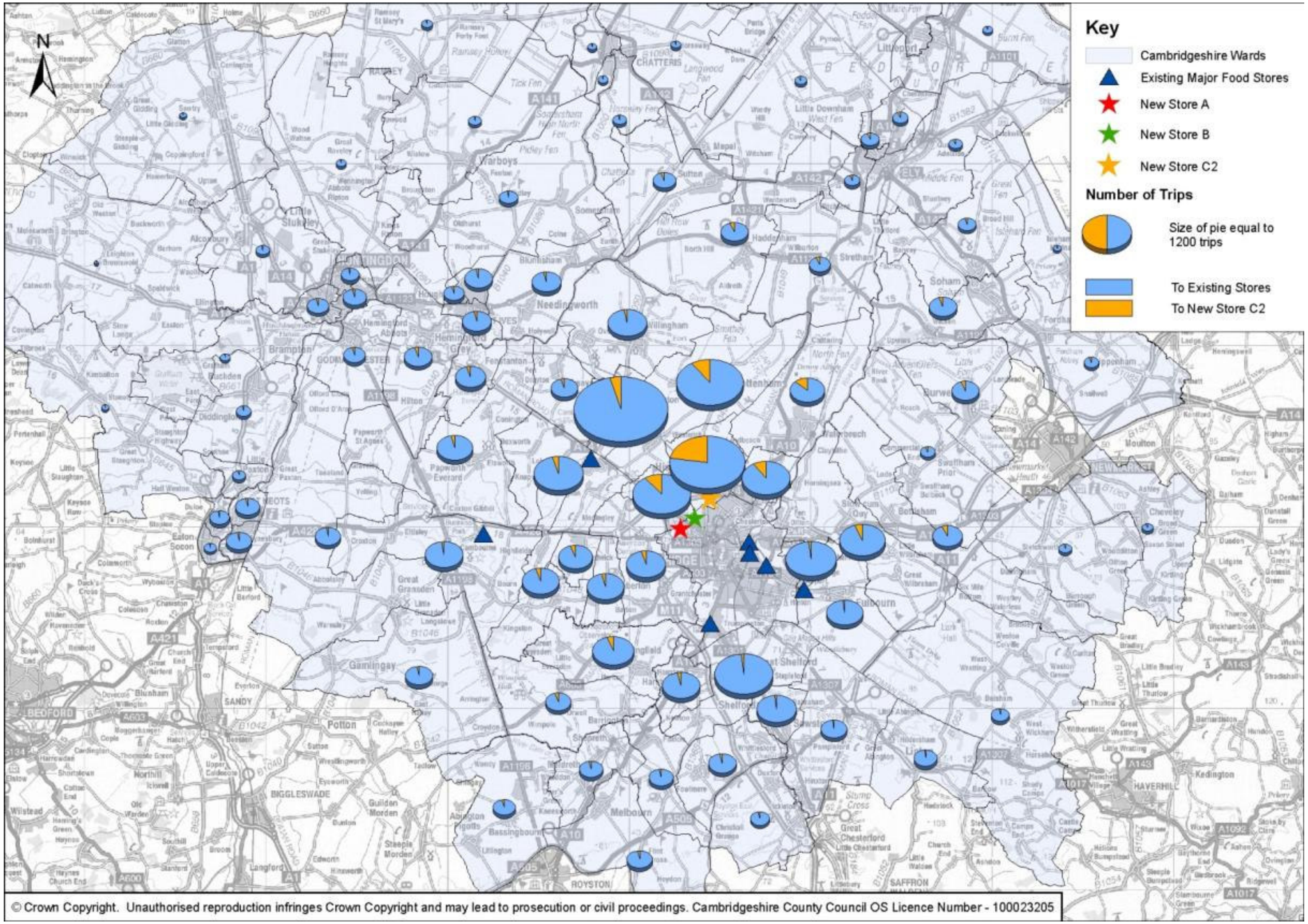


Figure 3.10 – Test 3 Shopping Destinations, Local Area

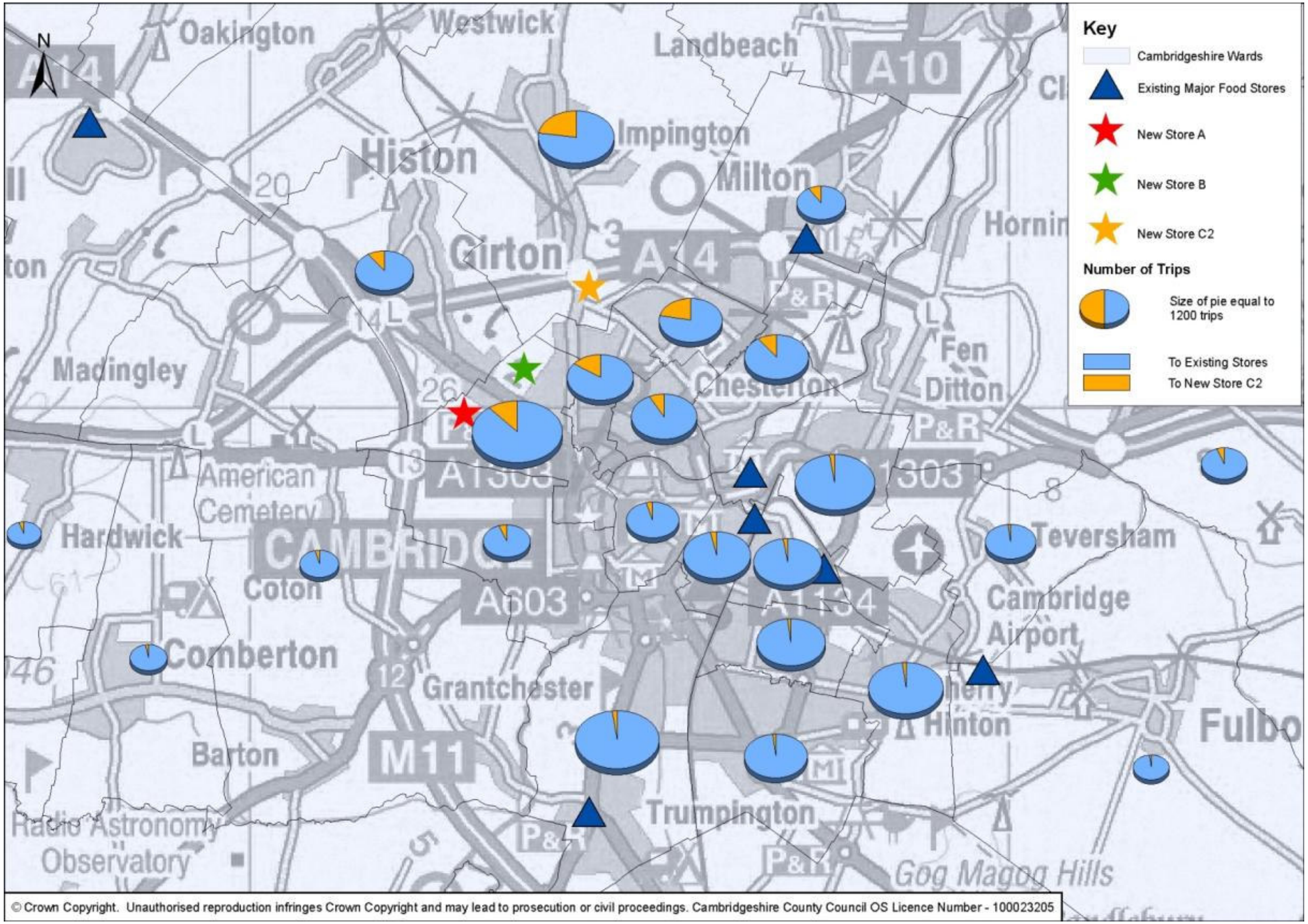


Figure 3.11 – Test 4 Shopping Destinations, Wide Area

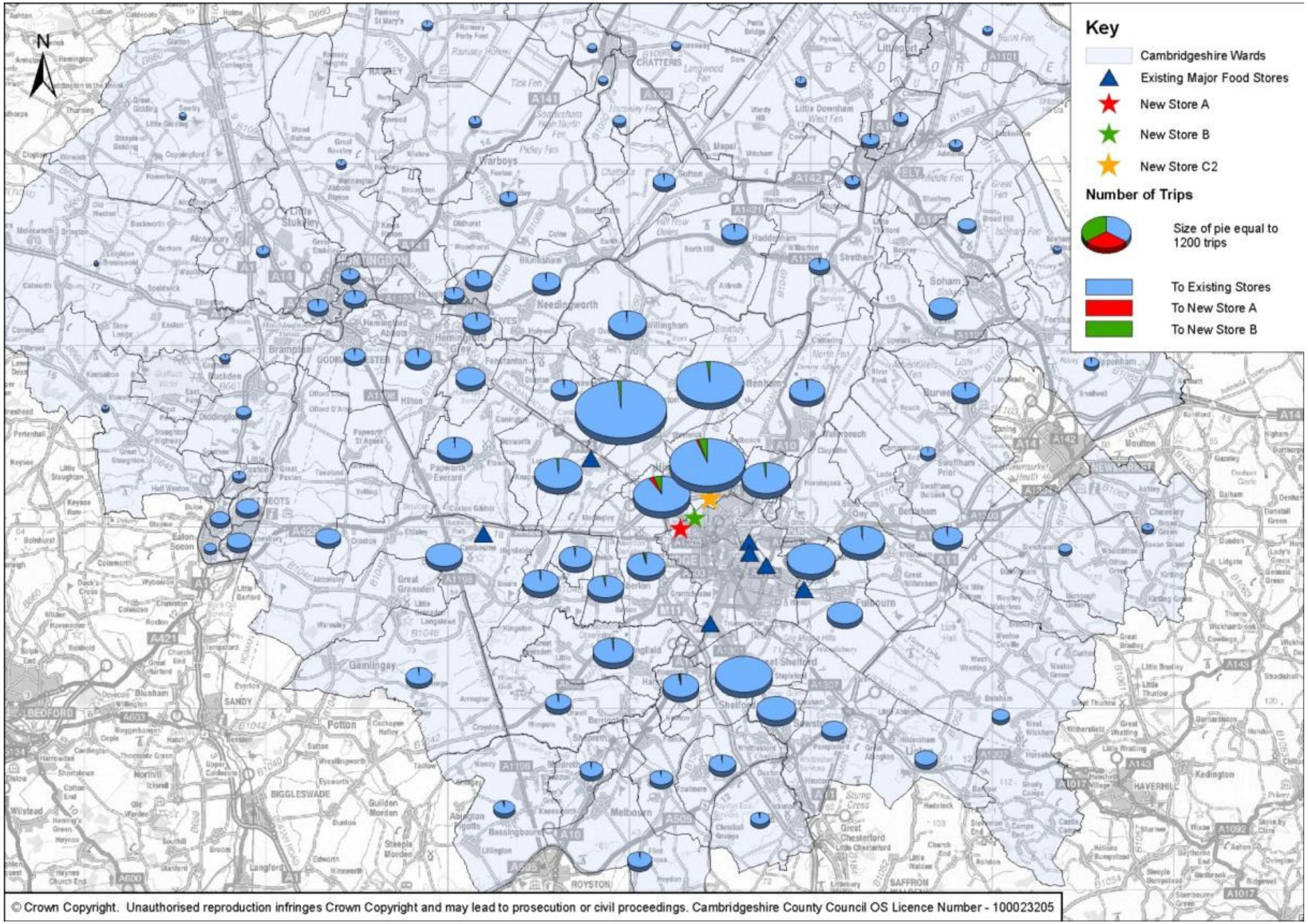


Figure 3.12 – Test 4 Shopping Destinations, Local Area

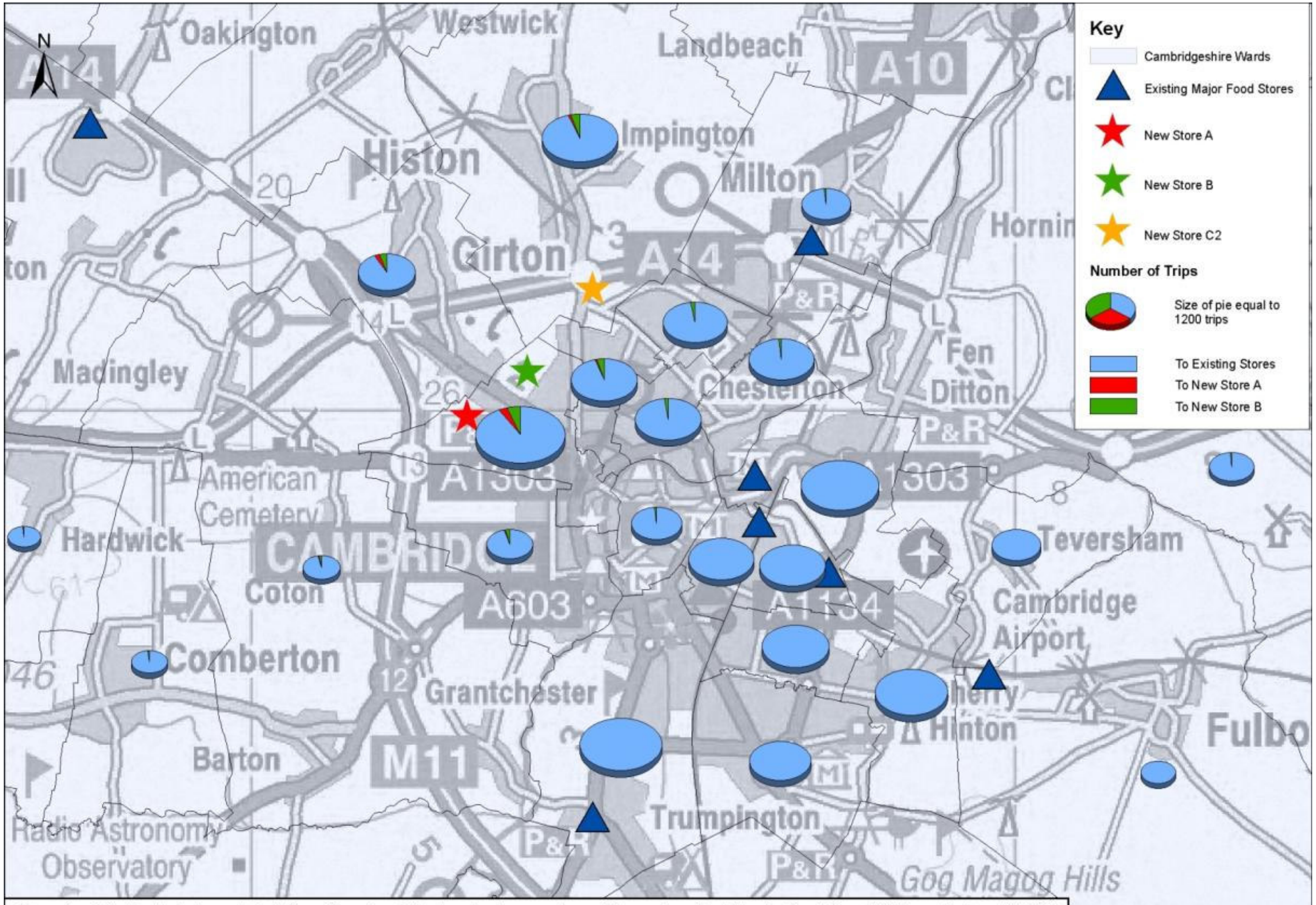


Figure 3.13 – Test 5 Shopping Destinations, Wide Area

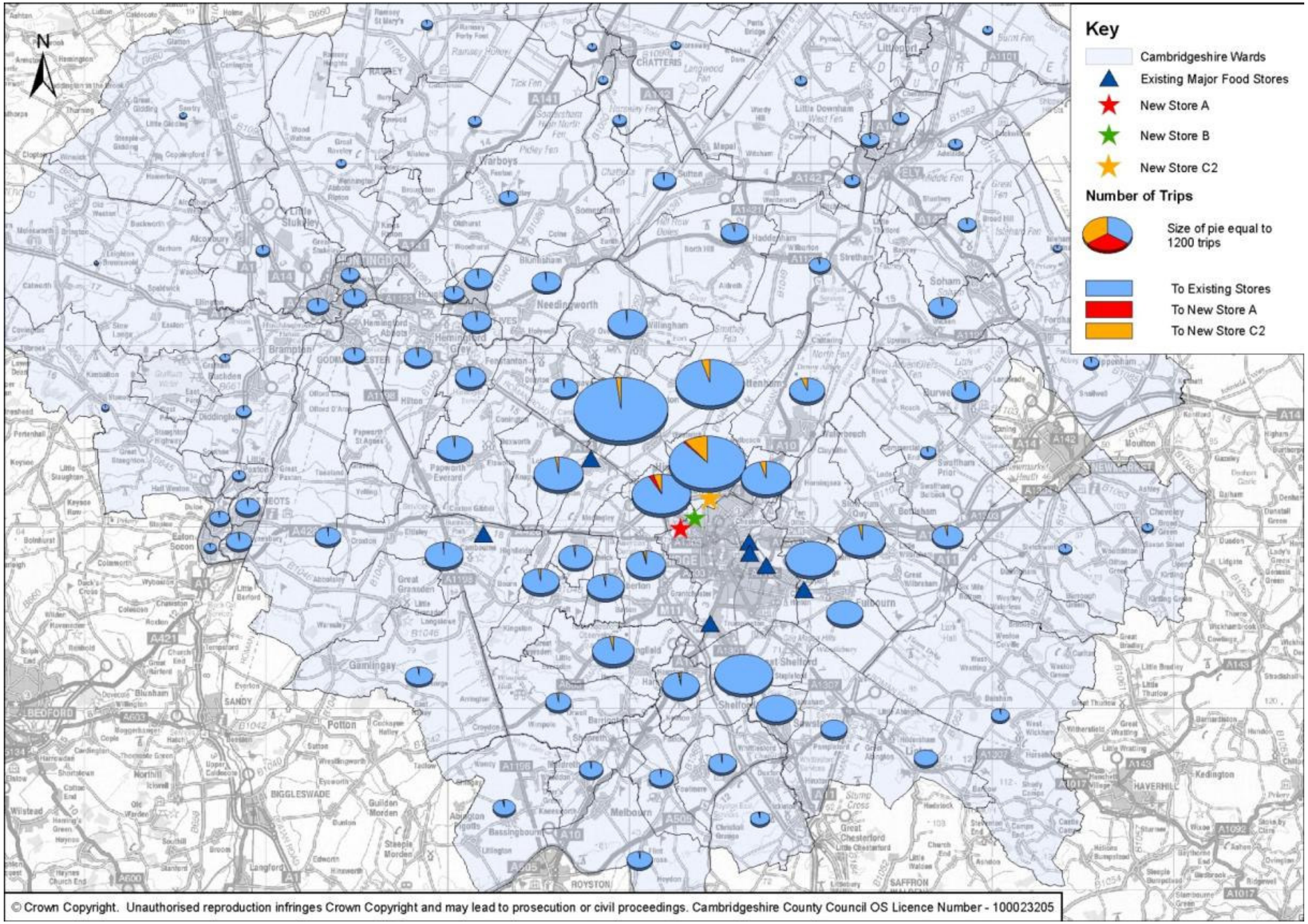


Figure 3.14 – Test 5 Shopping Destinations, Local Area

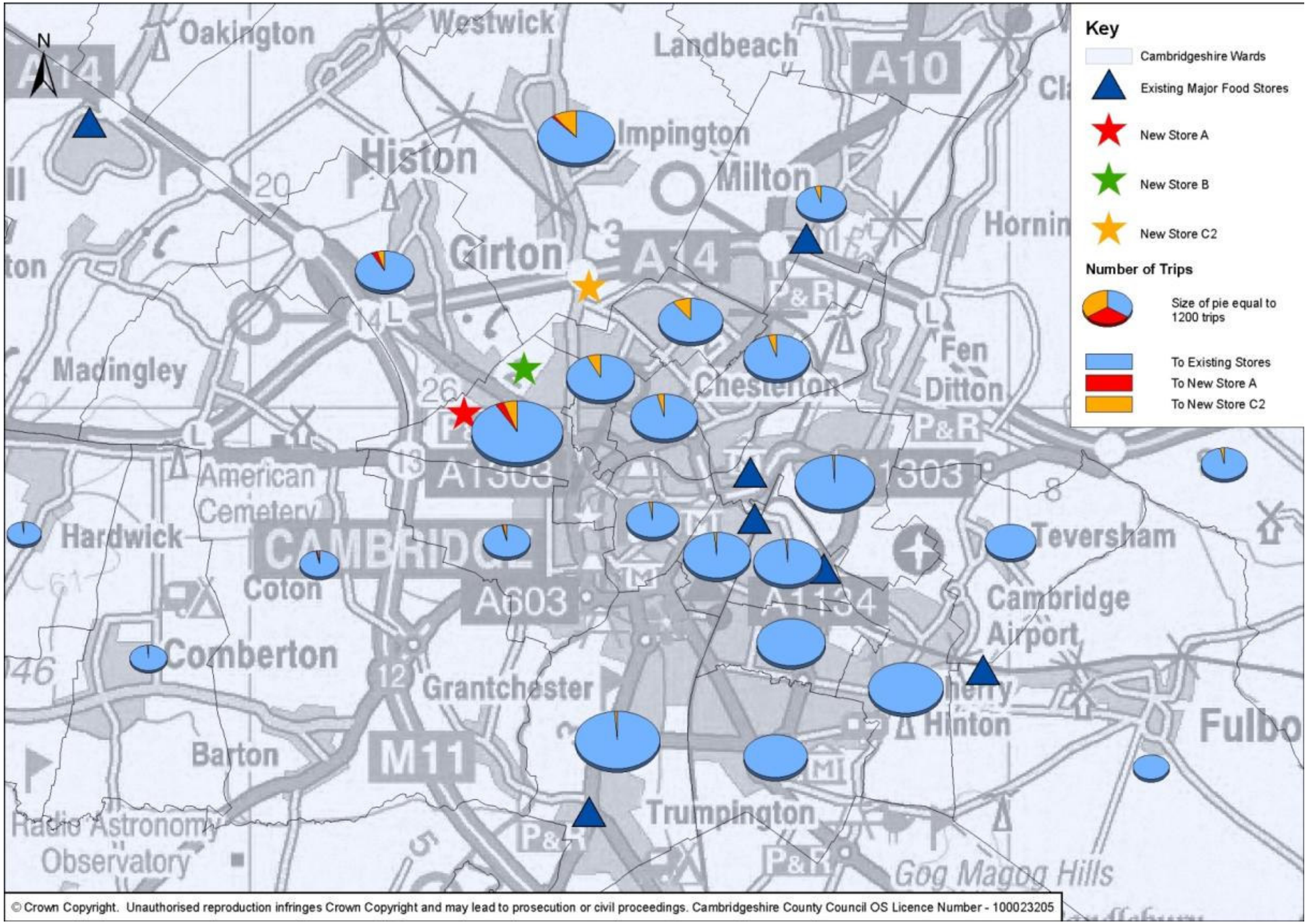


Figure 3.15 – Test 6 Shopping Destinations, Wide Area

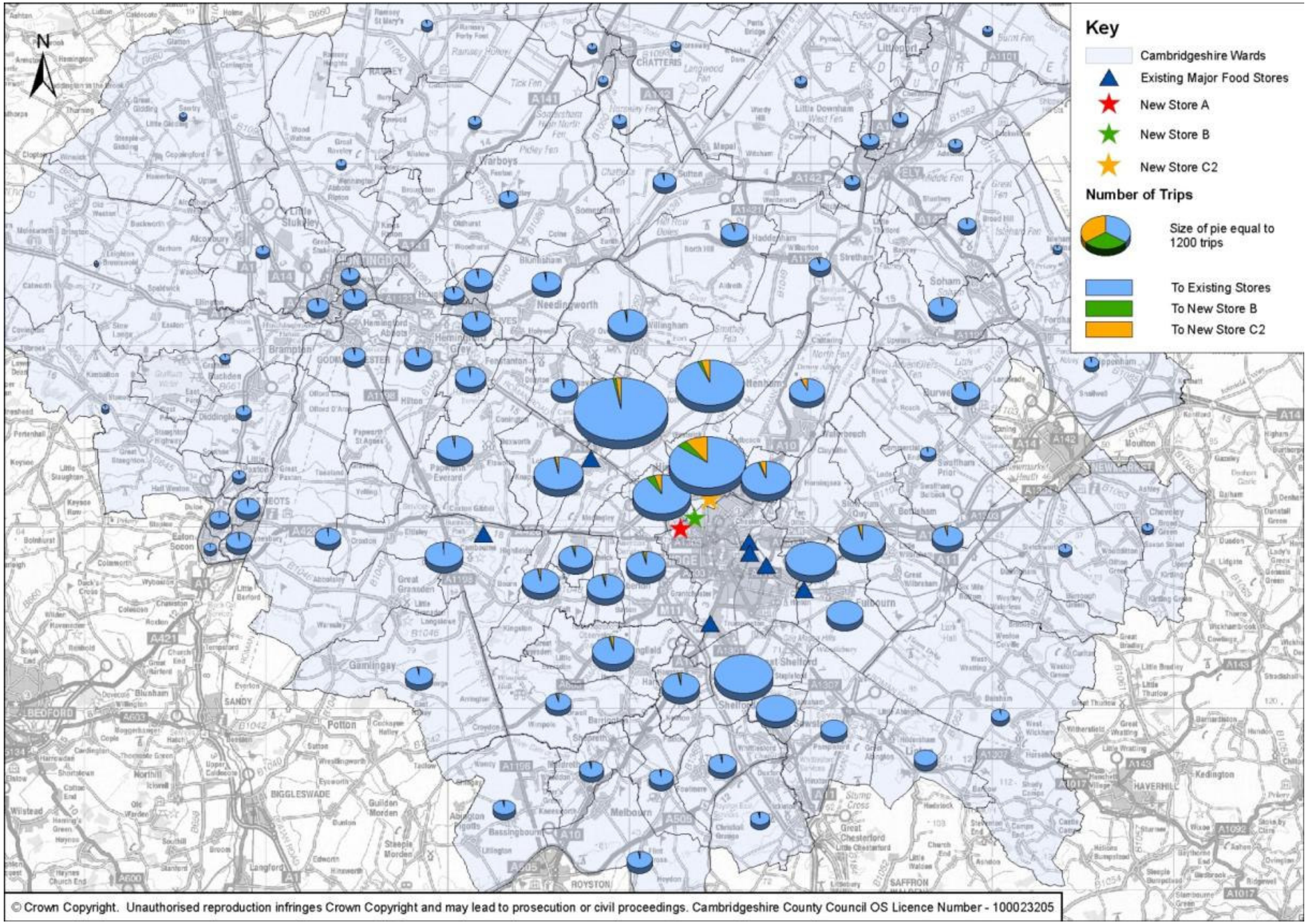
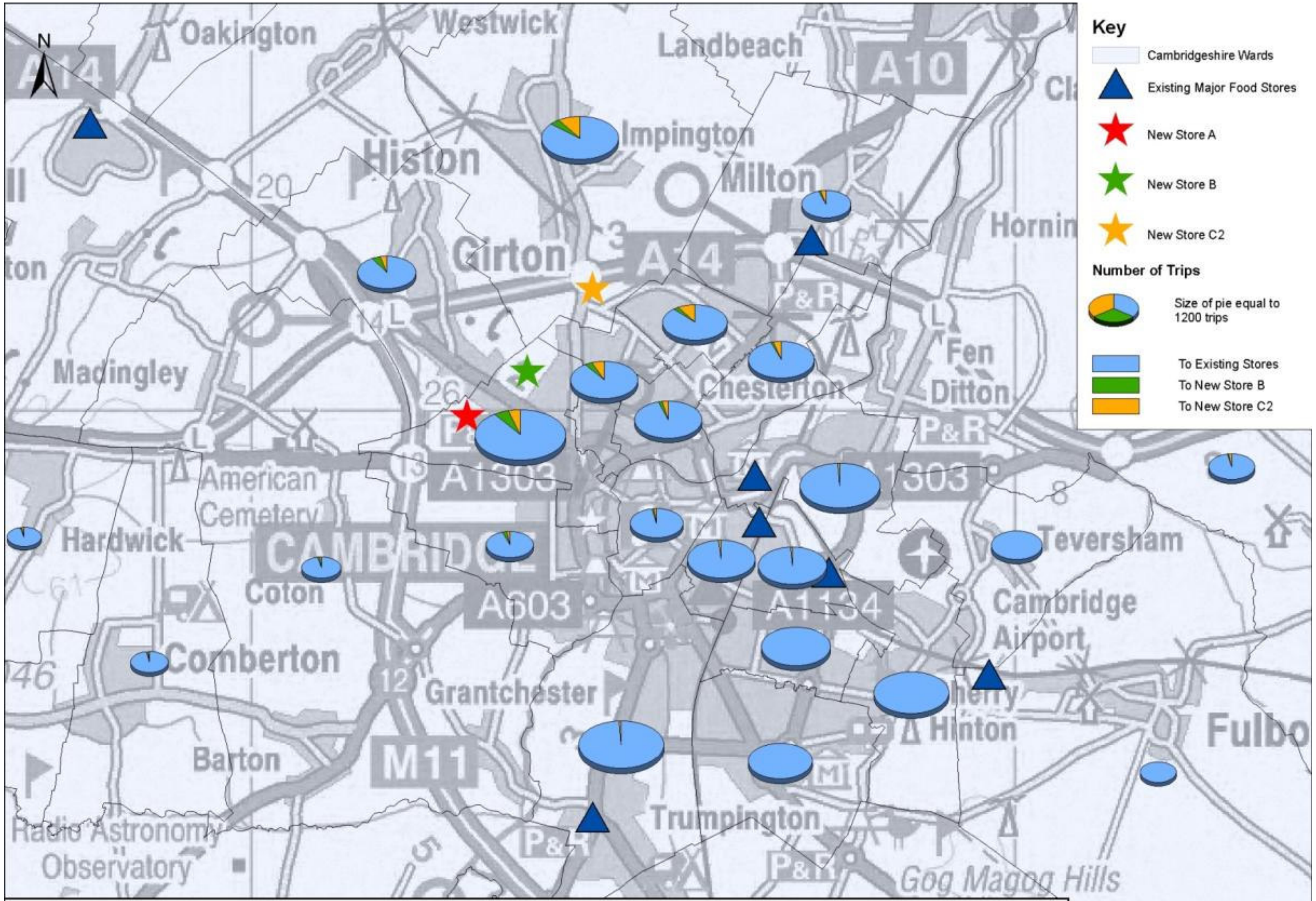


Figure 3.16 – Test 6 Shopping Destinations, Local Area



Summary of the Gravity Model Forecasts

3.29 The forecasts from the Gravity Model give an indication of the performance of each Test across Cambridgeshire with respect to:

- The ability of a new store in each of the main development sites to contain trips within NWC relative to a Planned Development Only scenario with no extra provision; and
- The likely changes in travel patterns arising from the location of a major new store across the wider City and South Cambridgeshire area.

3.30 Whilst it should be remembered that these forecasts do not take account of the affects of route choice, junction delays and general congestion on the highway network (which is assessed in the next chapter), the following analysis has been undertaken:

- The mode share of shopping trips to all existing and new stores in each test has been considered, showing that stores in NWC would be able to achieve lower car mode shares than many existing stores in the catchment area therefore supporting a move away from heavy car reliance;
- The changes in the generalised cost of shopping trips across the county brought about by each Test scenario have been monitored, suggesting that the trips to the new stores are lower in cost than for the overall average and that, as a whole, the cost of trips across the Gravity Model catchment area decreases when a new store is opened;
- The levels of abstraction from the existing stores have been analysed, showing that new stores in NWC abstract a proportion of their trips away from each of the existing stores, with the closer stores being affected the most;
- The proportion of trips to each store that originate from within the SRS Primary Catchment Area and from within NWC have been calculated, indicating that a good degree of internalisation can be achieved in each Test; and
- A series of maps have been produced, showing the relative number of shopping trips from each Ward in the model (recognising that the whole of Cambridgeshire is not served by the modelled stores alone, but that the observed data indicated a large geographical catchment area), and showing the proportion of these trips that patronise the new store(s) in NWC in each Test.

3.31 The density of dwellings per hectare on each of the development sites has a large part to play in the success of each potential store location (as measured against the criteria discussed above); a higher number of dwellings in close proximity to a store will reduce the reliance on cars (as the SOLUTIONS study has shown that main food shopping trips can use non-car modes for short distances), reduce the average cost of travel (in terms of time, distance and monetary cost), and increase the potential for a store to source its custom locally.

4. Cambridge Sub-Regional Model Forecasts

Introduction

4.1 This chapter provides more detailed transport related information extracted from the 2021 SATURN highway model forecasts for each of the test scenarios based on changes to highway travel patterns as informed by the gravity model. It includes information on:

- Changes in the levels of carbon emission, aggregate travel distances and time by time period and an annualised forecast for 2021;
- Expected changes in delay at a range of key junctions across the NWC and wider Cambridge city area resulting in each of the tests by time of day; and
- An analysis of the comparative potential for diversion of pass by trips across each of the scenarios.

4.2 These results are presented in terms of car trips in the AM Peak, Inter Peak and PM Peak modelled hours in CSRM (which are 08:00-09:00, 14:00-15:00 and 17:00-18:00 respectively). Annualised 12-hour data has been provided, which has been derived from a combination of the three modelled peak hours, using annualisation factors originating from the Cambridge Road Side Interview surveys undertaken during the development of the CSRM SATURN models. These factors are consistent with other work that has been carried out using the CSRM (for example, the Cambridgeshire TIF bid).

4.3 Vehicular data from the SATURN models is in Passenger Car Units (PCUs), rather than pure vehicles. For example, an HGV is counted as 2.3 PCUs, while a car is 1 PCU. This is due to the way the SATURN model represents the additional road space required by larger vehicles on the network.

Summary Statistics

4.4 Carbon dioxide emissions, vehicle kilometres and vehicle hours have been extracted from the CSRM SATURN models for the Planned Development Only scenario and each Test, to enable comparisons to be made between the overall traffic impacts of each store location. Table 4.1 gives these statistics for all SATURN links within the SRS Primary Catchment Area; Table 4.2 covers the SRS Secondary Catchment Area. (See Figure 2.4 for the locations of these catchment area boundaries.) Table 4.3 gives the same statistics for the "Cambridge Urban Area", which is defined as Cambridge City plus the parts of South Cambridgeshire within the A14/M11 envelope (see Figure 4.1).

4.5 The carbon dioxide emissions were calculated by SATURN, taking into account the distance travelled along each road, the average cruise speed along that road, the time spent idling in queues at junctions, the number of times each vehicle comes to a full stop and then accelerates relatively quickly (e.g. pulling away from a junction), the number of times each vehicle stops and starts while moving along a queue, and the traffic volumes. Vehicle kilometres and vehicle hours refer to the total distance travelled by all vehicles on all roads in the model and the total time spent travelling, respectively.

4.6 These tables show that the percentage differences between each Test and the Planned Development Only scenario are very small. This suggests that the overall traffic impacts of stores in the different locations would be broadly similar and that these differences are not significant across the modelled area. However, if these results are annualised, the differences in absolute terms between the Tests and the Planned Development Only scenario are more meaningful and show how, over a longer period of time, each of the scenarios compare with each other.

4.7 Within the SRS Secondary Catchment Area, the impacts are smaller and mostly beneficial relative to the Planned Development Only scenario. At a more local level, in the SRS Primary Catchment Area, the test scenarios mostly have a detrimental effect. In the Cambridge Urban Area, the effects vary between time periods and tests, but again the percentage changes are very small (less than 1%). In absolute terms, at an annualised 12-hour level, the benefits to the SRS Secondary Catchment Area are more clearly visible, although the disbenefits to the SRS Primary Catchment Area are much larger. Again, the Cambridge Urban Area shows more variation between the tests, with benefits generally for the two-store tests (4, 5 and 6) and disbenefits for the single store tests (1, 2 and 3).

4.8 This suggests that while the new store(s) reduce the number of shopping trips leaving the NWC area, there is an increase in the total number of shopping trips in the area due to the greater number of additional trips now attracted to the new store(s). Thus the residents of NWC do not need to drive as much, but the new store(s) attract more trips into the area. The overall number of trips in the SRS Secondary Catchment area is maintained at almost the same level in each Test as the Planned Development Only scenario, but these trips become shorter and/or faster, which is beneficial overall at this wider level. Within the Cambridge Urban area, overall benefits can again be seen in tests 4, 5 and 6, with the CO_2 and Vehicle Kilometres both reducing in these three tests (see Table 4.3).

4.9 In the SRS Primary Catchment Area, the Inter Peak and PM Peak generally show the greatest percentage increases in Vehicle Hours, which suggests that these periods experience a greater increase in congestion in NWC than the AM Peak. This is supported further by the delays at key junctions, particularly in the PM Peak (see analysis in the following section). This is due to the additional shopping trips in the SRS Primary Catchment Area, as described above.

4.10 The benefits in the wider SRS Secondary Catchment Area are due to the reduction in trips leaving NWC to do their shopping elsewhere. The impacts on the Cambridge Urban Area are generally positive in tests 4, 5 and 6 but negative in tests 1, 2 and 3; this is because the smaller stores have a smaller catchment area and higher non-car mode share, so they do not draw in as many trips from other parts of Cambridge and reduce car use in NWC.

4.11 In terms of the annualised absolute impacts of each test, Test 4 gives rise to the smallest changes in CO_2 emissions and vehicle kilometres in the SRS Primary Catchment area, and leads to the greatest decrease the CO_2 emissions in the SRS Secondary Catchment area. In the Cambridge Urban Area, Test 5 performs better in terms of reduction in CO_2 emissions and vehicle hours.

Figure 4.1 – Cambridge Urban Area Definition

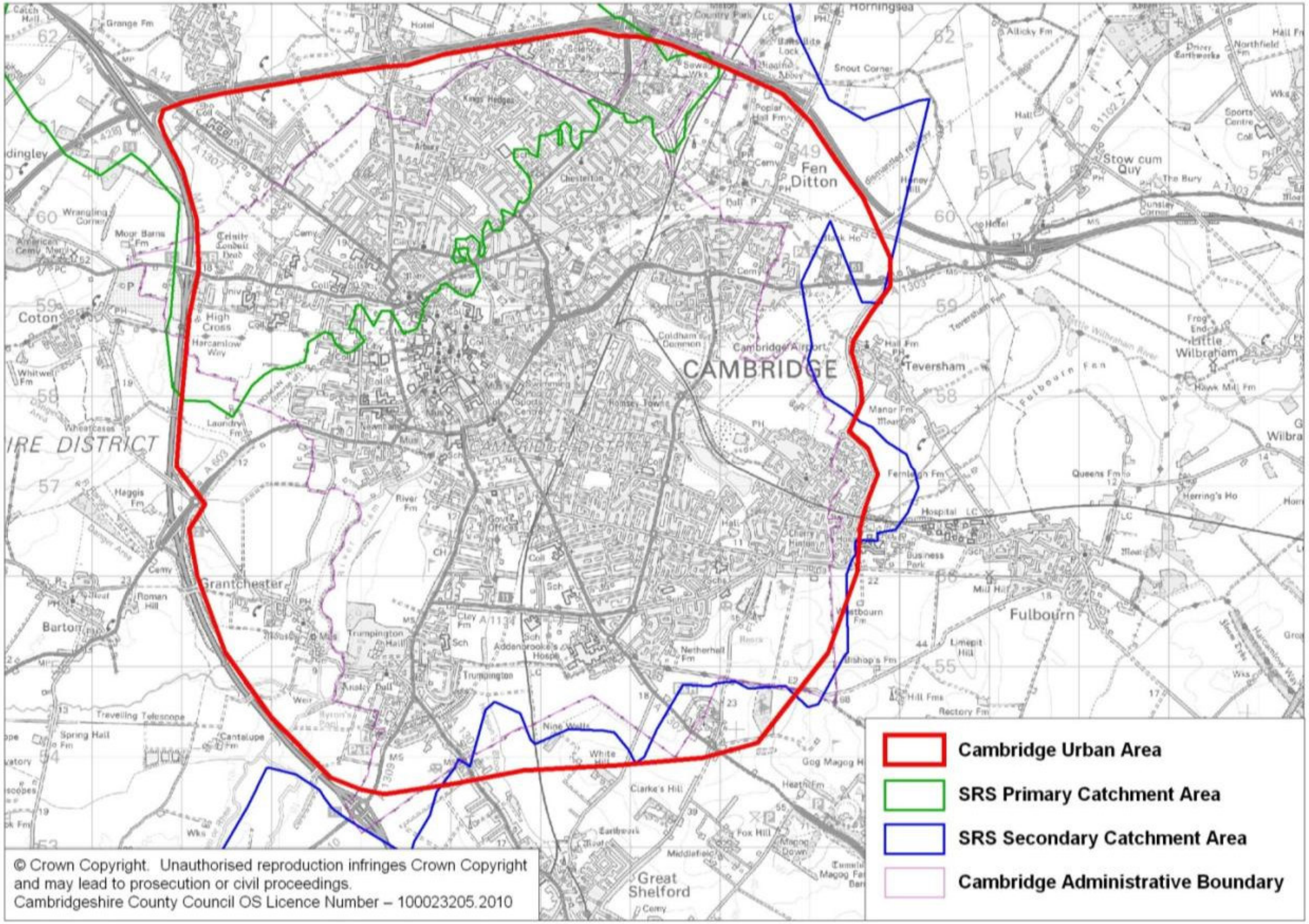


Table 4.1 – SATURN Model Statistics for SRS Primary Catchment Area (all vehicle trips)

	Planned Development Only	Percentage Change over Planned Development Only					
		Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
AM Peak 2021							
CO_2 Emissions – kilograms	13,909	100.12%	100.10%	100.10%	100.12%	100.05%	100.08%
Vehicle Kilometres	146,655	100.06%	100.03%	100.17%	100.01%	100.09%	100.02%
Vehicle Hours	3,148	100.41%	100.29%	99.91%	100.35%	99.89%	100.21%
Inter Peak 2021							
CO_2 Emissions – kilograms	10,935	100.30%	100.35%	100.52%	100.14%	100.22%	100.30%
Vehicle Kilometres	120,670	100.08%	100.20%	100.41%	100.01%	100.14%	100.22%
Vehicle Hours	2,088	100.91%	101.08%	100.92%	100.31%	100.46%	100.53%
PM Peak 2021							
CO_2 Emissions – kilograms	14,597	100.35%	100.32%	100.05%	99.88%	100.24%	100.33%
Vehicle Kilometres	148,991	100.04%	99.98%	100.33%	100.02%	100.11%	100.10%
Vehicle Hours	3,614	100.75%	101.27%	100.88%	100.84%	100.59%	100.79%
Annualised 12-hour 2021							
CO_2 Emissions – kilograms	36,110,536	100.28%	100.30%	100.31%	100.06%	100.19%	100.27%
Vehicle Kilometres	386,948,552	100.07%	100.11%	100.34%	100.01%	100.12%	100.15%
Vehicle Hours	7,696,321	100.76%	100.98%	100.71%	100.49%	100.39%	100.55%
Annualised 12-hour 2021 (actual differences)							
CO_2 Emissions – kilograms	-	102,184	106,864	112,600	22,090	70,145	96,328
Vehicle Kilometres	-	264,437	435,071	1,332,922	51,231	478,711	583,445
Vehicle Hours	-	58,702	75,793	54,564	37,469	29,970	42,254

Table 4.2 – SATURN Model Statistics for SRS Secondary Catchment Area (all vehicle trips)

	Planned Development Only	Percentage Change over Planned Development Only					
		Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
AM Peak 2021							
CO_2 Emissions – kilograms	50,500	100.10%	100.14%	100.07%	100.07%	100.09%	100.05%
Vehicle Kilometres	513,157	100.01%	100.01%	100.03%	99.98%	100.03%	99.99%
Vehicle Hours	11,038	99.92%	100.04%	100.07%	99.95%	99.83%	99.87%
Inter Peak 2021							
CO_2 Emissions – kilograms	39,389	99.94%	99.91%	99.96%	99.92%	99.93%	99.91%
Vehicle Kilometres	417,051	99.92%	99.91%	99.97%	99.91%	99.93%	99.92%
Vehicle Hours	7,517	100.02%	100.01%	99.98%	99.88%	99.91%	99.90%
PM Peak 2021							
CO_2 Emissions – kilograms	52,397	99.96%	99.79%	99.93%	99.80%	99.97%	100.06%
Vehicle Kilometres	529,655	99.93%	99.84%	100.00%	99.96%	99.96%	99.92%
Vehicle Hours	12,133	100.05%	100.12%	100.08%	100.11%	100.07%	100.06%
Annualised 12-hour 2021							
CO_2 Emissions – kilograms	130,140,008	99.97%	99.92%	99.97%	99.91%	99.97%	99.98%
Vehicle Kilometres	1,350,420,131	99.94%	99.91%	99.99%	99.94%	99.96%	99.93%
Vehicle Hours	26,964,552	100.01%	100.05%	100.03%	99.97%	99.95%	99.95%
Annualised 12-hour 2021 (actual differences)							
CO_2 Emissions – kilograms	-	-35,229	-100,270	-35,056	-113,125	-39,684	-27,607
Vehicle Kilometres	-	-852,523	-1,187,142	-139,894	-817,648	-573,784	-893,316
Vehicle Hours	-	2,180	14,035	8,586	-9,186	-14,445	-14,598

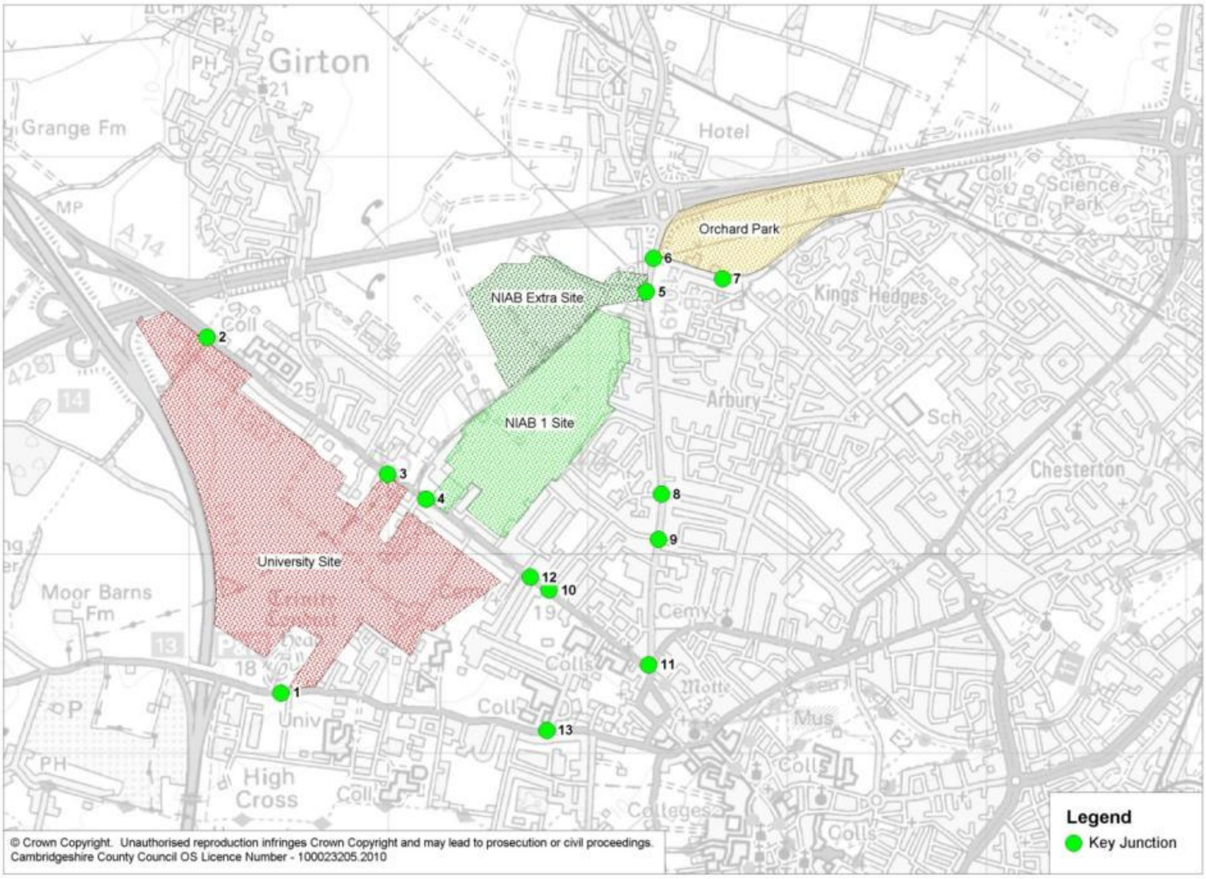
Table 4.3 – SATURN Model Statistics for Cambridge Urban Area (all vehicle trips)

	Planned Development Only	Percentage Change over Planned Development Only					
		Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
AM Peak 2021							
CO_2 Emissions – kilograms	14,014	99.88%	100.13%	100.23%	100.01%	99.88%	99.95%
Vehicle Kilometres	118,180	99.97%	100.02%	100.07%	99.99%	100.06%	100.06%
Vehicle Hours	4,751	99.87%	100.11%	100.04%	100.08%	99.61%	99.82%
Inter Peak 2021							
CO_2 Emissions – kilograms	8,962	99.77%	99.88%	99.86%	99.71%	99.72%	99.82%
Vehicle Kilometres	86,402	99.77%	100.03%	100.02%	99.78%	99.84%	99.93%
Vehicle Hours	2,953	100.02%	100.15%	99.90%	99.73%	99.75%	99.85%
PM Peak 2021							
CO_2 Emissions – kilograms	15,024	100.52%	100.16%	100.34%	100.16%	100.14%	100.26%
Vehicle Kilometres	120,308	99.88%	100.03%	100.27%	99.95%	100.00%	100.07%
Vehicle Hours	5,542	100.21%	100.54%	100.37%	100.34%	100.23%	100.38%
Annualised 12-hour 2021							
CO_2 Emissions – kilograms	32,940,541	100.03%	100.02%	100.09%	99.91%	99.88%	99.99%
Vehicle Kilometres	292,693,094	99.84%	100.03%	100.10%	99.87%	99.93%	100.00%
Vehicle Hours	11,321,441	100.05%	100.27%	100.09%	100.00%	99.88%	100.02%
Annualised 12-hour 2021 (actual differences)							
CO_2 Emissions – kilograms	-	8,543	6,196	28,063	-30,149	-38,114	-4,241
Vehicle Kilometres	-	-465,190	91,922	281,349	-380,592	-214,100	-12,966
Vehicle Hours	-	5,850	30,964	9,737	389	-13,340	2,779

Performance of Key Junctions

4.12 The total traffic delays (in seconds) at a selection of key junctions in the NWC area were monitored across all of the modelled scenarios. The locations of these key junctions are shown in Figure 4.2 with each number referencing the data presented in tables on the following pages.

Figure 4.2 – Key Junction Locations



4.13 Table 4.4 to Table 4.6 below present the delays per vehicle at each junction in each scenario for the AM Peak, Inter Peak and PM Peak hours. Numbers that are highlighted red indicate at least a 10% worsening than in the Planned Development Only scenario – this suggests a significantly negative impact on that junction. The delays shown in these tables are the average delay affecting each vehicle that passes through the junction.

4.14 The AM Peak shows very few junctions getting significantly worse, although Test 2 does cause delays at both entrances/exits to the NIAB site. In the Inter Peak hour, there is an increase of 10% or more in delays at the relevant site entrances/exits for all scenarios except Test 4. In the PM Peak, which has a much greater share of shopping trips than the AM Peak and when the network was already more congested than the Inter Peak, the significantly increased delays are more widespread, affecting junctions other than those directly related to the development sites, in all Tests except 4.

4.15 As expected, junctions at the access points to the development sites come under stress when a major food store is located on the site. This effect is greater in tests with a single large major food store than those with two smaller major food stores. These junction designs will therefore need considering in detail when Transport Assessments are developed for the sites.

4.16 However, some junctions not directly related to the development sites are also affected by the inclusion of major food stores in some of the tests. For example, the Histon Road / Gilbert Road junction (labelled 8 in Figure 4.2) comes under significant additional stress in tests 2, 3, 5 and 6. Issues at existing junctions within the surrounding area would therefore also require further investigation in Transport Assessments for the developments.

4.17 It is also noted that the Planned Development Only model is already showing relatively large delays at the development site entrances/exits, due in part to the fact that these junction designs are only preliminary and will need to be refined. Comparison against the CSRM Base Year model suggests that other key junctions (apart from the three development site entrances/exits) are not adversely affected by the NWC developments in the Planned Development Only scenario.

4.18 Further modelling on the junctions should be carried out using specialist junction modelling software: these figures from SATURN are broadly indicative of the scale of any issues, but should not be used as the basis for junction design.

Table 4.4 – AM Peak Delays at Key Junctions (Seconds per PCU)

ID	Junction	Planned Development Only	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
1	Madingley Road / University site entrance	57.5	56.7	57.4	57.3	57.1	57.3	57.4
2	Huntingdon Road / northern University site entrance	43.6	44.5	36.7	38.5	43.5	39.1	42.5
3	Huntingdon Road / southern University site entrance	84.9	87.2	79.4	80.4	85.2	80.4	82.5
4	Huntingdon Road / NIAB entrance	41.3	42.1	51.4	36.8	46.3	38.9	44.2
5	Histon Road / NIAB entrance	87.4	87.0	99.3	83.0	91.0	84.9	91.3
6	Histon Road / Kings Hedges Road	29.0	28.8	28.9	29.3	28.7	29.1	29.4
7	Kings Hedges Road / Orchard Park entrance	2.6	2.6	2.6	2.8	2.6	2.7	2.7
8	Histon Road / Gilbert Road	29.7	30.6	29.6	29.6	29.8	30.0	29.8
9	Histon Road / Windsor Road	2.0	2.0	2.0	2.0	2.0	2.0	2.0
10	Huntingdon Road / Oxford Road	2.9	3.0	2.9	2.9	2.9	2.9	2.9
11	Huntingdon Road / Histon Road / Victoria Road	78.9	78.4	78.2	78.5	77.8	78.5	78.4
12	Huntingdon Road / Storey's Way	3.8	3.8	3.8	3.8	3.8	3.8	3.7
13	Madingley Road / Storey's Way	3.6	3.5	3.6	3.6	3.7	3.6	3.6

Table 4.5 – Inter Peak Delays at Key Junctions (Seconds per PCU)

ID	Junction	Planned Development Only	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
1	Madingley Road / University site entrance	32.5	44.0	33.6	33.0	34.2	33.1	32.9
2	Huntingdon Road / northern University site entrance	17.6	19.3	17.1	17.4	17.5	17.5	17.0
3	Huntingdon Road / southern University site entrance	20.8	27.1	22.2	21.8	22.4	22.2	22.1
4	Huntingdon Road / NIAB entrance	2.5	2.6	3.1	2.5	2.7	2.5	2.7
5	Histon Road / NIAB entrance	27.3	27.1	33.9	28.7	29.6	27.4	29.9
6	Histon Road / Kings Hedges Road	24.1	24.1	24.4	25.7	24.1	24.9	25.0
7	Kings Hedges Road / Orchard Park entrance	1.6	1.6	1.5	2.0	1.6	1.8	1.8
8	Histon Road / Gilbert Road	16.5	16.9	16.4	17.0	16.5	16.8	16.7
9	Histon Road / Windsor Road	1.8	1.9	1.8	1.9	1.9	1.9	1.9
10	Huntingdon Road / Oxford Road	2.3	2.4	2.3	2.4	2.3	2.3	2.3
11	Huntingdon Road / Histon Road / Victoria Road	64.4	65.3	65.0	64.8	65.2	65.2	64.9
12	Huntingdon Road / Storey's Way	2.7	2.8	2.9	2.8	2.8	2.8	2.8
13	Madingley Road / Storey's Way	2.0	2.1	2.1	2.0	2.1	2.0	2.1

Table 4.6 – PM Peak Delays at Key Junctions (Seconds per PCU)

ID	Junction	Planned Development Only	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6
1	Madingley Road / University site entrance	46.2	48.2	48.2	48.4	48.2	48.3	48.1
2	Huntingdon Road / northern University site entrance	22.4	29.0	21.9	23.0	23.1	23.1	22.0
3	Huntingdon Road / southern University site entrance	81.9	99.0	77.4	81.3	87.0	89.7	80.4
4	Huntingdon Road / NIAB entrance	8.3	8.3	31.0	9.6	16.0	9.5	15.2
5	Histon Road / NIAB entrance	51.4	51.3	68.7	52.1	56.0	53.9	56.4
6	Histon Road / Kings Hedges Road	23.4	23.6	24.9	26.6	23.4	25.2	25.6
7	Kings Hedges Road / Orchard Park entrance	1.6	1.6	1.6	2.1	1.6	1.9	1.8
8	Histon Road / Gilbert Road	39.7	40.2	43.6	46.7	39.6	44.4	44.4
9	Histon Road / Windsor Road	2.2	2.2	2.1	2.2	2.2	2.2	2.2
10	Huntingdon Road / Oxford Road	4.3	5.1	4.5	5.3	4.5	5.1	4.7
11	Huntingdon Road / Histon Road / Victoria Road	64.7	65.4	65.5	64.7	64.6	65.2	64.1
12	Huntingdon Road / Storey's Way	9.1	9.6	9.6	9.3	9.7	8.7	9.2
13	Madingley Road / Storey's Way	2.8	2.7	2.9	2.8	2.8	2.8	2.8

Analysis of Pass-By Trips

4.19 The potential for each new store to attract pass-by trips has been investigated by considering the volume of traffic in the CSRM Planned Development Only SATURN model using the radial route(s) closest to the store, and the length of the detour required to visit a new store. The traffic volumes are shown in Table 4.7, and the distance from each store to the radial routes is shown in Table 4.8 (as measured from maps provided in the policy documents and masterplans). This information has then been used to rank the stores in terms of 'pass-by potential', by looking at each store in turn and weighting the annualised 12-hour two-way flow on the relevant radials according to the distance of the store from that route. For tests with two stores, the pass-by potential of these two stores was combined. The results of this exercise are shown in Table 4.9.

4.20 Unsurprisingly, the Tests that include stores in two locations have greater pass-by potential than single stores, since the total amount of traffic passing the two sites is always greater than the amount passing a single site.

4.21 The radial route with the highest flow is Huntingdon Road: this road is also closest to store locations A and B. Histon Road has the next highest radial flow, but the driving distance to any of the stores is much higher from this route (see Table 4.8). Madingley Road, whilst having the lowest flow, provides more convenient access to Store A than Histon Road does to any location. These factors lead to the rankings provided in Table 4.9, suggesting that Test 4 provides the solution with the highest potential for intercepting pass-by trips.

Table 4.7 – Two-Way PCU Flows on Radial Routes in Planned Development Only Model

Radial Route	AM Peak	Inter Peak	PM Peak	Annualised 12-hour
Madingley Road	1388	966	1808	3,620,584
Huntingdon Road	2158	1685	2306	4,574,298
Histon Road	2366	1540	2092	4,170,036

Table 4.8 – Approximate Road Distance from Stores to Adjacent Radial Routes

Radial Route	Store A	Store B	Store C2
Madingley Road	625m	-	-
Huntingdon Road	610m	510m	-
Histon Road	-	1240m	850m

Table 4.9 – Pass-By Potential of Stores

Test Scenario	Store Location(s)	Pass-By Potential Ranking
Test 1	A	4
Test 2	B	5
Test 3	C2	6
Test 4	A and B	1
Test 5	A and C2	2
Test 6	B and C2	3

4.22 This pass-by analysis has not been able to consider the visibility of a store from the main road since there is no data to support any hypothesis. However, if this could be incorporated then the pass-by potential of store location C2 (Orchard Park) would improve, since this location is likely to be the only one easily visible from a radial route. This would warrant further investigation if other evidence also supports a major food store on this site.

Summary of the CSRM Forecasts

4.23 In summary, the CSRM forecast outputs have been used to:

- Assess the transport impacts of these various tests in terms of the changes to travel time, distance and CO_2 emissions across the SRS Primary and Secondary Catchment Areas, showing that the inclusion of a new store is beneficial at the wider catchment area level although it does cause localised disbenefits within the NWC area;
- Analyse the effects of each Test on the performance of a selection of key junctions in the immediate vicinity and further afield, showing that the impacts are mostly small with a few exceptions which would certainly warrant further investigation if a new major store were to be built in NWC; and
- Compare the potential of each store location to maximise pass-by trips and thus reduce its vehicular impact, by considering the predicted traffic volumes along the radial routes passing close to each store.

5. Summary and Findings

5.1 The results given in Chapters 3 and 4 presented the impacts of each Test scenario from different perspectives, using both results extracted directly from the Gravity Model and those analysed using the CSRM SATURN model. This Chapter draws together those results and also analyses them from a qualitative point of view.

Summary

Travel Distance and CO_2 emissions

5.2 In terms of the average trip generalised costs, the trend is that all the Tests perform better than the Planned Development Only situation. This suggests that any major food store situated in NWC would overall have a beneficial effect over the whole of the Gravity Model catchment area. The CO_2 emissions across the SRS Secondary Catchment Area decrease in every Test scenario, particularly Tests 2 and 4.

5.3 In the SRS Primary Catchment Area, the CO_2 emissions increase in all Tests, with the smallest increase in Test 4. However, there are clear benefits to the residents of NWC in providing a larger store (or stores) than the Planned Development Only situation. The average trip costs to the NWC store(s) are lower than the Planned Development Only average cost. The non-car mode shares achieved, especially by store location A (the University site), are better than the Planned Development Only scenario because a large proportion of trips to the new stores originate from the local area.

5.4 It is worth bearing in mind when considering these results that the calibrated Gravity Model is known to underestimate the number of low-cost trips in the Base Year, and therefore this will have been carried through to the Future Year scenarios meaning that in practice, each test should perform slightly better than forecast.

Key Junctions

5.5 Delays at some of the key junctions are increased, but never by more than 25 seconds. In tests with two stores (Tests 4, 5 and 6), the increase in delay is never more than 8 seconds at any key junction. Impacts are more profound and widespread in the PM peak, however, reflecting the typical spread of main shopping trips throughout a day.

5.6 These impacts on key junctions (both those that form accesses to the development sites and existing junctions in the nearby area) will require further investigation as part of the Transport Assessments for the developments, with any mitigating measures to be funded by the developers.

Mode Share and Potential for Pass By and Linked Trips

5.7 Splitting the retail provision over two sites (Tests 4, 5 and 6) improves the potential for non-car journeys to be made. It also increases the amount of traffic passing close to the stores, thus improving the pass-by potential of these Test scenarios and reducing the vehicular impact of a major new food store.

5.8 In terms of mode share and pass-by potential, Test 4 (store locations A and B in combination) performs the best. If a single store is to be provided, then Test 1 (store location A) gives the best results.

Other

5.9 This modelling has not been able to take account of any brand loyalty or personal choice, since no empirical survey data on shopper preferences in the GVA Grimley survey is available. However, it is noted that a potential advantage in providing two smaller stores (as in Tests 4, 5 or 6), rather than a single larger store, would be that more choice in brand could be made available.

5.10 It is also noted that the Planned Development Only situation includes a varying degree of retail provision at each location, with a much larger amount at the University site than at Orchard Park. Therefore, for example, the impact of a 5500 m^2 GFA store at the University site is dampened (as it represents an increase of only 3000 m^2 GFA) relative to the Orchard Park site (an increase of 4542 m^2 GFA). Table A.10 shows the increase in food store provision over the Planned Development Only scenario in each Test.

Qualitative Discussion

5.11 The Districts have developed a number of objectives[8] for NWC to guide development of planning policy and decision making. Principal amongst these (for this transport study) are the following objectives:

- 3. To minimise carbon dioxide emissions and to make the best use of energy and other natural resources, by being an exemplar of sustainable living.
- 6. To maximise walking, cycling and public transport use and to achieve a modal split of no more than 40% of trips to work by car (excluding car passengers).
- 10. To create sustainable communities with an appropriate provision of shopping and services in appropriate locations, to serve the new and existing population, and reduce the need to travel overall, particularly by car.

5.12 An assessment of the tests in terms of how they perform with respect to these objectives is provided in Table 5.1 below. For each of the three objectives, each Test is ranked on a 5-point scale from -2 to +2, where -2 is a strong negative effect, 0 is neutral, and +2 is a strong positive effect. This provides the basis for understanding in a wider sense, how each of the tests delivers against the outcomes demanded for NWC by the Districts.

Table 5.1 – Analysis of Tests by Key NWC Transport Objectives

Scenario	3. Minimise CO_2	6. Maximise non-car mode share	10. Reduce need to travel by car (internalisation)
Planned Development Only	0	0	0
Test 1	+1	+2	+2
Test 2	+2	+1	+2
Test 3	+1	+1	+1
Test 4	+2	+2	+2
Test 5	+1	+2	+2
Test 6	+1	+1	+1

5.13 This assessment ranks Test 4 first place according to these three objectives, across the SRS Secondary Catchment Area. Other indicators have also broadly supported Test 4, re-enforcing this conclusion. This table also contains no adverse impacts, which shows that, against these three objectives, all of the Test scenarios are an improvement over the Planned Development Only scenario.

[8] NWC Options Report

Findings

5.14 Overall, in terms of transport impacts, this modelling suggests that two stores of 3000 m^2 GFA provided on the University and NIAB sites would serve the residents of NWC better than a single 5500 m^2 store or no major food store at all. However, any store provision will draw in some extra traffic to the area, which will have an impact on the carbon emissions and junction delays nearby.

5.15 At the level of the Cambridge Urban Area, the differences between the two-store tests (Tests 4, 5, and 6) and the single store tests (Tests 1, 2 and 3) are more distinguishable: in CO_2 terms, the two-store tests are beneficial whereas the single store tests give disbenefits. This is caused by the higher non-car mode shares achieved by two smaller stores, which itself is due partly to the dual location being 'local' to a greater number of dwellings, and partly due to the reduced overall catchment area because smaller stores have a smaller 'gravitational pull'.

5.16 In terms of the three key objectives (CO_2, mode share and internalisation), Test 4 performs better than the other tests in comparison to the Planned Development Only Scenario. This Test also has the greatest potential for intercepting pass-by trips and has the least impact on the performance of key junctions in the area (which will also reduce the likelihood of localised junction 'hotspots' of emissions where queues build up).

5.17 Of the three tests with two smaller major food stores rather than one larger one, the order of preference appears to be: Test 4, Test 5, Test 6. However, as indicated in paragraph 5.10 and Table A.10, out of these three tests Test 4 has the least additional food store floorspace and Test 6 has the most, and this is a key determinant in why Test 4 has the least impact in transport terms over the Planned Development Only scenario. In addition to this, Test 4 also has the largest amount of population close to the stores (due in part to the student accommodation on the University site).

5.18 The Planned Development Only scenario provides no major food stores in NWC. This has disadvantages for the local residents, in causing them to travel further for their shopping, but has other advantages since the Test scenarios all lead to some increases in carbon emissions within the SRS Primary Catchment Area. At a wider level, extra food store provision in NWC is generally beneficial to residents of Cambridge City and South Cambridgeshire.

5.19 Finally, the SRS carried out by NLP prior to this study concludes that one superstore or two large supermarkets are the most appropriate form of main food store provision within the planned local centres to meet the food store needs of North West Cambridge at 2021. The study reached its conclusions by assessing the qualitative and quantitative need for additional convenience retail provision and did not take into account other factors such as transport impacts when considering the nature and scale of food store provision required. This study has shown that two smaller stores are preferable in terms of their comparative transport impacts. It should be noted that these findings are based on the data inputs and assumptions outlined in Chapter 2 of this Report and that issues such as brand loyalty and personal shopping preferences will have an impact on the transport impacts of a new food store in NWC but it is not possible to include these more subjective determinants in transport modelling.

Further Work

Phasing

5.20 This study has considered the impacts of major food stores against a backdrop of the final situation of the developments, in 2021. This therefore assumes that all dwellings and other infrastructure (including that unrelated to NWC) are complete when a major food store is added. If, in reality, a major food store were to be opened earlier than 2021, then there could be further transport implications. These would need investigating as part of the Transport Assessment for any specific proposals.

5.21 The dwellings density around each store has been shown to impact upon that store's mode shares and average trip costs – i.e. Test 4 showed lower average trip costs and lower car mode shares for the new stores because they were located on the University and NIAB sites, accessible by a higher number of people than any of the other tests. If a new store were to be opened before the dwellings were complete, then it is possible that it could draw in trade from a wider catchment area, (and thus the average cost and car mode share for travel to that store would be higher). However, there would likely be a reduced level of trip generation until at least the remainder of the dwellings were in place which may off-set this.

5.22 The CSRM 2021 models include other developments and infrastructure around the County, as well as NWC. These may also be in different stages of development in the years leading up to 2021 and this could further impact upon the performance of the Test scenarios in earlier years. For example, the A14 improvements are assumed to be in place by 2021 and would significantly impact upon the cost of travel to Bar Hill Tesco Extra, but if they were not in place then the results of the Test scenarios would be different (as Bar Hill Tesco Extra would be a less attractive alternative).

5.23 Any planning application for a major food store on these development sites would therefore need to consider the implications of phasing in its Transport Assessment. This could involve further modelling work, as required.

Junction Designs

5.24 As was noted previously in this report, the designs of access junctions to and from the three development sites have not yet been finalised and those included in the modelling are only early proposals. This study has shown that some of the site access junction designs would require improvement before a major food store could be included – these issues would need to be considered in the Transport Assessments for those sites. These junctions also experience significant delays in the Planned Development Only scenario, and require further assessment whether or not a major food store is to be added.

5.25 In addition, some of the Test scenarios indicated that existing junctions may also require improvement as a result of the inclusion of a major food store. Transport Assessments for the development sites would therefore need to consider the wider area, as mitigation measures may be required further afield.

Appendix A – Modelled Scenarios

A.1 The Dwelling Scenarios

A.1.1 There are two Future Year dwellings scenarios, arising from the variations in location of dwellings and retail that will occur at Orchard Park if a large store is included at this site. These are as defined in the information passed to Atkins by the Districts: Option 1 has dwellings by the B1049 and a local centre by the A14 (store location C1); Option 2 has dwellings by the A14 and a food store and local centre by the B1049 (store location C2). This reflects a planning permission for a local centre by the A14. However, if a major food store were provided at Orchard Park, it would be located on the corner site with the local centre moving to locate with it.

A.1.2 The total increase in the number of dwellings assumed on each site up to 2021 is given in Table A.1. This information was provided by CCC on behalf of the Districts in a document entitled "NW Cambridge land use figures – for transport work.doc", e-mailed on 4th March 2010. The number of units of student accommodation was received via WSP, as listed in their technical note "TN001 CSRM Updates for NW Cambridge ISSUED.pdf" received on 30th March 2010.

A.1.3 It is noted that some of the dwellings at Orchard Park have already been built, so the modelling work (both the CSRM and the Gravity Model) adds the necessary amount of development to reach this total.

Table A.1 – Dwelling Assumptions

Site	No. of Dwellings	Average dwelling density over whole development site (Dwellings per Hectare)
University	3,000 + 2,405 student accommodation[9]	41
NIAB 1	1,780	35
NIAB Extra	1,100	38
Orchard Park	1,120	35

A.1.4 Assumptions on the locations and spread of the dwellings have also been provided by the Districts; where detailed information was available (for example, the dwellings that have already been built at Orchard Park), this has been used. Elsewhere, dwellings have been located using a uniform distribution according to the specified density. The average densities provided in Table A.1 above are broad indications which have been calculated by dividing the total number of dwellings per development site by the size of the development site. This gives only a broad indication of the dwelling density achieved; the actual densities vary across different parts of the development sites as indicated by the masterplans provided to this study.

A.2 The Retail Scenarios

A.2.1 The tables below describe the store provision on each of the three main sites assumed in each scenario. Store sizes are given in Gross Floor Area (GFA). Table A.10 summarises this information in terms of the amount of extra food store floorspace that is provided in each Test over the Planned Development Only scenario. Note that although the extra trips generated by each food store are calculated on the basis of this additional floorspace, the full size of the store is included within the Gravity Model so that its 'gravitational pull' is representative of its total size. A detailed map showing each development site and the proposed store locations (A, B, C1 and C2) is provided at the end of this appendix.

[9] Since the modelling work for this study was carried out, a discrepancy has been noticed in this data: the correct number of units of student accommodation should have been 2,000. The additional 405 units in the CSRM (referenced in WSP's technical note) are elsewhere in the land use zone, not in NWC. The effects of this error have been considered throughout the commentary in this report.

Table A.2 – NWC Retail Provision in the Base (2008) Scenario

	University	*NIAB*	*Orchard Park*
Store Size (GFA m^2)	0	0	0
Store Location	-	-	-
Orchard Park Dwellings Scenario	Base		

Table A.3 – NWC Additional Retail Provision in Planned Development Only (2021) over Base (2008)

	University	*NIAB*	*Orchard Park*
Store Size (GFA m^2)	2500	1800	958
Store Location	A	B	C1
Orchard Park Dwellings Scenario	Option 1		

Table A.4 – NWC Additional Retail Provision in Test 1 (2021) over Base (2008)

	University	*NIAB*	*Orchard Park*
Store Size (GFA m^2)	5500	1800	958
Store Location	A	B	C1
Orchard Park Dwellings Scenario	Option 1		

Table A.5 – NWC Additional Retail Provision in Test 2 (2021) over Base (2008)

	University	*NIAB*	*Orchard Park*
Store Size (GFA m^2)	2500	5500	958
Store Location	A	B	C1
Orchard Park Dwellings Scenario	Option 1		

Table A.6 – NWC Additional Retail Provision in Test 3 (2021) over Base (2008)

	University	*NIAB*	*Orchard Park*
Store Size (GFA m^2)	2500	1800	5500
Store Location	A	B	C2
Orchard Park Dwellings Scenario	Option 2		

Table A.7 – NWC Additional Retail Provision in Test 4 (2021) over Base (2008)

	University	*NIAB*	*Orchard Park*
Store Size (GFA m^2)	3000	3000	958
Store Location	A	B	C1
Orchard Park Dwellings Scenario	Option 1		

Table A.8 – NWC Additional Retail Provision in Test 5 (2021) over Base (2008)

	University	*NIAB*	*Orchard Park*
Store Size (GFA m^2)	3000	1800	3000
Store Location	A	B	C2
Orchard Park Dwellings Scenario	Option 2		

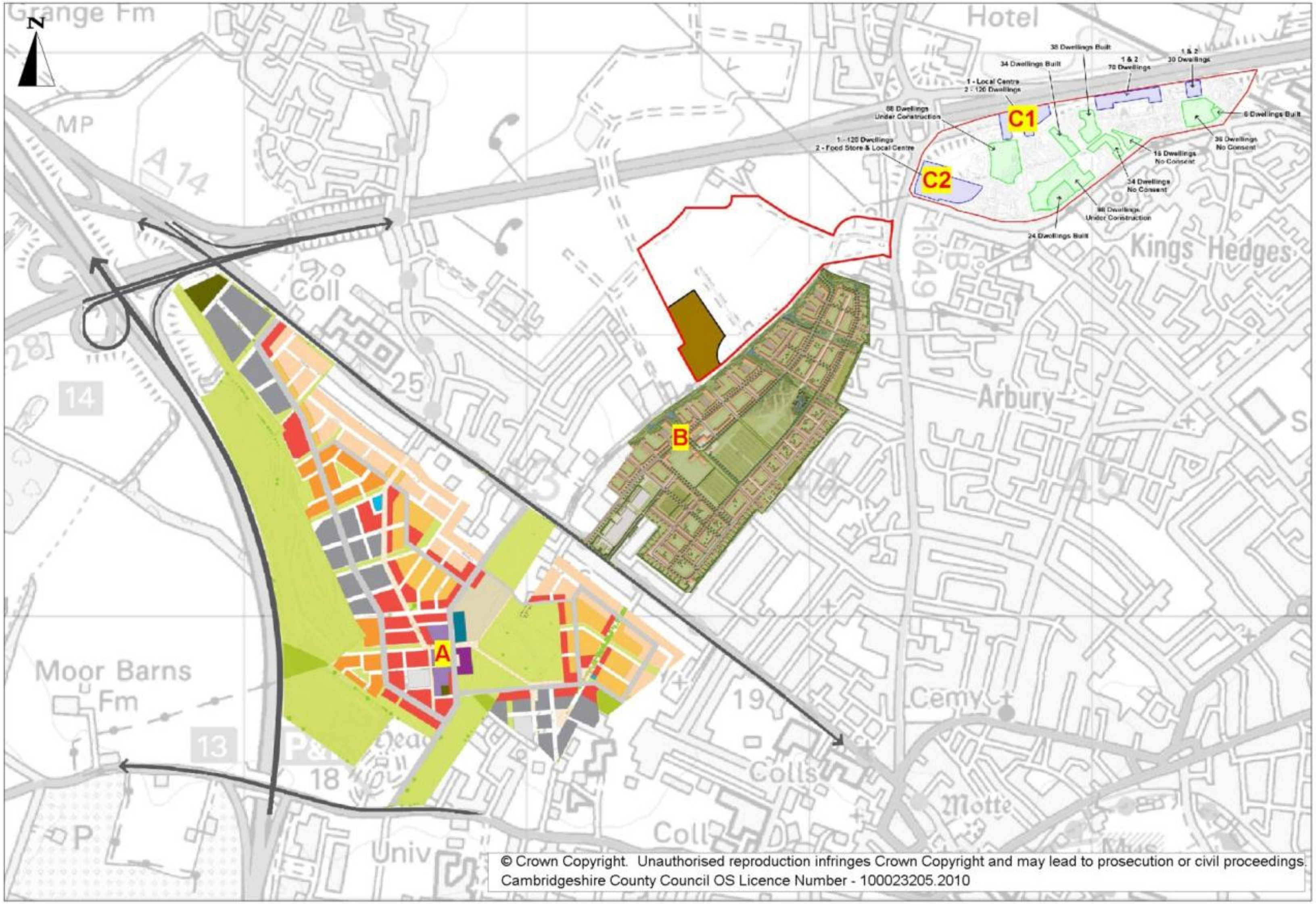
Table A.9 – NWC Additional Retail Provision in Test 6 (2021) over Base (2008)

	University	*NIAB*	*Orchard Park*
Store Size (GFA m^2)	2500	3000	3000
Store Location	A	B	C2
Orchard Park Dwellings Scenario	Option 2		

Table A.10 – Net Increase in Food Store Provision over Planned Development Only Scenario

Test Scenario	Additional m^2 GFA
Test 1	3000
Test 2	3700
Test 3	4542
Test 4	1700
Test 5	2542
Test 6	3242

Figure A.1 – Development Map



Atkins Limited
Woodcote Grove
Ashley Road
Epsom
Surrey KT18 5BW
England

info@atkinsglobal.com
www.atkinsglobal.com