Travel in London

Report 9

MAYOR OF LONDON

TRANSPORT FOR LONDON

EVERY JOURNEY MATTERS

Travel in London report 9

Executive summary

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Travel in London summarises trends and developments relating to travel and transport in London. Its principal function is to describe how travel in the Capital is changing and provide an interpretative overview of progress towards implementing the transport and other related strategies of the Mayor of London, to inform future policy development. It also provides an evidence and analysis base for the general use of stakeholders and policymakers whose responsibilities cover many different aspects of transport and travel in London.

This ninth Travel in London report draws on the latest available data, generally reflecting the 2015 calendar year, or the 2015/16 financial year, and sets these in the longer-term context of the evolution of transport and related trends in London. It looks at developments over the nominal period since 2000, when the Greater London Authority (GLA) and Transport for London (TfL) were established, although in many cases a shorter-term view is either necessary – reflecting the availability of data – or is appropriate, to better reflect contemporary trends and policy concerns.

This **executive summary** sets out the broad content of this report and highlights some key trends and developments that are of particular interest.

A city for all Londoners

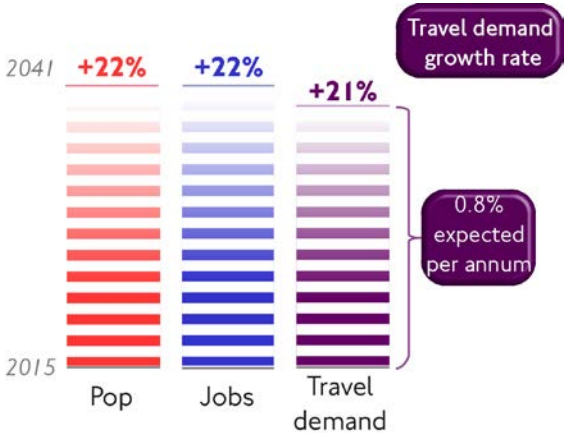
The Mayor of London, Sadiq Khan, took office in May 2016 and is in the process of reviewing his transport and environment strategies. The publication – for consultation – of the document 'A City for all Londoners' (see: https://www.london.gov.uk/get-involved/have-your-say/all-consultations/city-all-londoners) begins to map out his policy agenda for the future. The content of this Travel in London report is arranged around some of the priorities set out in this document, as well as providing the usual range of updates relating to developments across the transport modes.

Overall travel trends in London

London has **grown rapidly** in recent years, despite the economic recession, leading to increased demand on the transport system. This growth is expected to continue into the foreseeable future – and sets the context for our future transport planning.

London's growth has been achieved in the context of **reducing absolute levels of car use and strong investment in increased and improved public transport**, with rapid growth in public transport patronage. A continuation of these broad policies, in the context of London's ongoing development, frames our travel demand projections for the future.

London's future growth.



In 2015, London's population stood at 8.7 million – higher than the previous 'record' level of 8.6 million in 1939. By 2041, London's population is expected to reach 10.5 million – a 20 per cent increase over the current level and equivalent to adding the combined population of Birmingham and Glasgow during this time.

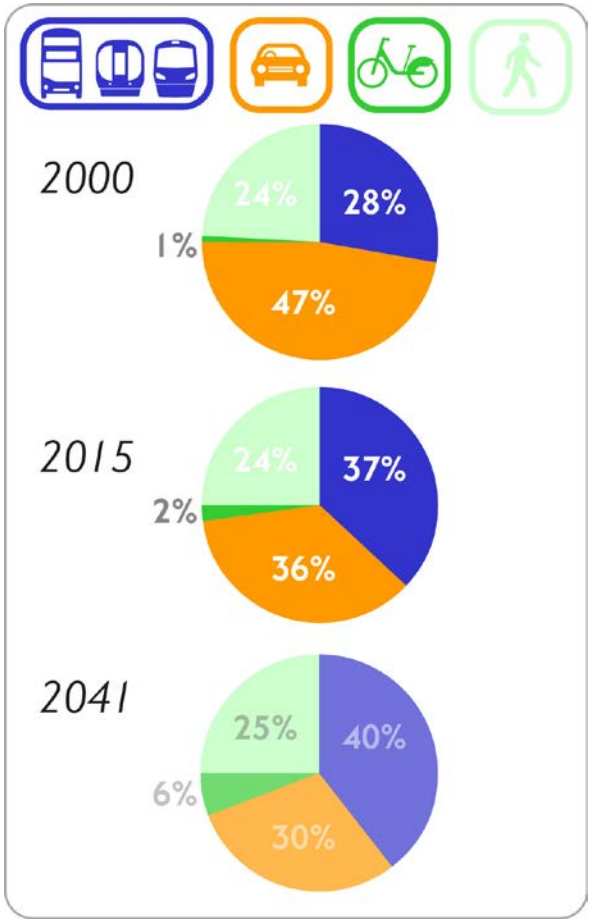
This population growth has been the primary driver behind increased travel demand, which has grown consistently. An average of 26.7 million trips per day were made in London in 2015 – an 18 per cent increase from 2000 and 0.2 per cent higher than 2014.

By 2041, it is expected that this figure will have grown to 32.2 million trips per day – a trend that will require significant new infrastructure, but also new approaches to better manage travel demand and obtain the most from the existing transport networks.

Alongside this strong historic growth in travel demand, London has achieved an unprecedented 10.4 percentage point **shift in mode share** away from the private car towards public transport, walking and cycling – reflecting sustained investment in these modes, limitations on the capacity of the road network, and wider structural, social and behavioural factors.

Private transport accounted for 47 per cent of all trips in 2000, but just 36 per cent in 2015, despite rapidly increasing population. **Public transport** accounted for 28 per cent of trips in 2000, and 37 per cent in 2015. Walking accounts for 24 per cent of trips in London, although this proportion has barely changed over the last twenty years.

Mode share change in London – 2000 to 2015 and (projected) to 2041.



Looking at the key contributors to this overall change in mode share, among **London residents** and at the trip level:

There has been a marked shift away from car travel in **inner London** – mode share is down from 26 per cent in 2005/06 to 21 per cent in 2015/16. Most of this shift has been towards walking (up two percentage points) and cycling (up one percentage point), alongside public transport (up two percentage points).

In **outer London**, car mode share fell by three percentage points, from 50 to 47 per cent, but with a six percentage point increase in public transport mode share, a one percentage point increase in cycle mode share, but a four percentage point reduction in walk mode share.

The **composition of London's population** is also expected to change, altering the emphasis of future demand pressures on the transport networks. In particular, there will be an increase in the number of older people – particularly focused in outer London – whose travel behaviour will emphasise specific types of demand.

Much of the Capital's future growth will be focused on London's **Opportunity and Growth Areas**, which will feature dense, mixed-use developments with high public

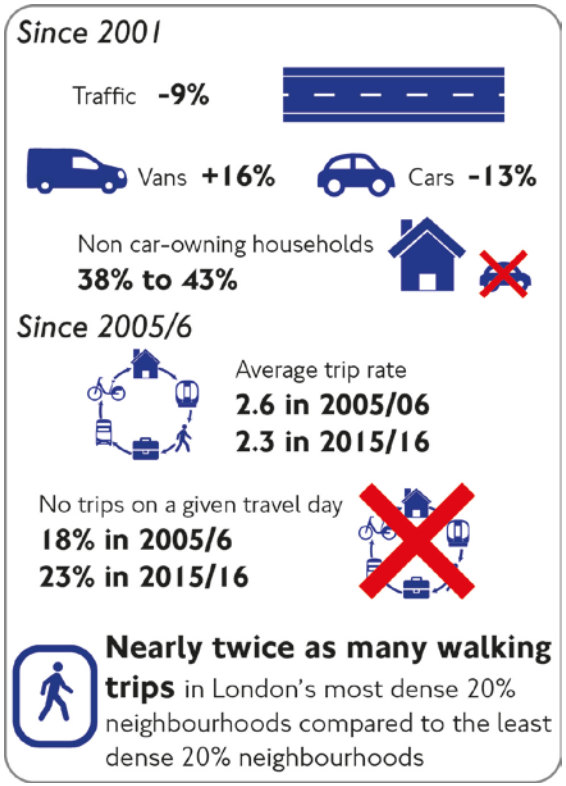
transport connectivity – particularly to the east of London, which should help facilitate continued mode share change.

As well as growth in numbers of people and trips, it is clear from trends over the last decade that **many aspects of travel behaviour are also changing**, and our forecasts need to take these into account.

For example, **household car ownership levels are falling** – in 2015/16, 43 per cent of London households did not have access to a car – and low car ownership is strongly correlated with urban density. Household car ownership is 26 percentage points lower in inner London compared to outer London.

Factors such as **density** also play a large role in determining mode share – 'active travel' trip rates (walk and cycle), for example, are almost twice as high in London's densest 20 per cent of neighbourhoods compared to the least dense 20 per cent.

Changing travel behaviour.



The **'internet economy'**, with increased opportunities for informal working and increased use of home deliveries, appears to be impacting the daily frequency of travel, both in London and nationally, with **increased evidence of 'non-travel'** on any given day – up for example by 74 per cent among young men (aged 17-24) and by 14 per cent among young women between 2005/06 and 2015/16. Furthermore, the frequency of shopping trips is falling, alongside an **increase in van trips** on the road network.

Increasing awareness of, and provision for, **healthier active travel**, such as cycling and walking, should see substantially increased travel by these modes in future, as should a continued shift towards public transport – trips which usually feature intermediate walk stages.

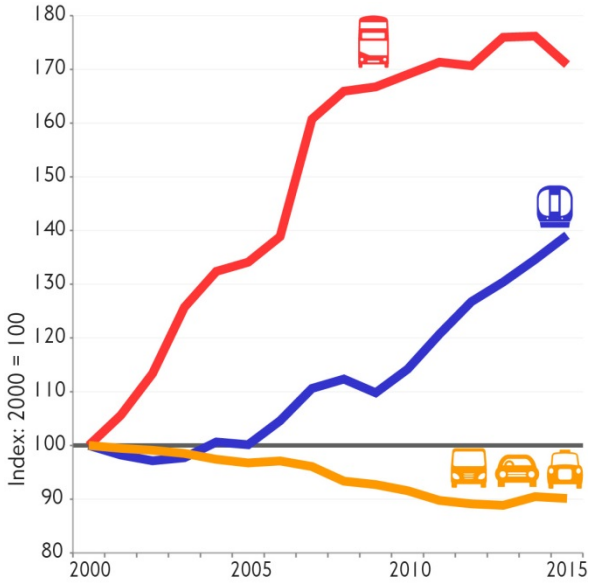
Key trends affecting specific modes of transport

The overall picture of stronger than expected growth in population and travel demand has affected the various travel modes in different ways. There has been strong growth on the core public transport networks, but road traffic volumes have declined.

In 2015/16 the **Underground** carried a total of 1.35 billion journeys – 39 per cent higher than 2000/01 and a 3.3 per cent growth over the most recent year.

The benefits of the **Tube upgrade** have fed through to increased capacity and reliability – with consistently more than 97 per cent of scheduled services being operated today (against, typically, 92 per cent in 2000/01).

Demand changes affecting the principal modes of transport, 2000-2015.



The growth of London's **bus network**, particularly in the early years of the last decade, was unprecedented as it was the best way to provide additional transport capacity over the short term.

Bus demand in 2015/16 stood 71 per cent higher than in 2000/01, at 2.3 billion journeys over the year. Service supply, in terms of bus kilometres operated, stood 35 per cent higher. However, bus patronage fell over the most recent year – by three per cent – reflecting congestion caused by construction on the road network.

There have also been dramatic gains in **bus service reliability** over the period, although recently bus service reliability has suffered in line with a rise in general traffic congestion

Patronage on **National Rail** services serving London (London and South East operators) has also grown strongly over the period since 2000. Journeys on National Rail by London and South East operators totalled 1.2 billion in 2015/16, 78 per cent higher than in 2000/01, and 2.4 per cent higher than the previous year. This equates to an average annual growth rate of 3.9 per cent since 2000/01.

General **reliability of National Rail** has improved over the period, although available capacity into central London during the weekday morning peak remains a major constraint in terms of expected future growth and crowding.

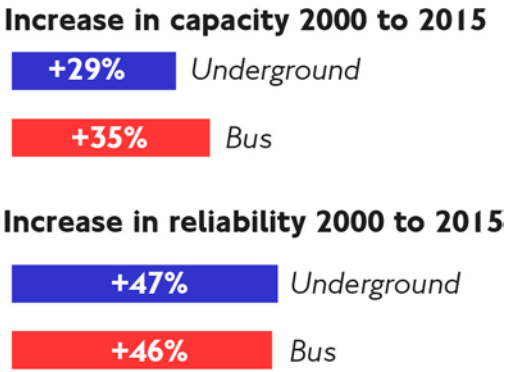
Growth has been reflected and magnified on **London Overground**, which now carries 184 million journeys per year, equivalent to 1.3 per cent of all journeys in London, and with a growth of 32 per cent over the most recent year. This growth is set to develop significantly over the next few years with the progressive opening of the Elizabeth line.

With a **different approach** to features like service frequency and staffing, London Overground continues to deliver high levels of service reliability and customer satisfaction.

From small beginnings late in the last century, London's **light rail networks** are now very significant components of the wider integrated network.

Over the period since 2000/01, the **Docklands Light Railway (DLR)**, serving rapidly developing parts of east London, has increased its service offering by 103 per cent. Demand is up by 205 per cent, including 6.1 per cent growth in the most recent year. The **London Trams** network – centred on Croydon – carries 27 million passengers per year.

More public transport operating more reliably.



Levels of road traffic have fallen for much of the period since 2000, but this fall shows some signs of stabilising over more recent years as the economy recovers from the recession and population continues to grow.

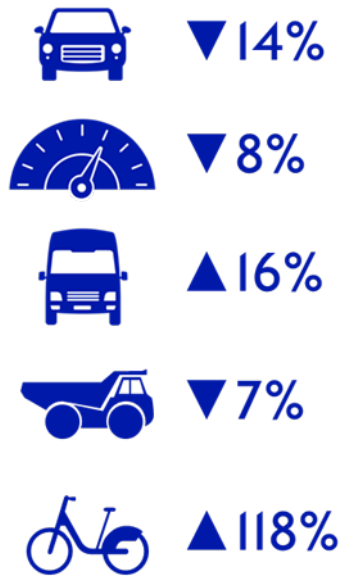
The total volume of road traffic in London in 2015 was 10 per cent lower than in 2000. The reduction was particularly intense in central London, at 21 per cent, partly reflecting the introduction of Congestion Charging to part of this area in 2003, but there were also significant and consistent falls in both inner and outer London, totalling 17 and 6 per cent respectively since 2000. Over the most recent year, London's road traffic fell by a further 0.3 per cent, although there is considerable local variation in traffic trends.

These falls reflect the wider shift in mode share for travel in London, including better and more attractive alternatives to the car. However, they also reflect wider structural and societal change, as well as limitations on the available capacity of the road network – reflecting increased emphasis on urban realm, safety, public transport priority and infrastructure development priorities, **resulting in increasing congestion pressure**.

Within this overall trend towards less road traffic there have also been a number of specific developments.

Since 2000, heavy goods vehicle (HGV) kilometres in London fell by 7 per cent, while there was a 16 per cent increase in van traffic. Freight is essential to both city function and growth, demonstrated by an almost corresponding relationship between goods vehicle kilometres and London's population and jobs since 2000.

Key changes affecting traffic and the road network.



More recently, there have been changes to the market for **licensed private hire vehicles** (PHVs), resulting in a rapid increase in these vehicles – particularly in central London – where they now account for an estimated 12 per cent of motorised traffic during the working day.

Perhaps the most significant development over the period since 2000 has been the **increase in cycling** on London's roads – up by an estimated 118 per cent overall since

2000 but up by 193 per cent in central London.

Across London as a whole, cycle stages increased by 3.5 per cent in the latest year and 133 per cent since 2000.

All of these developments have brought **challenges for traffic management** and have required increasingly innovative initiatives to get the most from London's limited road capacity.

Although **traffic congestion** is the most pressing problem in terms of managing the road network on a day-to-day basis, mode shift to public transport, walking and cycling means that fewer people are affected by congestion. However, for those who need to make journeys by car as well as freight vehicles, delay has been increasing. Bus reliability and journey times have also deteriorated.

A focus on **maintaining and improving journey time reliability** for road users has however maintained this at a good level – between 87 and 90 per cent of journeys on London's major roads are completed within five minutes of their 'expected' time.

The period since 2000 has seen much progress with improving safety on London's roads. Total **killed or seriously injured (KSI) casualties** in 2015 were 66 per cent below those of 2000, and successive casualty reduction targets have been met ahead of schedule.

Nevertheless, **vulnerable road users** (pedestrians, cyclists and motorcyclists) account for a disproportionate number (79 per cent in 2015) of all KSI casualties, and increasing focus on these types of casualty is required, especially in view of the desire to increase active travel in London.

Evidence to inform the contemporary policy debate and highlight key developments and trends

The remainder of this report presents selected analysis, evidence and insight around a range of transport topics that is intended to inform the contemporary transport policy debate in London, and to provide a resource for more general use by stakeholders and others concerned with transport and travel in London.

Healthy Streets

Recent policy thinking for London's streets is increasingly crystallising around the concept of '**Healthy Streets**'. In policy terms this means focusing on delivering the 10 experiential Healthy Streets outcomes. This serves to improve public health by enhancing the experience of being on London's streets which generates mode shift to walking, cycling and public transport use. Motorised road transport generates negative health impacts for those within vehicles (physical inactivity) and those outside vehicles (air pollution, noise, road danger, severance). The 10 Healthy Streets indicators serve as the outcomes to be delivered by a range of policies and new survey techniques have been developed to measure attainment of these objectives.

Encouraging more **active travel** through mode shift from the car to public transport, walking and cycling is now recognised as one of the best ways to improve public health more generally – to promote better health for Londoners and reduce unfair inequalities as well as to help manage growing demand on the networks.

There is much scope to increase the amount of active travel undertaken in

London. It is estimated that up to 2.4 million trips per day currently made by other modes could potentially be walked, given a set of reasonable assumptions relating, for example, to trip length and encumbrance. Although this is very much an upper bound it does illustrate the scope of what is potentially possible.

Illustration of key public health concerns in London.

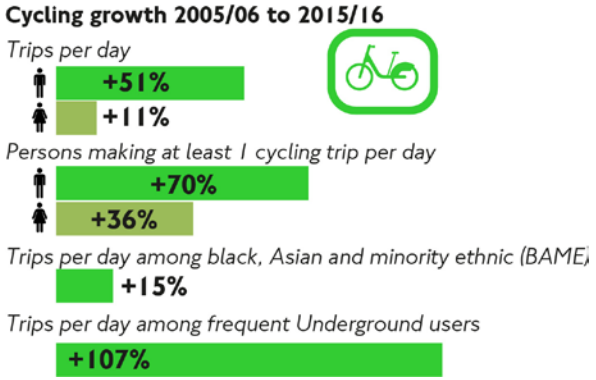
Based on current travel patterns, if Londoners **walked or cycled all of the trips that could potentially be walked or cycled**, then an estimated 60 per cent would achieve the recommended minimum physical activity level (2 x 10 minutes per day) from this source alone.

Not to be overlooked is the important **role of public transport in facilitating active travel**. Public transport journeys usually involve one or more intermediate journey stages that are walked or cycled – and the recent growth in public transport patronage has been a major contributor to the increase in walking journey stages between 2005/06 and 2015/16. Furthermore, denser urban development facilitates more walking – with the active travel trip rate in the densest 20 per cent of London being approximately twice that in the least dense 20 per cent.

Cycling accounts for a mode share of 2 per cent at the all-London level, and this has changed slowly given the rapid growth in public transport. However, there have been dramatic increases in the number of cycling trips.

The full benefits of the current cycling infrastructure programme have yet to emerge. However, there is evidence that the **increase in cycling** comprises both 'new' cyclists and established cyclists making more trips.

The changing socio-demographics of cycling in London.

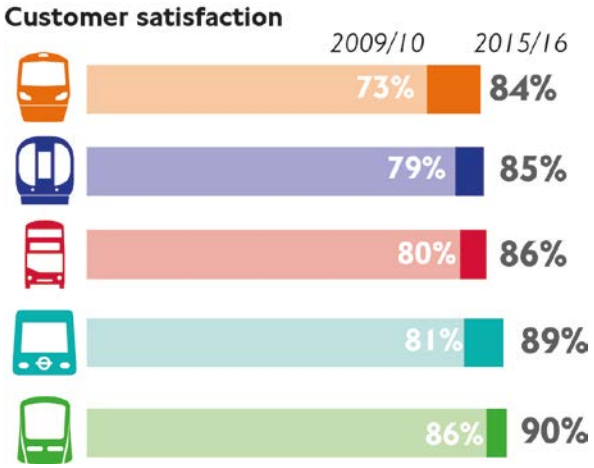


The quality and attractiveness of public transport

London's public transport offering has improved dramatically over the period since 2000. However, a continued focus on this is essential, to facilitate future growth and to continue to address a number of known priorities for Londoners.

We regularly measure aspects of customer perception and satisfaction relating to public transport in London. Feedback from these surveys identifies and drives a range of improvements – the result of which over recent years has been a general improvement in the 'overall satisfaction' of customers with each of the main public transport modes.

Increasing customer satisfaction with the principal public transport modes.



Generally, over the past two decades, **public transport fares** and trends in London have compared relatively favourably with those at the national level. However, the average real fare paid increased by 3 per cent between 2009/10 and 2015/16, and the average London household spends 15 per cent of their income on transport.

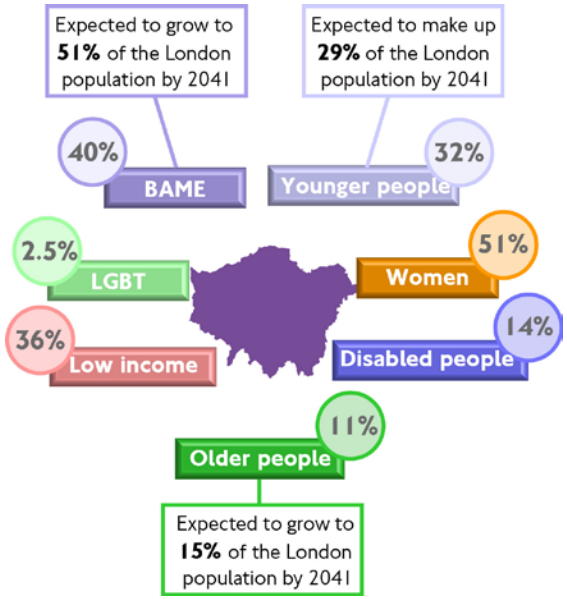
The last decade saw significant improvements to the physical accessibility of London's public transport. For example, the entire bus fleet became step-free from 2005. However, some 41 per cent of the public transport networks in London were not fully accessible in 2015.

This has practical implications in terms of journeys foregone or longer journeys for people who require step-free access. Indeed, the **average trip rate for disabled Londoners is 34 per cent lower than for non-disabled people**. Furthermore, using the step-free rail network only, accessibility to town centres is, on average, 31 per cent lower across London when compared to using the full rail network. Step-free infrastructure also brings a range of benefits to all users, for example, people with heavy items.

Travel by disabled people.

Disabled people are not the only group of specific interest from a transport perspective. **The large majority of Londoners belong to one or more of the seven 'equalities groups'**, and many people belong to more than one. For example, older people are also disproportionately members of low-income households. Furthermore, there is increasing recognition that transport has a role in shaping the life changes of all people, and can have a particular role, for example, in addressing issues such as 'generational' disadvantage for London's younger people.

Membership of London's equalities groups.



Recent developments to public transport have included the progressive opening of the Night Tube, and the introduction of

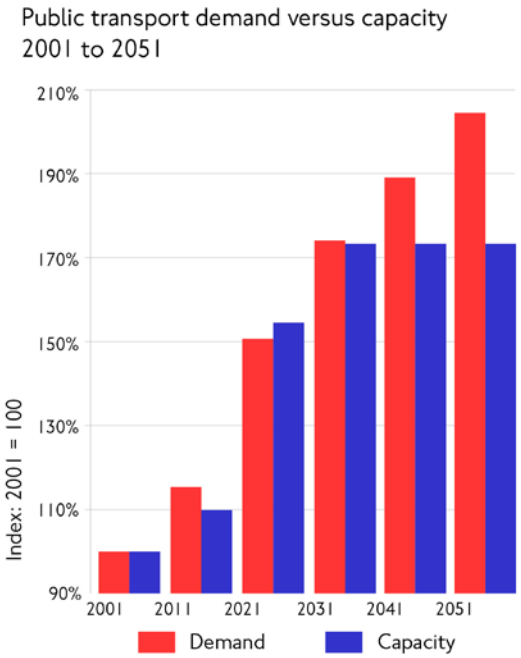
Hopper fares on the bus network. **The millionth Night Tube journey** was made over the weekend of 21/22 October, and it is forecast that 4.37 million journeys will be made in the 2016/17 financial year and 11.9 million in 2017/18. Meanwhile, within 11 weeks of rolling out the scheme, some **21 million Hopper bus journeys** had been made in London.

Supporting the economy, growth, homes and jobs

Continued investment in transport is vital to support London's growth, in terms of meeting the additional demand for travel in the most efficient and environmentally sustainable way, as well as helping unlock the additional housing that will be needed to accommodate London's growing population. It provides the connectivity increasingly required and valued by business, and also provides enhanced opportunities for all Londoners.

Our current plans will see around a **70 per cent increase in public transport capacity** between 2001 and 2051. However, this only keeps pace with London's expected growth, and further infrastructure investment will be required beyond 2031.

Relationship between inbound rail-based public transport capacity and demand at the Central Activities Zone (CAZ) zone 1 cordon in the AM peak.



A **shortage of affordable homes** can act as a drag on the attractiveness of London as a place to live and work. Furthermore, the housing crisis affects the city's attractiveness to businesses as the cost of housing affects all employees.

Building enough new homes and catering for the needs of all Londoners is extremely challenging. Some 270,000 homes in London have been granted planning permission but have not yet been built. In 2014/15 alone, nearly 70,000 new homes were approved – and **only around half the homes that Londoners need** have actually been delivered in recent years.

Growth is enabled by good connectivity and capacity. Since 2000, **73 per cent of new residential development homes have been within 800 metres of a rail or Tube station**.

Transport provides access to jobs and services, and creates places where people want to live, while well-connected areas have high population and/or workplace density. Many of the areas with greatest capacity for development have poor connectivity, which has directly limited private sector investment in housing. There is thus considerable scope for transport to play a major role in **'unlocking' such developments** in the future.

The **East London line extension** demonstrates this potential. There was an increase in the number of new build units in the areas within 500 metres of new stations at Hoxton and Haggerston, from 50 per year in 2008 and 2009 to more than 350 in 2013, a disproportionate increase compared with the London average.

Central London (the Central Activities Zone), the Isle of Dogs and London's new Opportunity Areas, such as Old Oak Common and Vauxhall, Nine Elms and Battersea (VNEB) are expected to be the primary engines of London's future economic growth and new and improved transport capacity to these areas will be vital.

Travel demand to central London in the weekday morning peak grew by 18 per cent between 2000 and 2015, although the growth rate in more recent years has been much faster, at an average of 2.9 per cent per year since 2011, as London's economy recovered from the recession. The increase in public transport capacity to the central area has broadly kept pace over this period, but future **projections indicate increasing capacity limitations** – particularly beyond 2031 – on the basis of current committed plans.

Travel to the **Isle of Dogs** has also increased strongly – up by 147 per cent in the morning peak between 2000 and 2015. Key links like the Jubilee line are now effectively 'full' during the peak period – despite not existing at all just 17 years ago – amply demonstrating how 'success breeds success' and the continuing need to provide new capacity to facilitate and support London's development.

Air quality and greenhouse gas emissions

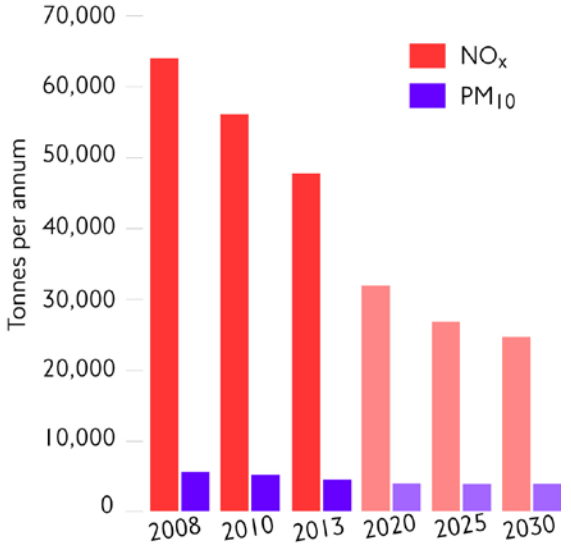
Although several initiatives have been put in place since 2000 to improve the Capital's air quality, poor air quality remains a major issue and is thought to be responsible for the equivalent of up to **9,400 premature deaths** per year.

On the positive side, the period between 2008 and 2013 saw estimated reductions of 20 per cent in London's particulate matter (PM_{10}) emissions, and 25 per cent reductions in London's nitrogen oxide (NO_x) emissions.

London now **consistently meets the EU limit value for PM_{10}** at sites where this is reported. However, high pollution episodes still occur, with PM_{10} known to be dangerous at any level, and further reduction will therefore bring health benefits.

Furthermore, there is increasing evidence that a **greater proportion of particulate pollution is in the smaller, most dangerous size category** ($PM_{2.5}$), in part reflecting changing vehicle technologies. Also, as the emissions performance of vehicle exhausts improves, proportionately more of the PM_{10} in the air arises from **sources that are difficult to address** through technological improvement alone – notably vehicle tyre and brake wear.

Actual and projected change in London's emissions of PM_{10} and NO_x



London **does not currently meet EU limit values for nitrogen dioxide (NO_2),** with widespread exceedances throughout central and inner London, and along major roads throughout the Capital. A primary reason for the delay in reducing NO_2 has been the **non-performance of successive generations of 'Euro' emissions reduction standards** to deliver the expected reductions in NO_x/NO_2 under real-world

driving conditions in London – for a variety of technical reasons.

Furthermore, poor air quality is disproportionately focused on areas of high population in inner London and areas of multiple deprivation.

There is therefore currently a **major focus** on measures that can be taken, by the Mayor and Government, to **bring London and other major UK cities into compliance for NO_2 at the earliest opportunity**. The Ultra Low Emission Zone (ULEZ) and upgrades to the TfL bus fleet are initiatives where London is leading the way.

Towards a new Mayor's Transport Strategy

This report has set out some of the main trends in travel and transport in London since 2000. It has identified the latest emerging trends and set these in the context of the challenges facing London over the next 25 years.

The recent publication of **A City for all Londoners** sets out the general direction of Mayoral thinking on transport, alongside that on a range of other priorities facing the Capital. This Travel in London report forms part of the evidence base to help the Mayor develop his **transport and environment strategies and his London Plan** over the coming months. Over the longer term, it will provide a means to monitor and report progress against strategy goals, as well as to update the broader context and backdrop against which transport policy is framed.

Transport and travel demand patterns in London are continually evolving, as are the transport networks themselves – reflecting factors both immediate to the networks or wider societal changes. In much the same way policy thinking also evolves – and so approaches to transport problems that may not have been considered two decades ago can now be regarded as mainstream. Reflecting on the data in this report, and on key trends that have emerged over the last few years, the following are perhaps the **'top 10'** emerging trends that may be of most interest to policymakers:

- London's **sustained mode shift** away from the car has been impressive in magnitude and sustained year-on-year. For this to continue will require continued provision of increased public transport capacity.
- Reflecting this, **volumes of traffic in London continue to fall**, although the trend seen since 2000 shows signs of bottoming out, as population continues to increase and the economy grows. Essential traffic will always need an efficient road network, and increased pressure on reducing amounts of road space will continue to require ever more innovative responses to get the most out of London's roads.
- There are signs, both in London and nationally, that the **level of trip making by individuals is decreasing**. This is thought to reflect the impact of technology and changed working practices. While small in scale and not yet confirmed as an established trend, this may have implications for assumptions about future levels of travel demand, given the likely continued evolution of technology.
- **Increased density is a natural corollary of London's growth**, and high density, mixed-use developments featuring high public transport connectivity are increasingly seen as the preferred model for the future. The travel behaviour of people using these locations is markedly different from average, in ways that are mostly considered to be beneficial (lower car ownership, higher active travel, but lower overall trip rates).
- Cycling has grown rapidly in London, but the growth is not evenly spread

across all parts of the city or all parts of the population. **There are large potential 'markets' for increasing cycling** – in outer London, among women and among those on lower incomes – all of which need to be effectively tapped, through targeted measures and in parallel with the roll-out of new infrastructure, if aspirations for much higher levels of cycling are to be fully realised.

- **Walking as a mode of travel**, taken for granted by many, has enormous potential to improve the public health of Londoners. However, at the trip level the **walking mode share has not changed substantially over the last decade**. Active travel is the most effective way of improving public health, is free at the point of use, and has few or no undesirable side effects. As with cycling, there is scope to increase the volume and mode share of travel on foot – given appropriate infrastructure improvements and other incentives.
- **Central London is a vitally important engine of the UK economy** and has recovered rapidly from the recent recession. Post European Union referendum, aspects such as international competitiveness will become ever more important. Travel to central London in the weekday morning peak is up by an average of 2.9 per cent per year since 2011, with particularly strong growth seen on rail, and on the Underground which distributes commuters around central London. Few National Rail termini have 'spare' capacity to accommodate future demand growth and new capacity provided by firmly committed infrastructure such as the Elizabeth line will only absorb growth to the early 2030s.
- Despite concerns about rising traffic congestion, mode shift to public transport, walking and cycling **means that fewer people are affected by road congestion.** However, for those who need to make journeys by car as well as freight vehicles, delay has been increasing. Bus reliability and journey times have also deteriorated. Although journey time reliability for general road traffic has been maintained, in the face of growing competition for road space, through an emphasis on efficient operation.
- The role that **transport can play in increasing the supply of housing** in London is increasingly recognised. The role of the East London line extension shows what can be done, and can lead to a virtuous circle – in that housing requires transport connectivity, which in turn can emphasise both public transport and active travel, promote more 'efficient' travel by reducing things like commuting distances, and create vibrant and more sustainable new neighbourhoods.
- **London's air quality remains poor – and is a major public health issue**. Despite considerable gains in meeting limit values for particulate pollution in recent years, levels of both nitrogen dioxide and particulate matter remain stubbornly high and require concerted and, in the case of particulate matter – increasingly innovative approaches to reduce levels at the earliest opportunity.

About Transport for London

We are the integrated transport authority for London. Our purpose is to keep London moving, working and growing, and to make life in our city better. We reinvest all of our income to run and improve London's transport services.

Our operational responsibilities include London Underground, London Buses, Docklands Light Railway (DLR), London Overground, TfL Rail, London Trams, London River Services, London Dial-a-Ride, Victoria Coach Station, Santander Cycles and the Emirates Air Line. On the roads, we regulate taxis and the private hire trade, run the Congestion Charging scheme, manage the city's 580km red route network, operate all of the Capital's 6,300 traffic signals and work to ensure a safe environment for all road users.

We are delivering one of the world's largest programmes of transport capital investment, which is building the Elizabeth line, modernising Tube services and stations, transforming the road network and making it safer, especially for more vulnerable road users, such as pedestrians and cyclists. We are a pioneer in integrated ticketing and providing information to help people move around London. Oyster is the world's most popular smartcard, and the rise in contactless payment is making travel ever more convenient. Real-time travel information is provided directly by us and through third party organisations, which use the data we make openly and freely available to power apps and other services. Improving and expanding transport in London is central to driving economic growth, jobs and housing across the country.

1. Introduction and contents

1.1 TfL's Travel in London reports

Travel in London is TfL's annual publication that examines and summarises trends and developments relating to travel and transport in London. It provides an authoritative source of transport statistics as well as topical evidence-based analysis, and tracks trends and progress in relation to the transport and other related strategies of the Mayor. It also provides an interpretative commentary that looks across the immediate impacts of TfL and its delivery partners, as well as external influences and trends, in shaping the contribution of transport to the daily lives of Londoners and the economic and social vitality of the Capital. As such, it serves as a general resource for those planning and operating transport in London, as well as a more specific 'evidence base' in relation to particular policy themes and challenges.

1.2 Travel in London report 9

This ninth edition of Travel in London provides a comprehensive overview of key travel and related trends and their causes, to inform the ongoing development of the transport and related strategies of the Mayor of London. It covers much of the ground that will be of relevance to current topical transport issues and, in looking back over a decade or more of trends and developments, provides an interpretative commentary that should inform and underpin the formulation of future transport policy.

The report consists of the following chapters:

Chapter 2 looks at the overall patterns of travel demand in London, covering aspects such as the total amount of travel in London on a typical day and the transport modes used. It looks backwards at how today's patterns have developed over the last decade or more. It also contains statistics and trends that characterise the nature of daily travel patterns in London and the travel choices of London residents, derived from TfL's London Travel Demand Survey (LTDS).

Chapter 3 focuses on the public transport modes in London, in terms of travel demand trends and operational performance. For each of the main public transport modes, it considers travel demand trends specific to that mode, and looks at the nature and level of service offered, in terms of aspects such as service reliability. It looks back over a decade or more in describing past trends, and considers some specific contemporary developments that will be of relevance to future planning.

Chapter 4 considers aspects of the public transport customer experience, including fares and customer satisfaction with using public transport in London. It also covers aspects of equality and inclusion, physical accessibility and connectivity, and safety and security.

Chapter 5 focuses on the emerging 'Healthy Streets' agenda, firstly outlining what this means, both in conceptual and practical terms. Analysis and insight that illustrate current trends and opportunities in relation to the two key 'active travel' modes – cycling and walking – are explored, aiming to present a collection of resources and insight that will inform the developing policy debates in this area.

Chapter 6 considers London's road network and trends and patterns in the traffic that uses it. It maps out traffic demand patterns across London, examining how these have changed over time and drawing out those aspects of particular relevance to future planning. It then looks at aspects of road network management, such as congestion and reliability, and, finally, focuses on freight traffic in London, assembling a range of statistics relevant to current policy debates in this area.

Chapter 7 picks up the major theme of supporting London's future growth, firstly setting out the nature of the transport challenges that this presents before picking up specific aspects such as how transport in London can best support the demand for new housing in the context of a city that is expected to grow rapidly over the coming decades.

Chapter 8 addresses the theme of improving London's environment – focusing on local air quality and carbon dioxide (CO_2). The current policy debate is informed by insights arising from TfL's tools and analysis that help scale and explain the nature of London's air quality.

1.3 Further information

For specific technical queries on the contents of this report, readers should contact TILenquiries@tfl.gov.uk.

2. Overall travel trends in London

2.1 Introduction and contents

This chapter looks at overall travel demand trends in London, in terms of the overall number of trips made, the mode shares for the different forms of transport, and the factors underlying these trends. It also explores how various aspects of travel in London have changed over recent years, as a preliminary to material considered in chapter 7 of this report that summarises how TfL expects them to change into the future – reflecting London's continuing population and economic growth.

The chapter then focuses on two aspects particularly relevant to future policy. It looks at mode shares in London from several different perspectives – illustrating how mode shares vary by time of day, by different groups of people, different types of trip and in different parts of London. The chapter also characterises the travel behaviour of London residents – giving a baseline of quantities that illustrate the richness and diversity of travel demand patterns and illustrate several key challenges and opportunities for the future.

The volume of travel in London has grown substantially over the last two decades or so, more recently at a notably faster rate than previously anticipated, albeit matched by a consistent shift in mode share away from private car towards public transport, walking and cycling. These trends are projected to continue into the foreseeable future, and London's expected future rapid population growth will significantly intensify many transport challenges. It is important that the transport system continues to provide additional, appropriately targeted capacity so that London can reach its full economic potential, and understanding past trends will allow TfL to make better projections of future travel demand.

2.2 Total travel in London

Previous Travel in London reports consolidated historic information on travel trends over the last two decades or so. Principal features of these trends have been:

- Sustained growth in demand for travel, most directly reflecting population and employment growth.
- A substantial and sustained shift in mode share away from private car and towards public transport, in parallel with increased public transport supply.

In 2015:

- Total travel demand in London, measured as journey stages, grew by 0.8 per cent over 2014, maintaining a consistent pattern of annual increases stretching back to the 1990s.
- A total of 26.7 million trips were made to, from, or within London on a typical 2015 day, with growth at the trip level lower (0.2 per cent) than previous years, this averaging 1.3 per cent per year over the last 10 years.
- This means that there are now 17.8 per cent more trips, and 24.4 per cent more journey stages in London on an average day than in 2000.
- The net shift in mode share away from private transport towards public transport, walking and cycling that has been a major feature of the past decade continued in 2015. In relation to 2014 there was a further 0.3 percentage point fall in the private transport mode share, to 36.2 per cent of trips, and a 0.1

percentage point decrease in the public transport mode share (at the trip level). There were small net increases in the walking and cycling mode shares at the trip level.

- This means that, over the period between 2000 and 2015, there was a 10.4 percentage point net shift in mode share to public transport, walking and cycling away from private transport at the trip level, with public transport, walking and cycling now accounting for 63.8 per cent of all trips in London.
- The equivalent shift at the journey stage level between 2000 and 2015 has been an 11.3 percentage point shift in mode share away from private transport to public transport, walking and cycling.

2.3 Journey stages in London

Essential background and terminology

This section updates consolidated estimates of total travel in London on an average day. A **trip** is defined as a one-way movement from an origin to a destination to achieve a specific purpose, for example, to go from home to work. Each trip may involve travel by one or more individual modes of transport. These component parts of trips are referred to as **journey stages**. Key concepts relating to trips, journey stages and main mode of travel were explained in detail in Travel in London report 5.

Travel in London report 5 also discussed the requirement that had arisen for TfL to revise the methodology used for calculating estimates of trips and journey stages in London. This requirement arose from changes to the input data series used to derive the estimates, most notably the release of data from the 2011 Census: Population Estimates for the United Kingdom, which revealed London's population to be higher than previously understood, but also series relating to road traffic volumes and bus passengers. The figures shown in table 2.1 are therefore on a consistent basis from 2007 to 2015.

Total number of journey stages

Daily journey stages in London in 2015 were 31.5 million, up from 31.3 million in 2014 and 30.6 million in 2013. This is a 0.8 per cent increase in journey stages in the latest year. In 2015 there were 24.4 per cent more journey stages per day in London than in 2000.

Annual growth in journey stages was particularly high for rail-based modes, with strong growth in 2015 of 6.2 per cent on London Underground (LU) and 9.3 per cent on DLR, compared with the previous year. National Rail stages also increased in 2015, albeit at a slower rate than previous years, with growth of 2.6 per cent. Bus stages fell by 1.8 per cent, the first fall since 2010.

Car driver stages fell slightly, down by 0.7 per cent on 2014 following a slight increase in the previous year. Despite the decrease in bus stages, strong growth on rail-based public transport has continued the established trend of increased mode share for public transport use in London, at the stage level, with a corresponding continued net shift away from private motorised transport.

Notable from table 2.1 is the 15-year trend, showing a 24.4 per cent increase in total journey stages from 2000, with rail stages up by 81.1 per cent over the same period. Also notable is the 77.5 per cent increase in bus stages since 2000, despite the fall in the most recent year.

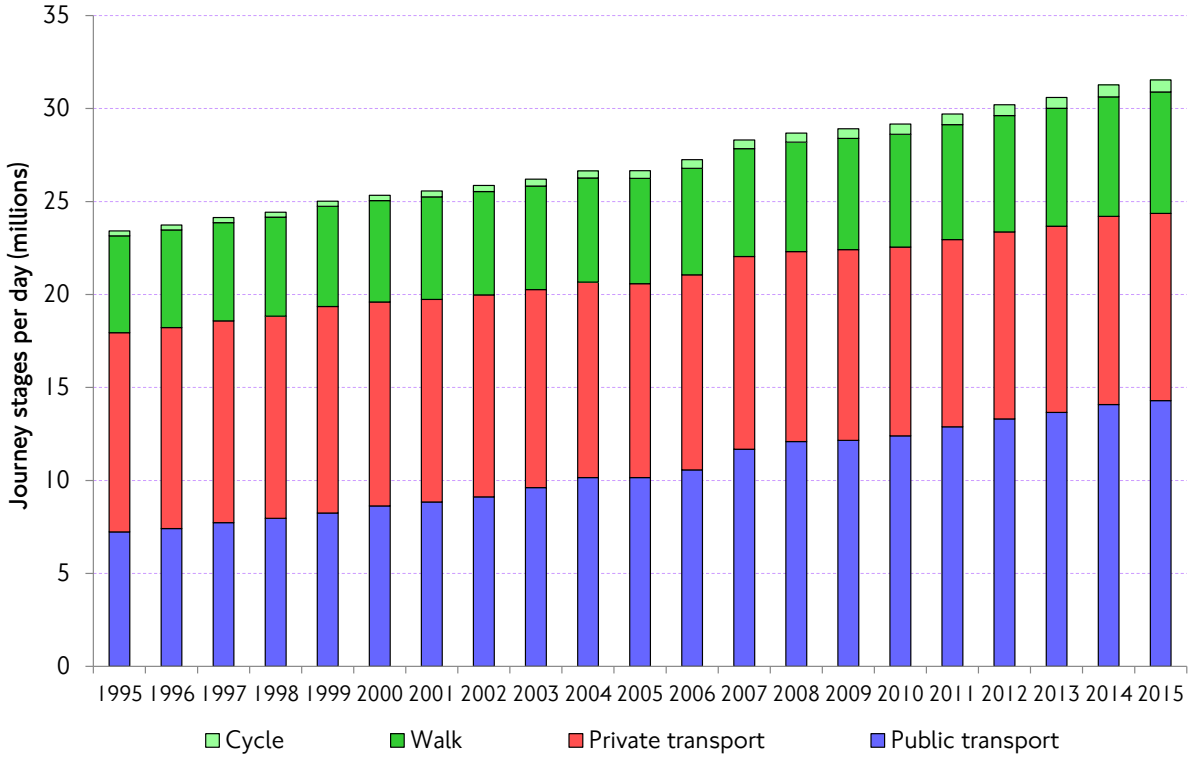
Table 2.1 Aggregate travel volumes in Greater London. Estimated daily average number of journey stages by mode, 1995 to 2015. Seven-day week.

Millions of journey stages

Year	Rail	Under-ground	DLR	Bus (incl. tram)	Taxi /PHV	Car driver	Car passenger	Motor cycle	Cycle	Walk	All modes
1995	1.5	2.1	0.0	3.3	0.3	6.8	3.7	0.2	0.3	5.2	23.4
1996	1.5	2.1	0.0	3.4	0.3	6.9	3.8	0.2	0.3	5.3	23.7
1997	1.6	2.2	0.1	3.5	0.3	6.9	3.8	0.2	0.3	5.3	24.1
1998	1.7	2.4	0.1	3.5	0.4	6.9	3.8	0.2	0.3	5.3	24.4
1999	1.8	2.5	0.1	3.5	0.4	7.1	3.8	0.2	0.3	5.4	25.0
2000	1.8	2.6	0.1	3.7	0.4	7.0	3.8	0.2	0.3	5.5	25.3
2001	1.8	2.6	0.1	3.9	0.4	6.9	3.7	0.2	0.3	5.5	25.6
2002	1.9	2.6	0.1	4.2	0.4	6.9	3.7	0.2	0.3	5.6	25.9
2003	1.9	2.6	0.1	4.6	0.4	6.8	3.6	0.2	0.4	5.6	26.2
2004	2.0	2.7	0.1	5.0	0.4	6.7	3.6	0.2	0.4	5.6	26.6
2005	2.0	2.6	0.1	5.0	0.4	6.6	3.6	0.2	0.4	5.7	26.7
2006	2.1	2.7	0.2	5.2	0.4	6.6	3.7	0.2	0.5	5.7	27.2
2007	2.3	2.9	0.2	5.9	0.4	6.4	3.7	0.2	0.5	5.8	28.3
2008	2.4	3.0	0.2	6.2	0.4	6.3	3.7	0.2	0.5	5.9	28.7
2009	2.3	2.9	0.2	6.3	0.4	6.3	3.7	0.2	0.5	6.0	28.9
2010	2.5	3.0	0.2	6.3	0.3	6.3	3.7	0.2	0.5	6.1	29.2
2011	2.7	3.2	0.2	6.4	0.4	6.1	3.8	0.2	0.6	6.2	29.7
2012	2.9	3.3	0.3	6.4	0.4	6.0	3.8	0.2	0.6	6.3	30.2
2013	3.1	3.4	0.3	6.5	0.4	6.0	3.8	0.2	0.6	6.3	30.6
2014	3.2	3.5	0.3	6.7	0.4	6.1	3.9	0.2	0.6	6.4	31.3
2015	3.3	3.7	0.3	6.5	0.3	6.0	3.9	0.2	0.7	6.5	31.5
Percentage change 2014 to 2015	*2.6*	*6.2*	*9.3*	*-1.8*	*-12.5*	*-0.7*	*-0.3*	*1.9*	*3.5*	*1.6*	*0.8*
2000 to 2015	*81.1*	*41.0*	*221.7*	*77.5*	*-9.7*	*-13.8*	*2.2*	*-9.7*	*133.2*	*19.9*	*24.4*

Source: TfL Planning, Strategic Analysis.
1. A journey stage is a part of a trip made by a single mode of transport.
2. Each rail interchange between train operating companies is a new journey stage.
3. Bus journey stages are counted by starting a new stage each time a new bus is boarded.
4. Underground journey stages are counted by station entries; interchanges within stations are ignored.
5. Walks are counted only when they form complete trips (ie walking all the way), not when they are part of trips using other modes of transport.

Figure 2.1 Aggregate travel volumes in Greater London. Estimated daily average number of journey stages, 1995 to 2015. Seven-day week.



Source: TfL Planning, Strategic Analysis.

2.4 Trips in London

Total number of trips

The number of trips made in London in 2015 averaged 26.7 million per day, an increase of 0.2 per cent over the previous year (table 2.2). This is a smaller increase to that observed for journey stages, and could represent a slowing down of the previously long-established growth in travel demand.

Included in these totals are all trips with an origin, a destination, or both, in Greater London by London residents and by non-residents, including commuters and day visitors from outside London as well as overnight visitors and tourists. The London resident population in 2015 was 8.7 million, 1.6 per cent higher than in 2014 and 19.9 per cent higher than in 2000. The larger 'daytime population' of Greater London, including non-resident visitors, was estimated at 9.8 million in 2015, 1.6 per cent higher than the previous year.

Over the period since 2000, total trips have increased by 17.8 per cent, with particularly notable increases of 74.4 per cent in rail trips and 60.3 per cent in bus trips, with cycle trips (as main mode) increasing by 118 per cent. Car driver trips decreased by 13.9 per cent over the same period.

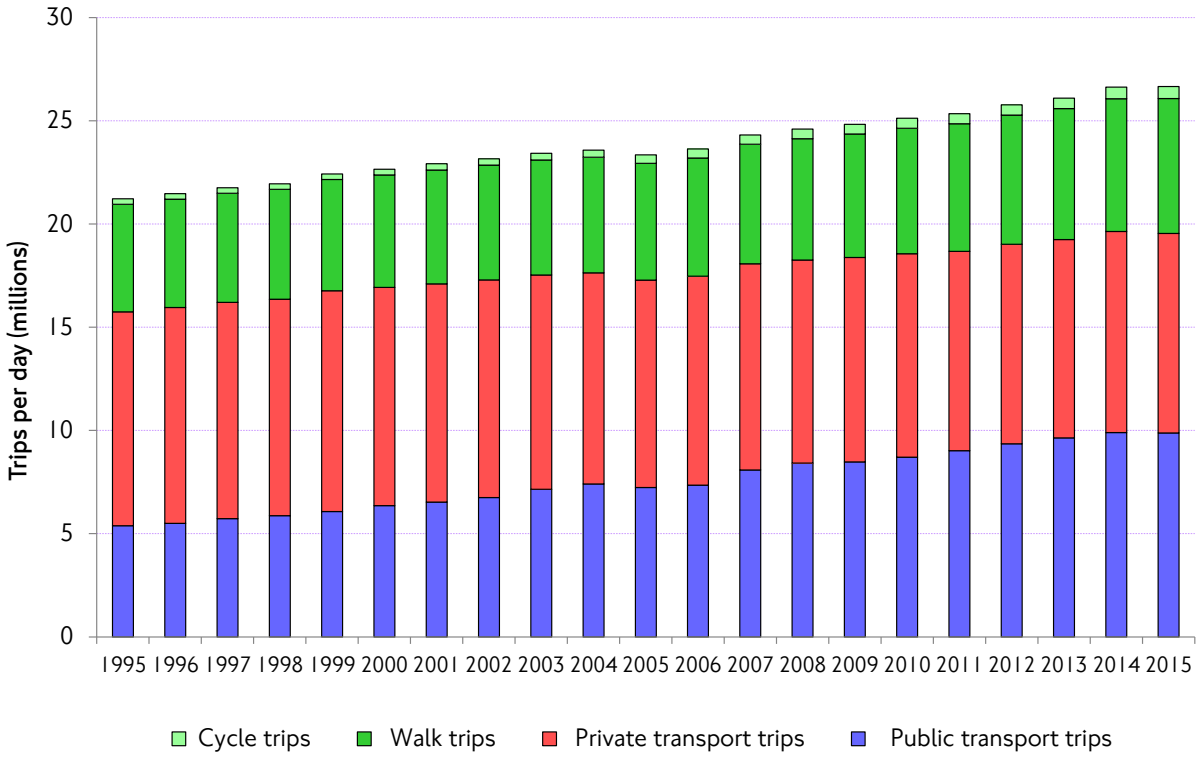
Table 2.2 Aggregate travel volumes in Greater London. Estimated daily average number of trips by main mode of travel, 1995 to 2015. Seven-day week.

	Millions of trips									
Year	Rail	Under-ground /DLR	Bus (including tram)	Taxi/ PHV	Car driver	Car passenger	Motor cycle	Cycle	Walk	All modes
1995	1.3	1.6	2.2	0.3	6.6	3.6	0.2	0.3	5.2	21.2
1996	1.4	1.5	2.3	0.3	6.7	3.6	0.2	0.3	5.3	21.5
1997	1.5	1.6	2.3	0.3	6.7	3.6	0.2	0.3	5.3	21.8
1998	1.5	1.7	2.3	0.3	6.7	3.6	0.2	0.3	5.3	21.9
1999	1.6	1.8	2.3	0.3	6.9	3.6	0.2	0.3	5.4	22.4
2000	1.7	2.0	2.4	0.3	6.8	3.6	0.2	0.3	5.5	22.7
2001	1.7	1.9	2.6	0.3	6.8	3.6	0.2	0.3	5.5	22.9
2002	1.7	1.9	2.8	0.3	6.8	3.5	0.2	0.3	5.6	23.2
2003	1.8	1.9	3.2	0.3	6.7	3.5	0.2	0.3	5.6	23.4
2004	1.8	2.0	3.3	0.3	6.6	3.4	0.2	0.3	5.6	23.6
2005	1.8	1.9	3.2	0.3	6.5	3.4	0.2	0.4	5.7	23.4
2006	1.9	2.0	3.1	0.3	6.4	3.5	0.2	0.4	5.7	23.6
2007	2.1	2.0	3.6	0.4	6.3	3.5	0.2	0.4	5.8	24.3
2008	2.2	2.1	3.8	0.3	6.1	3.5	0.2	0.5	5.9	24.6
2009	2.1	2.2	3.9	0.3	6.2	3.5	0.2	0.5	6.0	24.8
2010	2.3	2.1	4.0	0.3	6.1	3.6	0.2	0.5	6.1	25.1
2011	2.4	2.2	4.1	0.3	5.9	3.6	0.2	0.5	6.2	25.3
2012	2.6	2.4	4.1	0.3	5.9	3.6	0.2	0.5	6.3	25.8
2013	2.7	2.5	4.1	0.3	5.8	3.6	0.2	0.5	6.3	26.1
2014	2.8	2.6	4.1	0.3	5.9	3.7	0.2	0.6	6.4	26.6
2015	2.9	2.8	3.9	0.3	5.9	3.6	0.2	0.6	6.5	26.7
Percentage change 2014 to 2015	*2.7*	*9.0*	*-6.6*	*-16.4*	*-0.7*	*-0.8*	*0.8*	*7.0*	*1.6*	*0.2*
2000 to 2015	*74.4*	*42.6*	*60.3*	*-4.4*	*-13.9*	*1.6*	*-10.2*	*118.0*	*19.9*	*17.8*

Source: TfL Planning, Strategic Analysis.
1. Trips are complete one-way movements from one place to another.
2. Trips may include use of several modes of transport and hence be made up of more than one journey stage.
3. In tables 2.2 and 2.4 trips are classified by the mode that is typically used for the longest distance within the trip.
4. Round trips are counted as two trips, an outward and an inward leg.
5. Values for 'rail' include London Overground.

Over the most recent year there were again noticeable increases in patronage on rail and Underground, although there was a decline in bus trips. Car driver trips also decreased, following an increase in the previous year.

Figure 2.2 Trips in Greater London – trend in total travel demand by principal mode. Estimated daily average number of trips by main mode of travel, 1995 to 2015. Seven-day week.



Source: TfL Planning, Strategic Analysis.

Trip rates

Trip rates (the average number of trips per person per day) have been broadly stable over the whole period covered by table 2.2, at around 2.7 to 2.8 trips per person per day. However, evidence is beginning to emerge, both in London and further afield, of a possible trend towards slightly lower travel volumes on a per capita basis (see section 2.7 of this report for further information on this topic).

Trip rates are calculated for the average daily population, which makes allowance for overnight visitors and commuters from outside London making trips in the Capital. The historic relative stability of trip rates indicates that the increase in stages and trips in London is driven primarily by increases in population, both of London residents and visitors to the Capital, rather than individuals making more trips.

Looking specifically at London residents, using the LTDS survey, average trip rates in 2015/16 were 2.3 trips per person per day, lower than the average of 2.7 for all travellers in London. This difference is to be expected, given that the large majority of non-resident day visitors are already (by definition) in the course of making at least one trip on the day in question to get to or from London.

Further details of travel demand trends affecting specific modes of transport are given in chapters 3 and 6 of this report.

2.5 Mode shares in London

Journey stage based mode shares

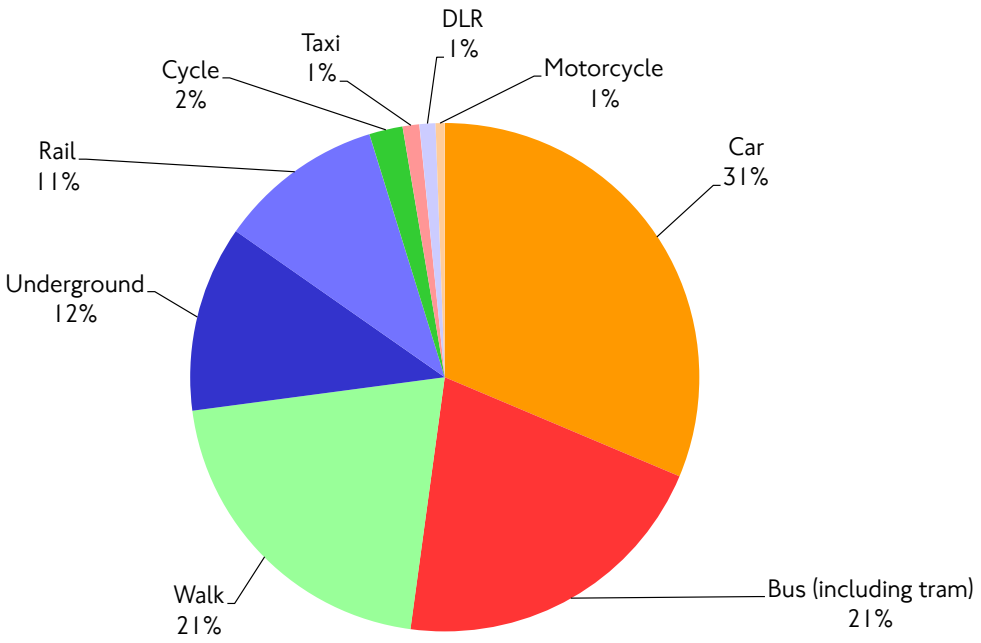
In 2015, 45 per cent of journey stages in London were made by public transport, compared with 32 per cent by private transport. This reflects and continues a now well-established trend of a net shift in London away from private motorised transport to the public transport modes. Since 2000 the public transport mode share has increased by 11.1 percentage points. In the latest year, the public transport mode share increased by a further 0.2 percentage points while the private transport mode share fell by a corresponding 0.4 percentage points. Cycling and walking mode shares remained at 2 and 21 per cent respectively.

Table 2.3 Percentage shares of journey stages by type of transport, 1995 to 2015.

	Percentage of journey stages			
Year	Public transport	Private transport	Cycle	Walk
1995	31%	46%	1%	22%
1996	31%	46%	1%	22%
1997	32%	45%	1%	22%
1998	33%	45%	1%	22%
1999	33%	44%	1%	22%
2000	34%	43%	1%	21%
2001	35%	43%	1%	22%
2002	35%	42%	1%	21%
2003	37%	41%	1%	21%
2004	38%	39%	1%	21%
2005	38%	39%	2%	21%
2006	39%	39%	2%	21%
2007	41%	37%	2%	20%
2008	42%	36%	2%	21%
2009	42%	35%	2%	21%
2010	43%	35%	2%	21%
2011	43%	34%	2%	21%
2012	44%	33%	2%	21%
2013	45%	33%	2%	21%
2014	45%	32%	2%	21%
2015	45%	32%	2%	21%

Source: TfL Planning, Strategic Analysis.
Note: Mode shares are calculated from the consistent series for journey stages given in table 2.1. Totals may not add up to 100 per cent due to rounding. Walks are counted only when they form complete trips (ie walking all the way), not when they are part of trips using other modes of transport.

Figure 2.3 Modal shares of daily journey stages in London, 2015.



Source: TfL Planning, Strategic Analysis.
Note: Walks are counted only when they form complete trips (ie walking all the way), not when they are part of trips using other modes of transport.

Trip based mode shares

The decrease of 11.3 percentage points between 2000 and 2015 in the private transport mode share in terms of journey stages is equivalent to a decrease of 10.4 percentage points in terms of trips. Similarly, the public transport mode share, which increased by 11.1 percentage points in terms of journey stages, increased by 9.0 percentage points in terms of trips since 2000 (note that public transport trips typically involve more than one stage). Public transport accounted for 37.0 per cent of trips in 2015, up from 28.1 per cent in 2000. Over the most recent year, private transport mode share decreased by 0.3 percentage points to 36.2 per cent.

This means that the mode share for public transport trips in London remains higher than for private transport – continuing the trend first seen in 2013. This highlights the large shift in how people travel around London, given that in 1993 the public transport mode share was less than half the private transport mode share. Cycle and walk mode shares remained constant, at 2 per cent and 24 per cent respectively.

Table 2.4 Trip-based mode shares – public and private transport by main mode.

	Percentage of trips			
Year	Public transport	Private transport	Cycle	Walk
1995	25%	49%	1%	24%
1996	26%	49%	1%	24%
1997	26%	48%	1%	24%
1998	27%	48%	1%	24%
1999	27%	48%	1%	24%
2000	28%	47%	1%	24%
2001	28%	46%	1%	24%
2002	29%	46%	1%	24%
2003	30%	44%	1%	24%
2004	31%	43%	1%	24%
2005	31%	43%	2%	25%
2006	31%	43%	2%	24%
2007	32%	43%	2%	23%
2008	34%	40%	2%	24%
2009	34%	40%	2%	24%
2010	34%	39%	2%	24%
2011	36%	38%	2%	24%
2012	36%	37%	2%	24%
2013	37%	37%	2%	24%
2014	37%	37%	2%	24%
2015	37%	36%	2%	24%

Source: TfL Planning, Strategic Analysis.

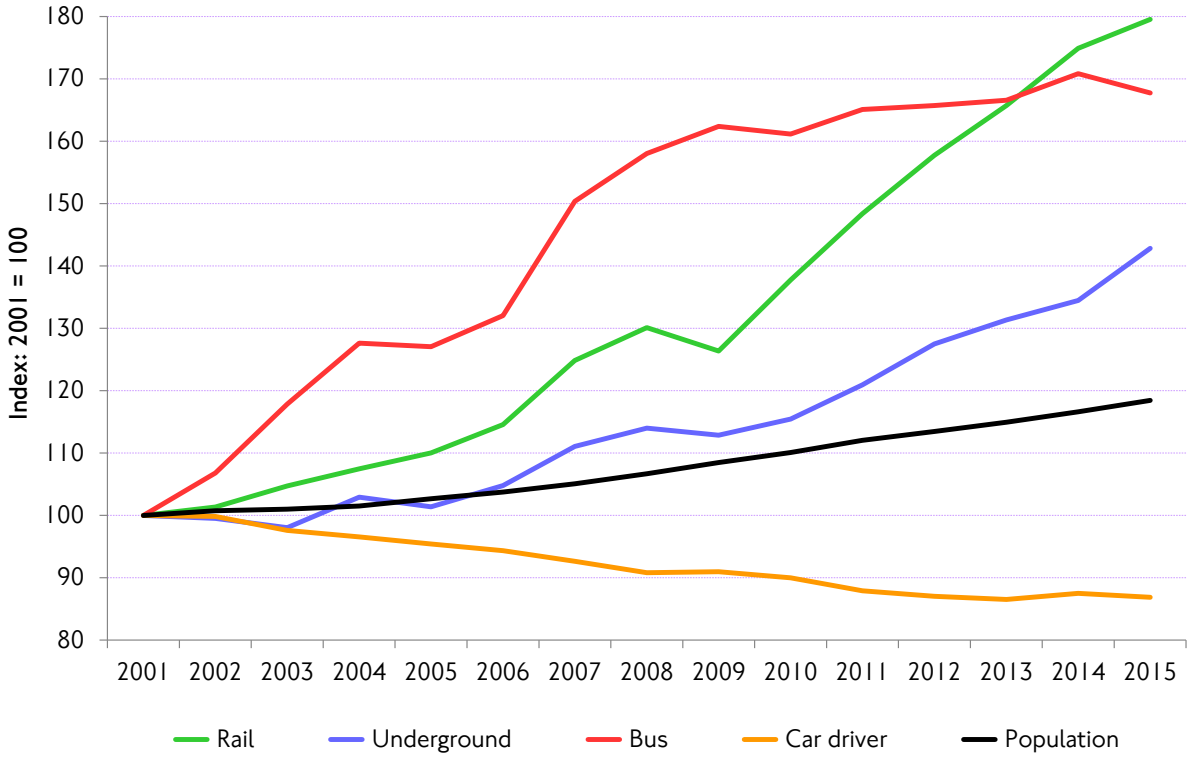
Trends in journey stages by mode

Figure 2.4 shows trends in demand on the principal travel modes since 2001. Public transport use has grown strongly over this period, with demand for all of the public transport modes growing faster than population, reflecting changing mode shares. Initially, growth was strongest on the bus network, with a 27.6 per cent increase in bus journey stages between 2001 and 2004, and despite a decline in the most recent year, bus stages in 2015 were 67.7 per cent higher than in 2001.

Growth in National Rail use (including London Overground) was initially slower than bus use until 2009. Over the past five years, rail journey stages have increased by 30 per cent, partly helped by the opening of TfL's Overground network, with rail stages now 79.5 per cent higher than in 2001.

In contrast, Underground passenger growth closely followed population growth between 2001 and 2006, although use has started to grow at a faster rate in recent years, reflecting completion of upgrades to several lines which has added extra capacity to the network. Car driver stages are 13.1 per cent below the 2001 level.

Figure 2.4 Growth in journey stages on selected modes, 2001 to 2015.



Source: TfL Planning, Strategic Analysis.

2.6 Insight: Mode shares – some different perspectives

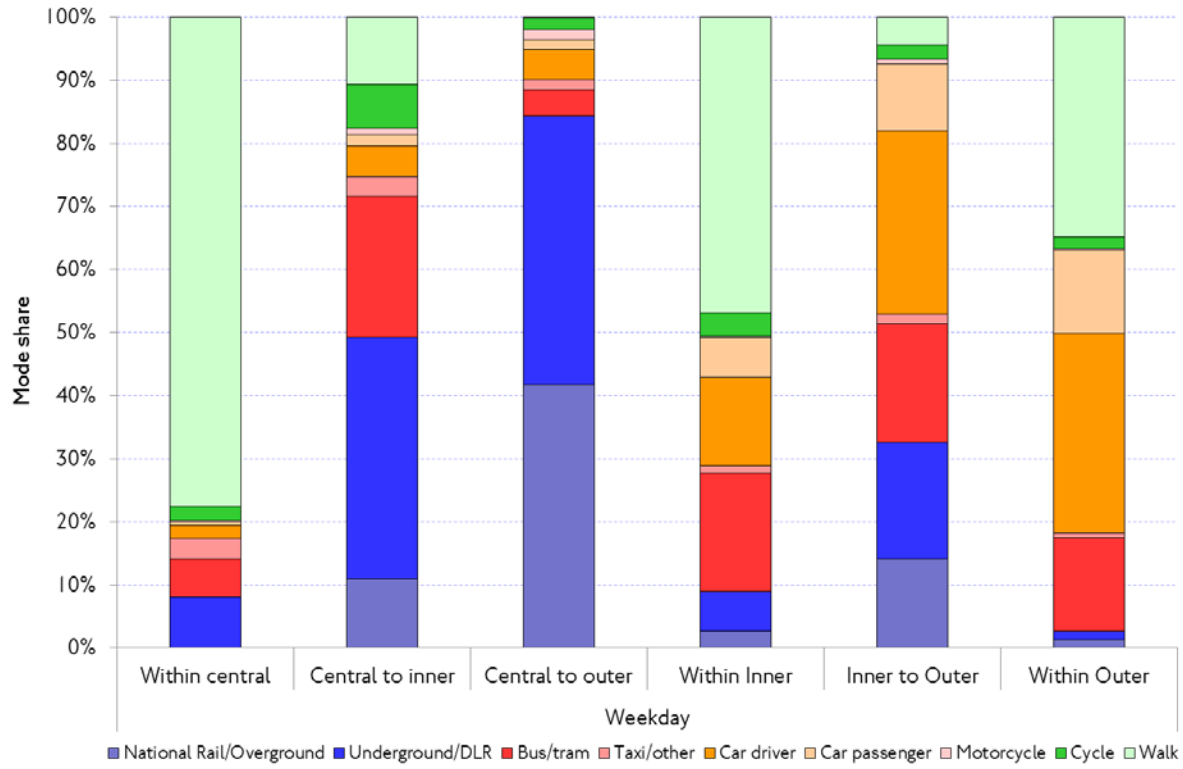
Introduction and content

Mode share trends across London as a whole were discussed in section 2.5. While these have changed over the long term, there is relative stability in the short term. However, mode shares vary enormously across London depending on the time of day, purpose, and origin/destination of the trip. LTDS gives us an insight into how mode shares can differ for London residents, depending on the particular perspective taken.

Mode shares by origin and destination

Mode shares differ greatly depending on the origin and destination of the trip (figure 2.5). Trips to central London tend to be on public transport, particularly rail-based modes. Some 84 per cent of all trips between central and outer London are by Rail or Underground. Trips within central London tend to be relatively short, explaining why walking dominates, accounting for 78 per cent of all trips here. However, trips wholly within outer London are most likely to be made by car, which makes up 45 per cent of all trips. Only 18 per cent of trips wholly within outer London are made on public transport.

Figure 2.5 Weekday mode share by trip origin and destination, LTDS 2012/13 to 2014/15 average.



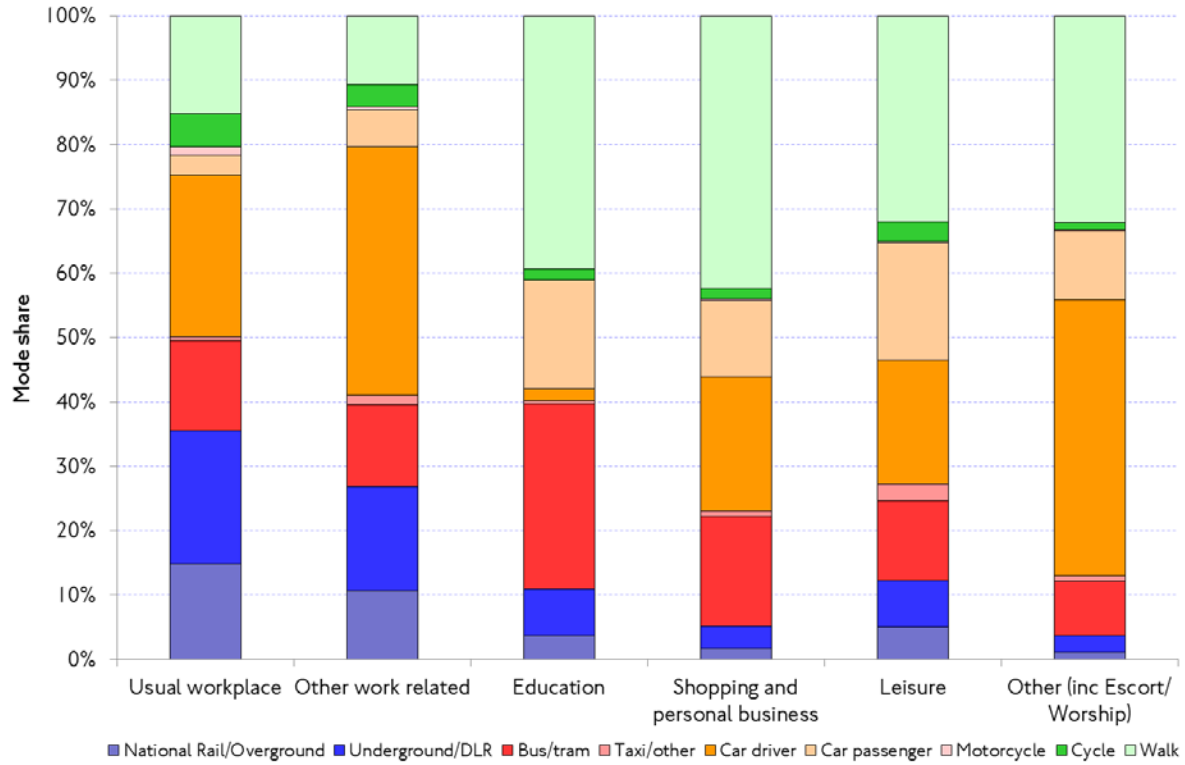
Source: TfL Planning, Strategic Analysis.

The mode shares discussed in this section do not include travel by non-London residents, such as commuters and visitors. In 2015, there were an estimated 1.16 million commuters and visitors in London on an average day, around 13 per cent of London's resident population. Commuters and visitors are more likely to travel by rail-based modes, and to travel to and from central London.

Mode shares by journey purpose

London residents use different modes for different purposes (figure 2.6), with work (50 per cent) and education (40 per cent) trips the most likely to be on public transport. Car mode shares are highest for other work-related trips (44 per cent) and other trips, including drop off and pick up (54 per cent).

Figure 2.6 Mode share by purpose of trip, LTDS 2012/13 to 2014/15 average.

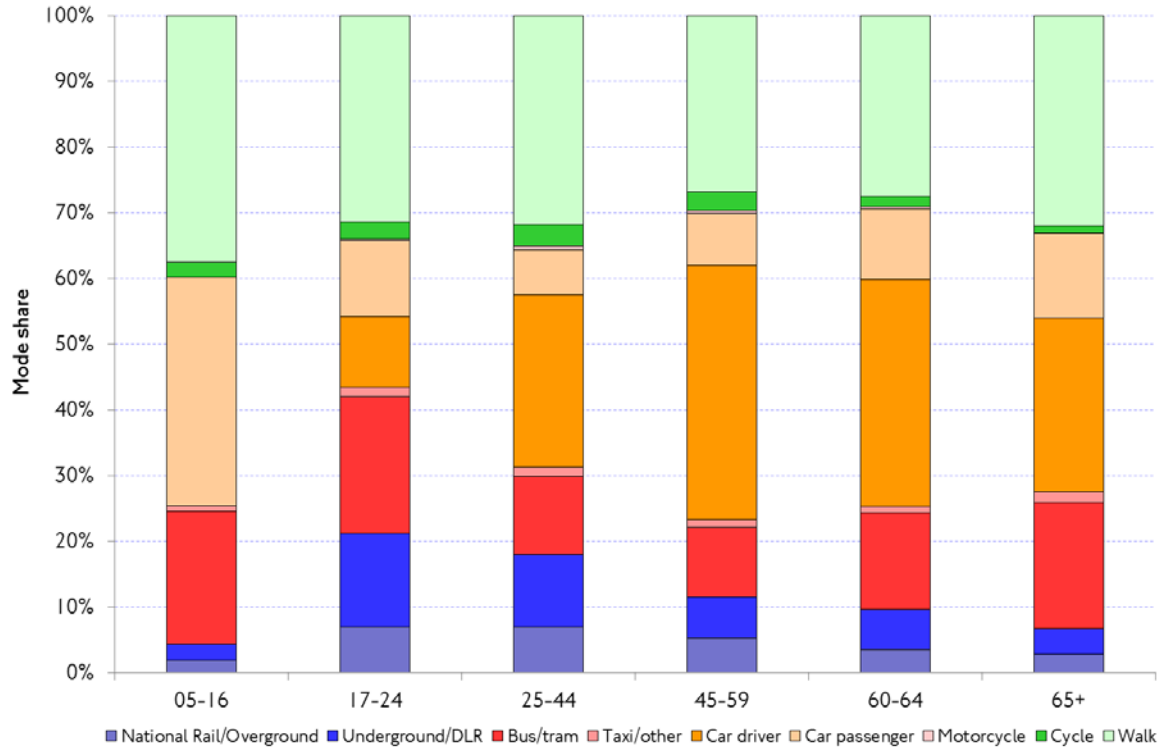


Source: TfL Planning, Strategic Analysis.

Mode shares by age group

Car use is higher among older Londoners (figure 2.7), particularly in those aged 45 to 59, where the car mode share is 47 per cent. Public transport use is highest among the 17 to 24 age group, with a 43 per cent modal share. Correspondingly, only 22 per cent of trips by 17 to 24-year-olds are by car.

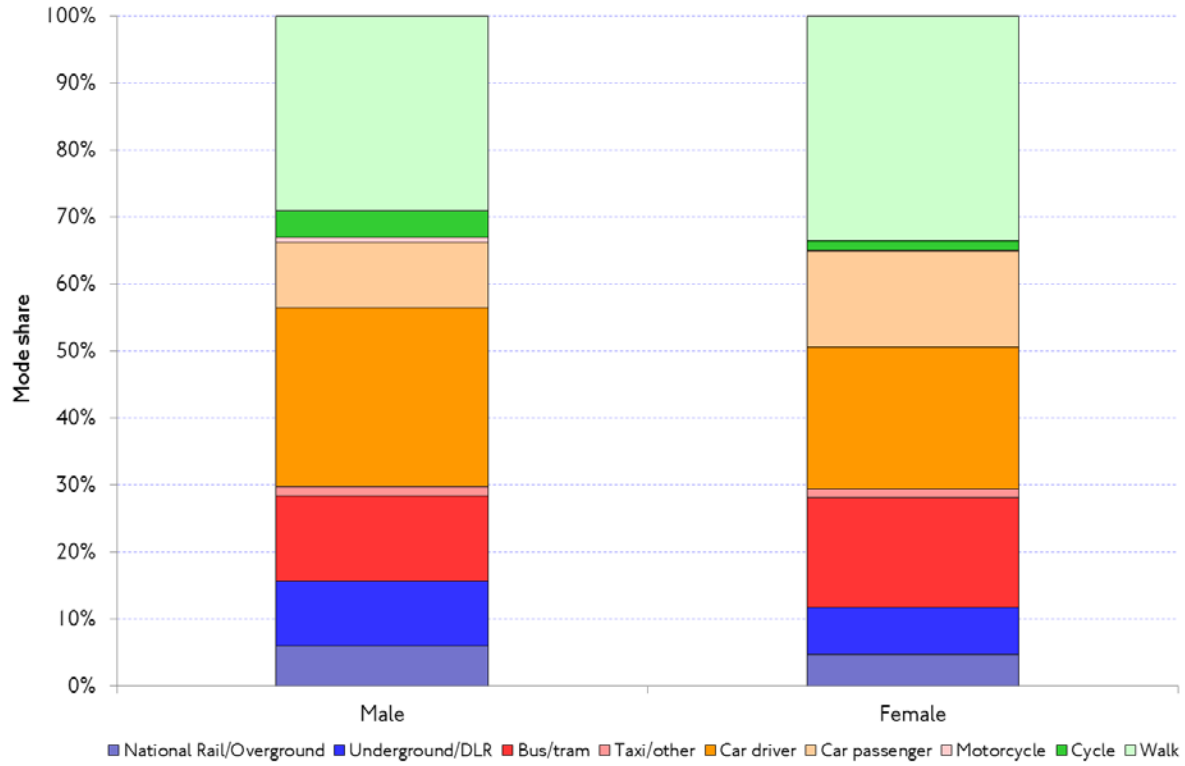
Figure 2.7 Mode share by age group, LTDS 2012/13 to 2014/15 average.



Source: TfL Planning, Strategic Analysis.

Mode shares by gender

Figure 2.8 Mode share by gender, LTDS 2012/13 to 2014/15 average.



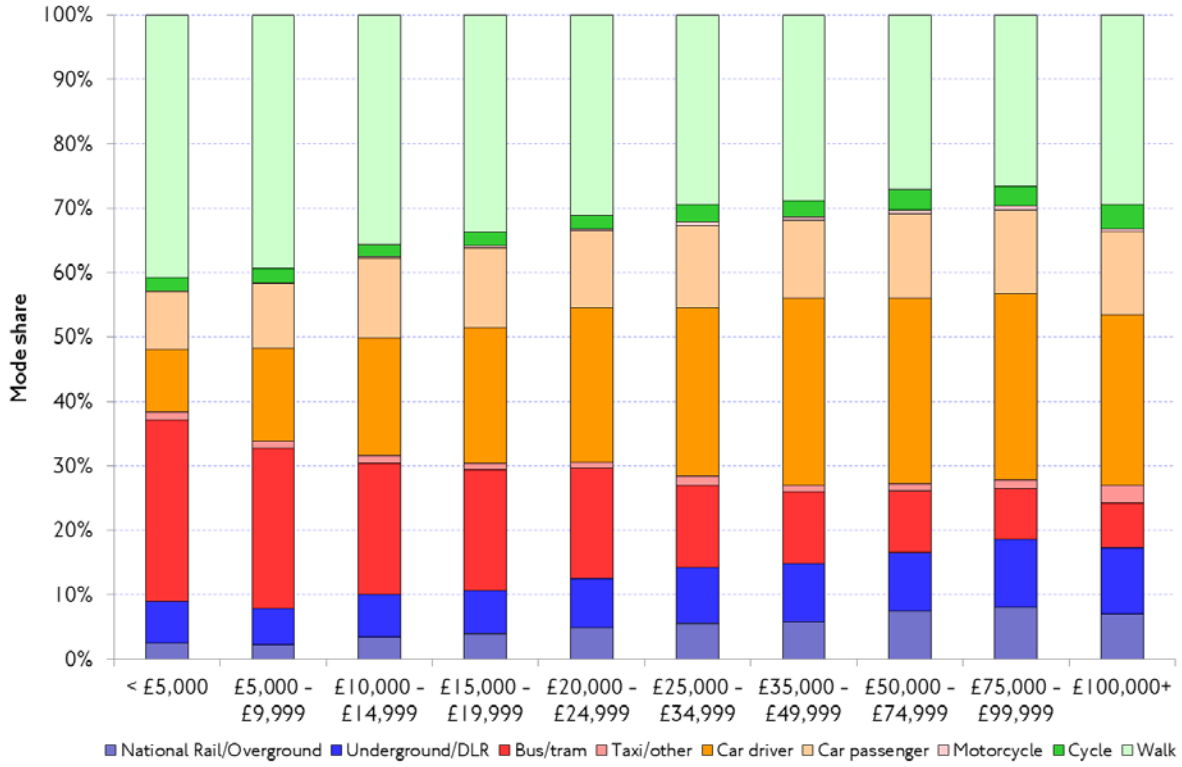
Source: TfL Planning, Strategic Analysis.

Figure 2.8 shows how modal use differs between the genders. Men make more rail and Underground trips than women. Car driver mode share is also much higher for men, as is cycling at 4 per cent. Among women, bus and walk mode shares are higher, with cycle mode shares of 1 per cent.

Mode share by household income

As household income increases, car use also increases, with car mode shares of more than 40 per cent for households earning £35,000 or more. Rail and Underground mode shares also increase with household income, while bus mode share decreases. Cycle mode share also increase in households with higher incomes, with the highest mode share for cycling of 4 per cent in households earning £100,000 or more (figure 2.9).

Figure 2.9 Mode share by household income, LTDS 2012/13 to 2014/15 average.

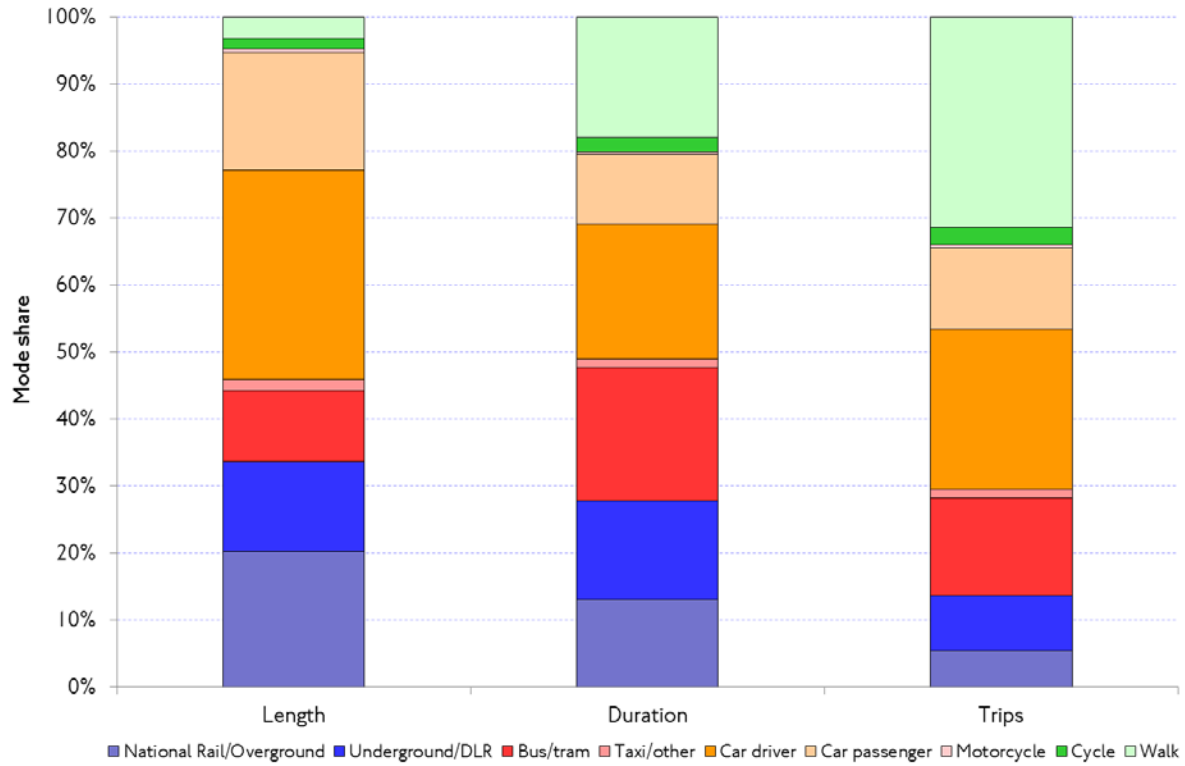


Source: TfL Planning, Strategic Analysis.

Mode share by trip length and duration

Mode shares by distance travelled and time spent travelling are very different (figure 2.10), although this partly reflects the characteristics of the different modes. Walk trips make up 31 per cent of all trips, but only 3 per cent of total travel distance. Car trips account for 49 per cent of all distance travelled, but only 31 per cent of time. Rail and Underground trips make up 14 per cent of all trips, but account for 34 per cent of distance travelled.

Figure 2.10 Mode share by trip length, duration, and number of trips, LTDS 2012/13 to 2014/15 average.

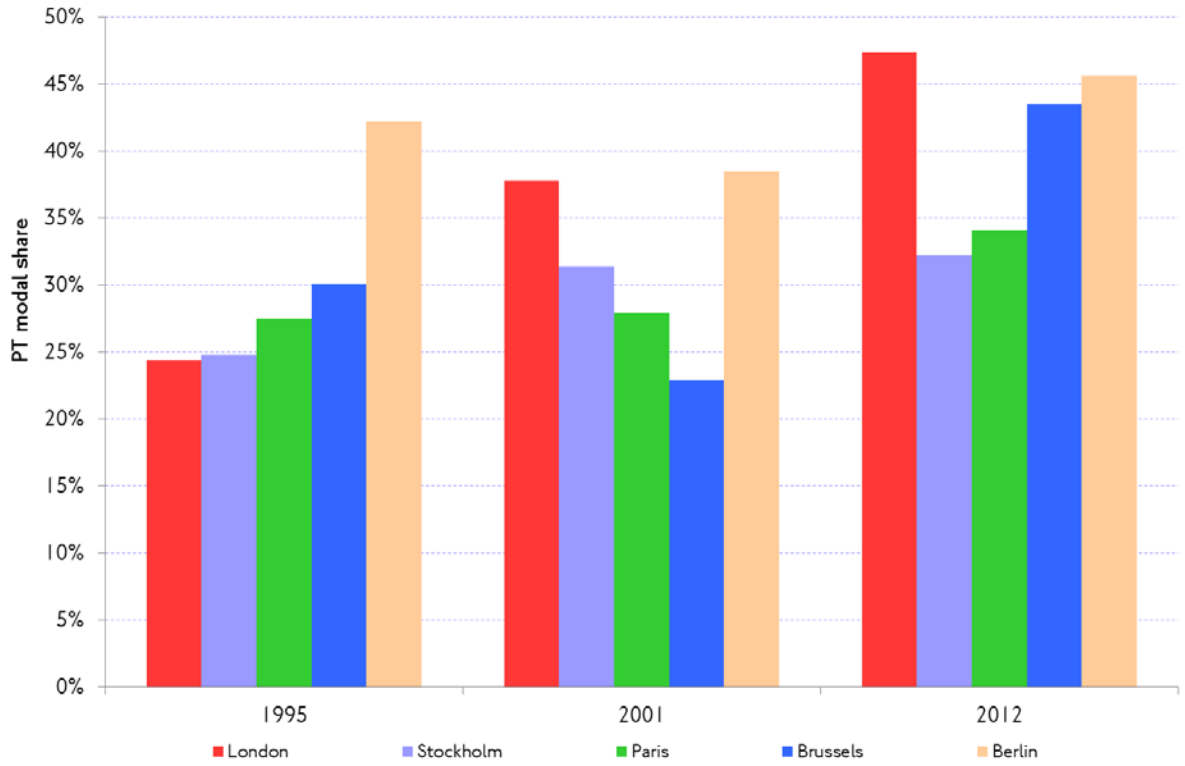


Source: TfL Planning, Strategic Analysis.

Mode share comparisons with other European cities

London's public transport mode share has increased from one of the lowest in comparable European cities in 1995, to higher than Stockholm, Paris, Brussels and Berlin in 2012 (figure 2.11).

Figure 2.11 Public transport modal share: London compared with other major European cities.



Source: International Association of Public Transport.

Mode share – what changes have been the primary drivers of aggregate mode share change in London?

Travel in London report 8, section 11.10, looked at some of the aspects of travel behaviour change that were driving the overall mode share change in London. This section summarises and updates key findings from that section, as well as extending the scope to cover consideration of more aspects of travel.

Among inner London residents, there has been a sustained decline in private transport mode share, falling from 27 per cent in 2005/06 to 22 per cent in the latest year (figure 2.12). The modal shift away from private transport has been equally shared between public transport, cycling and walking. Public transport mode shares have increased from 36 per cent in 2005/06 to 38 per cent in 2015/16, while over the same period cycle mode share increased from 2.5 per cent to 4 per cent, with walk mode share increasing from 34 per cent to 36 per cent.

In outer London, the trends have been fairly different, with private transport mode share falling at a slower rate, from 50 per cent in 2005/06 to 48 per cent in 2015/16 (figure 2.13). Cycling increased from 1 per cent to 2 per cent over the same period, but the greatest increase has been in public transport mode share, which has increased from 20 per cent to 26 per cent. Part of this modal shift has been at the expense of walking, with walk mode shares decreasing by 4 percentage points between 2005/06 and 2015/16 among residents.

Figure 2.12 Mode shares among inner London residents. LTDS 2005/06 to 2015/16.

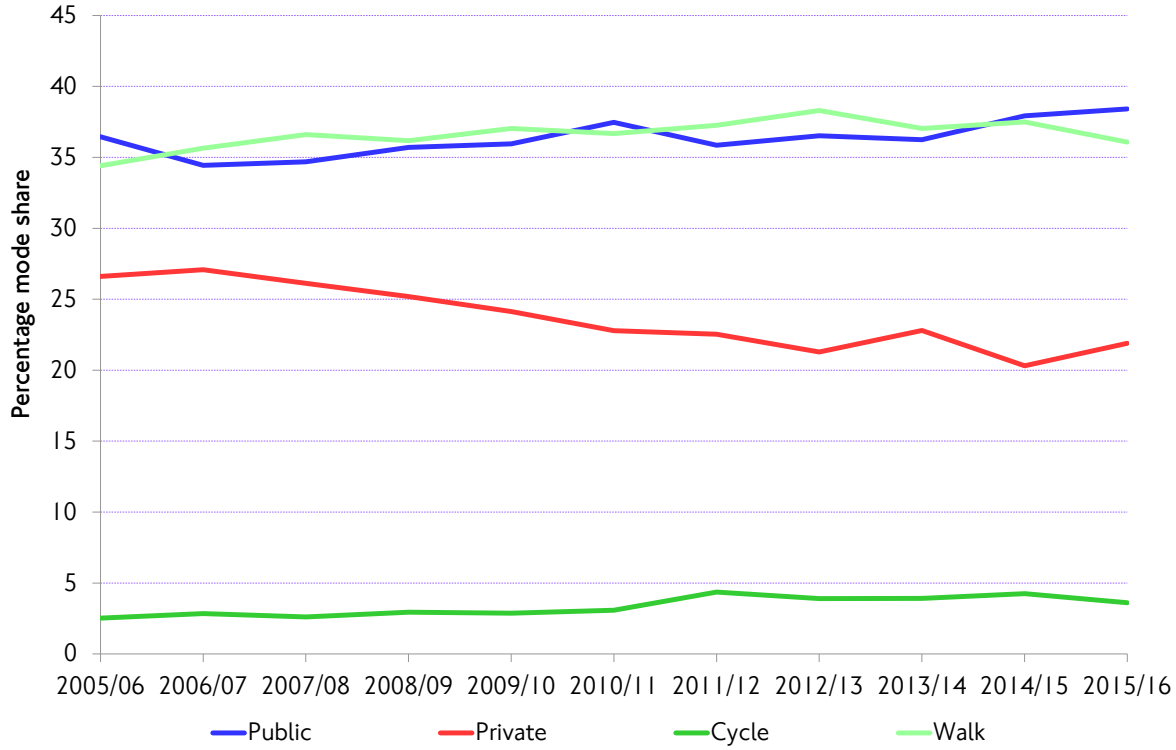
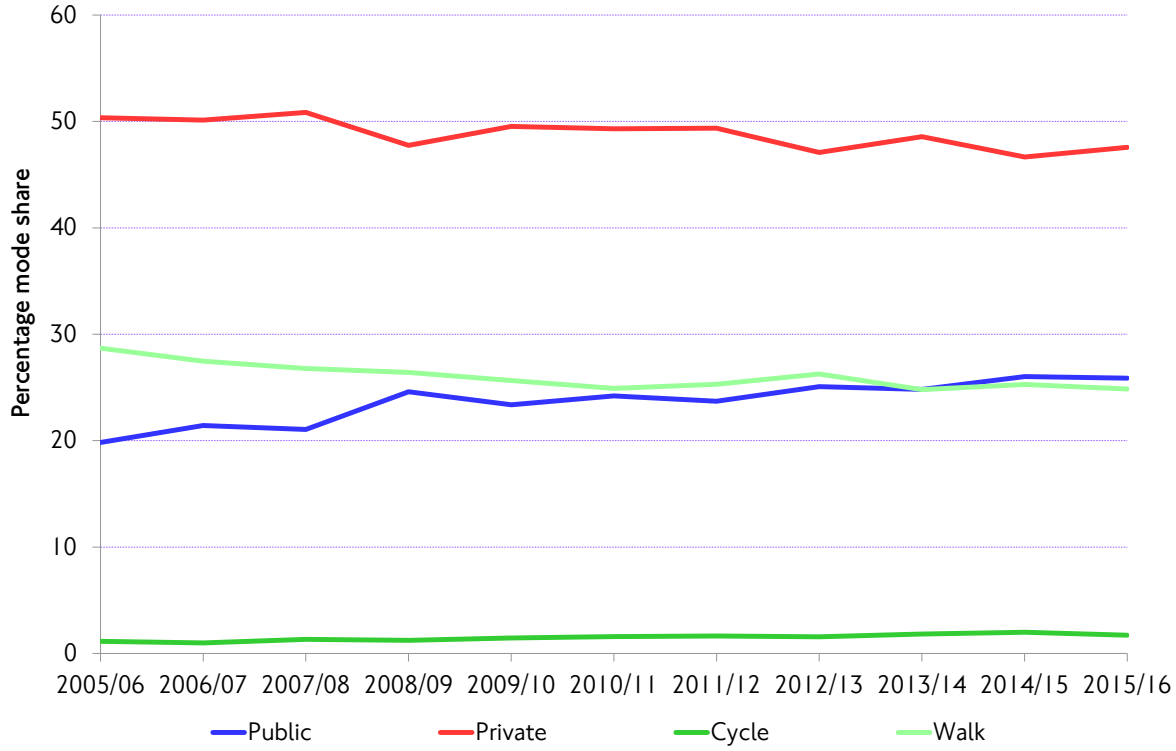


Figure 2.13 Mode shares among outer London residents. LTDS 2005/06 to 2015/16.



One explanation for this modal shift over the past ten years can be seen when analysing changes in journey purpose. Figure 2.14 shows trip rates by purpose

between 2005/06 and 2015/16. Over most of this period, commuting and education trip rates have remained fairly stable. However, shopping and personal business trip rates have fallen sharply since 2011/12, and are now 27 per cent lower than in 2005/06. Leisure trip rates have also fallen over the last two years.

Figure 2.14 Trips per person per day by purpose. LTDS 2005/06 to 2015/16.

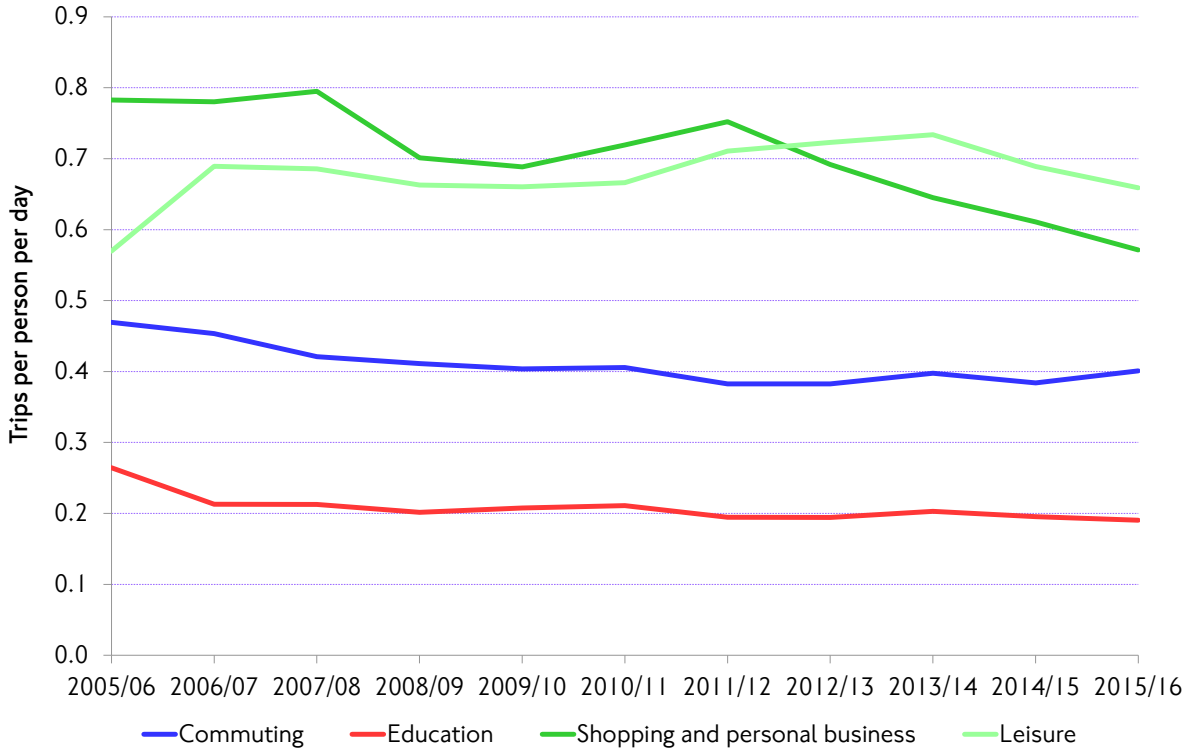
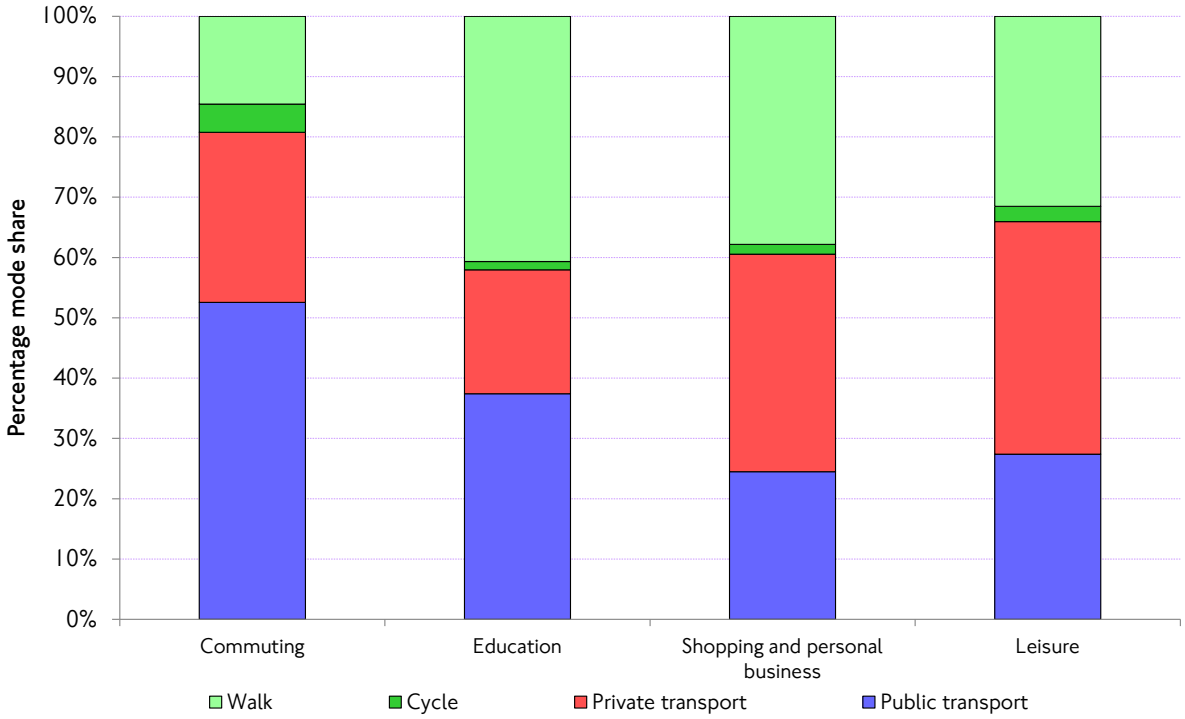


Figure 2.15 shows how this decline in shopping and leisure trips has affected mode shares in London. Shopping and personal business and leisure trips have relatively high private transport mode shares, of 36 per cent and 39 per cent respectively in 2015/16. In contrast, private transport mode share for commuting trips is only 28 per cent. Therefore, a large fall in shopping and leisure trips will be more likely to have an impact on private (rather than public) transport mode shares.

Figure 2.15 Mode share by purpose. LTDS 2015/16.



2.7 Insight: Variations in trip making by London residents

Introduction and contents

This section looks at several dimensions of trip making by London residents. The basic unit for this analysis is the trip rate – which is the average number of trips made per day by residents. At the aggregate level, there is emerging evidence – both at the London and national level – that average trip rates may be starting to reduce, and it is therefore of interest to explore the main components of any change – from the point of view of what factors may be causing it, but also in terms of its relevance for future planning if the trend proves to be sustained. A second dimension of contemporary interest is how travel behaviour varies by place of birth of London residents – as there is evidence that the changing population structure of London underlies many aspects of travel behaviour change.

TfL's London Travel Demand Survey

This section draws on data provided by TfL's London Travel Demand Survey. LTDS is an established annual household travel survey of London residents that has been running on a continuous basis since 2005/06. The survey seeks to understand and quantify, in a statistically-robust way, the travel behaviour of Londoners and the relationships of this to a range of socio-demographic, spatial and transport network factors. Further details of the LTDS survey can be found at: https://tfl.gov.uk/corporate/publications-and-reports/london-travel-demand-survey. Further examples of LTDS analysis can be found throughout this report.

LTDS underlies much of TfL's planning through providing inputs to predictive models of future travel demand, allowing the responses to, and impact of, schemes and proposals to be explored and quantified, and, in particular, providing much information through which the interaction between travel demand and various social and demographic factors can be understood. The annual sample of

approximately 8,000 households is expanded, using sources such as data from the Census of population, so as to be representative of total personal travel by all London residents. Although the resulting quantity is not representative of all travel in London (see sections 2.3 and 2.4), since a proportion is made by non-residents (commuters, other day visitors, tourists, freight, people undertaking travel as a primary element of their work, such as driving a bus or making deliveries, etc), it is however representative of the 'total market for personal travel', including travel in the course of business, presented by people who live in Greater London.

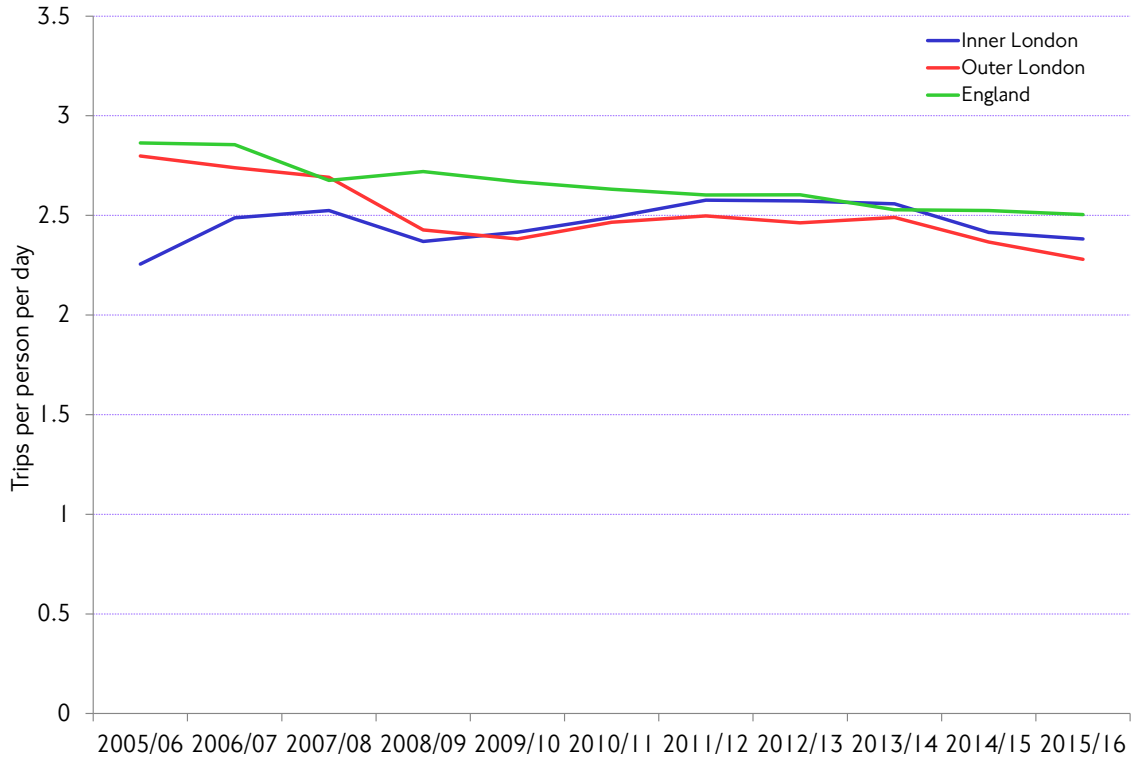
How much do Londoners travel – and are they travelling more or less?

Figure 2.16 shows the average trip rates for residents of inner and outer London separately, including how this has changed over the period covered by LTDS. It is seen that Londoners' trip rates have fluctuated since 2005/06, but that there has been a general downward trend since 2011/12.

This is in line with the national trend – trip rates in England have declined by 3.8 per cent between 2011/12 and 2015/16, compared to 7.6 per cent in inner London and 8.7 per cent in outer London. However, trip rates in England have been in decline for a longer period, by a total of 12.5 per cent over the ten years between 2005/06 and 2015/16.

Absolute trip rates in inner and outer London have mostly been lower than the national average, most likely due to the higher density in London and the greater mix of land uses, meaning that residents can complete their daily activities in fewer trips.

Figure 2.16 Average trip rates for London residents. Showing inner and outer London and national-scale equivalent trend for comparison (average day, seven day week).



Source: TfL Planning, Strategic Analysis. LTDS Survey and National Travel Survey (Department for Transport)

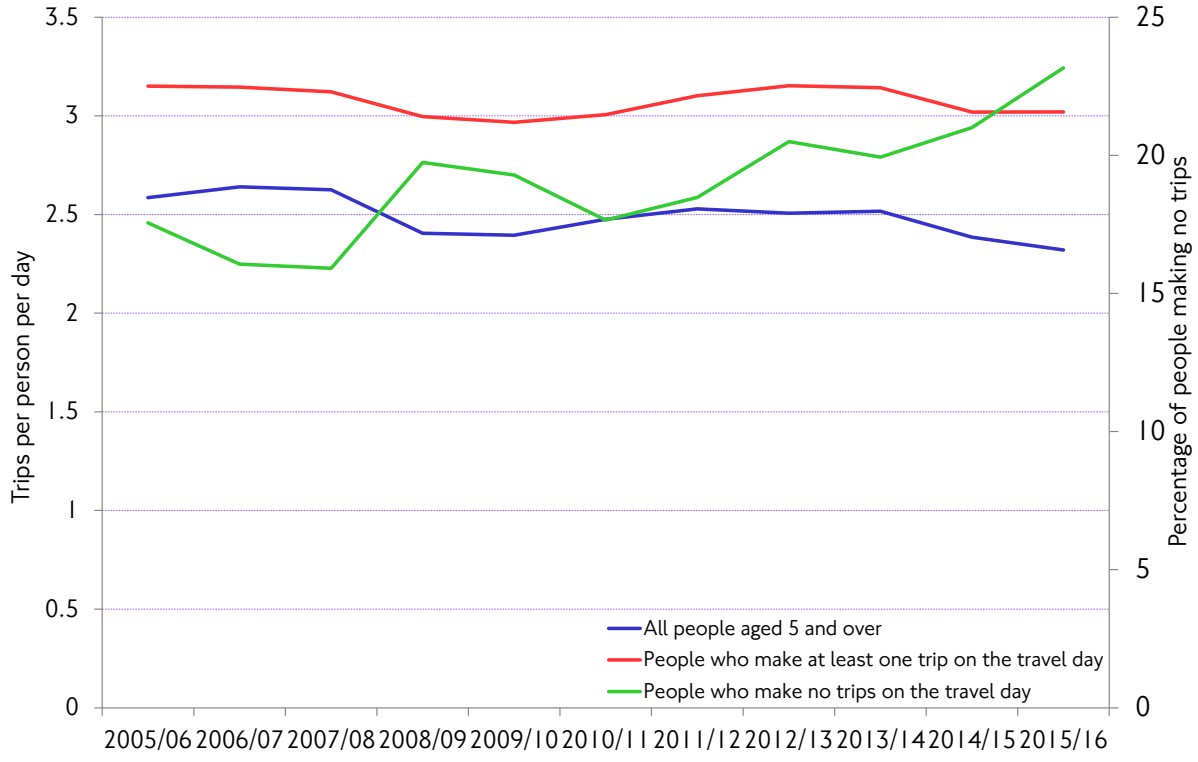
Declining trip rates in London indicate that people are tending to travelling less, on the whole, and if this proves to be sustained over the longer term, it has important implications for the planning of the transport system. However, looking at the overall trend in trip rates can mask the patterns in travel for different groups. It is therefore useful to look at trends in travel among different groups, which should reveal whether the decline in trip rates reflects proportionally less travel by all people, or whether it mainly reflects specific individuals making much fewer or even no trips (on the basis of an average day), and how this is changing over time.

Who is travelling more or less?

Figure 2.17 shows three different views of trip rates – this time all at the Greater London level. Comparing against average trip rates for all people (blue line), trip rates only for those who make at least one trip on the selected 'travel day' (red line) are seen to be rather higher – on average by around 24 per cent. Furthermore, the difference is seen to be progressively increasing over time.

This means that much of the overall change in average trip rates can be attributed to more people making no trips on any given day, rather than those who do travel travelling markedly less. This is supported by the trend in the proportion of London residents who make no trips on the survey day (green line on right hand axis), which has increased by 5 percentage points over the same period.

Figure 2.17 Trip rates among different groups of travellers – all people, people who make at least one trip on the survey day, and non-travellers.



Source: TfL Planning, Strategic Analysis.

How do trip rates vary by age and gender?

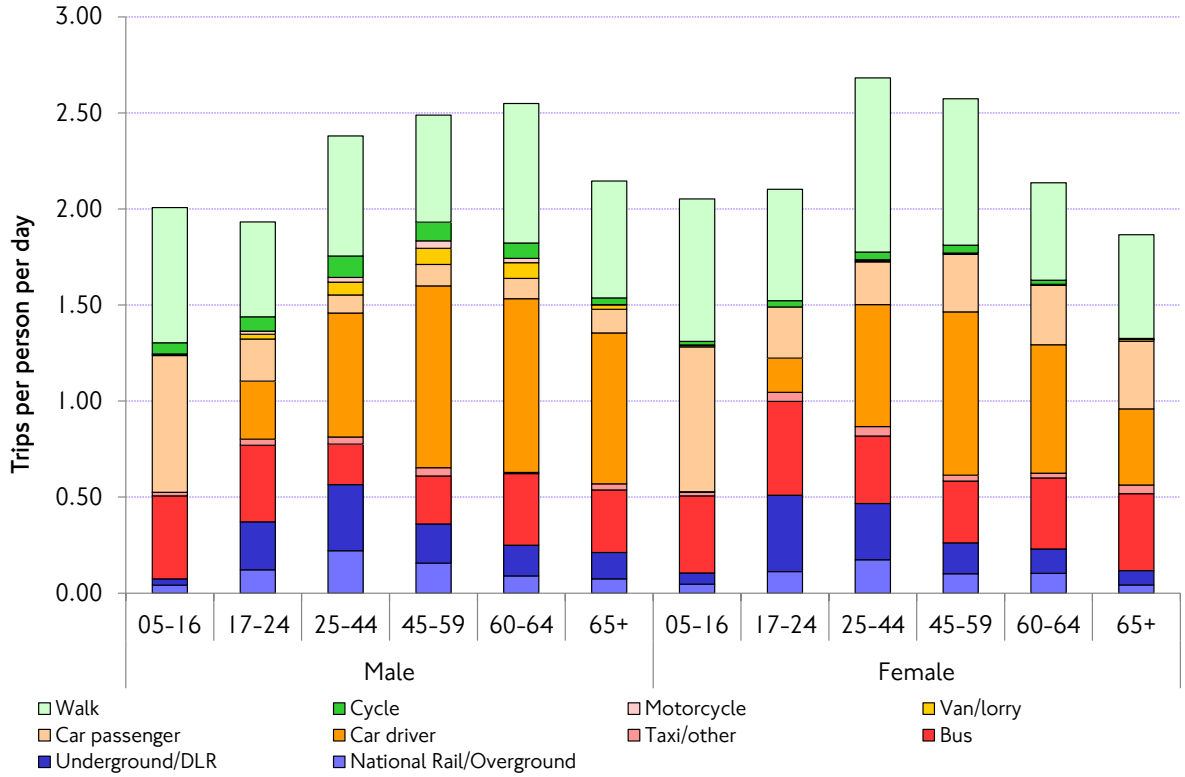
The average trip rates described above conceal much variation – self-evidently some people travel more, sometimes much more, than others. Also, trips are made in varying proportion by the different modes of travel.

Figure 2.18 explores three dimensions of this variability – looking at how average trip rates vary by age and gender and by mode for 2015/16. It is possible to make many observations from this figure, some key ones are:

- The highest average trip rates are found in people of working age.
- While trip rates are broadly similar for men and women, the highest average trip rates are found among younger women, and the lowest among older women.
- As a rule, women make more frequent use of the bus than men, and men make more frequent use of the car.
- Trip rates by cycle are higher for men, while those for walking are higher among women.

The importance of comparisons such as these lies in the frequent need to identify and address, for example through a change to pricing, transport provision or other intervention, the 'market' for a proposed policy. An example of how this kind of analysis can be used is described in section 5.8 of this report, which looks at the potential to increase levels of walking in London.

Figure 2.18 Trip rates by gender, age and main mode of transport (average day, seven-day week) 2015/16.

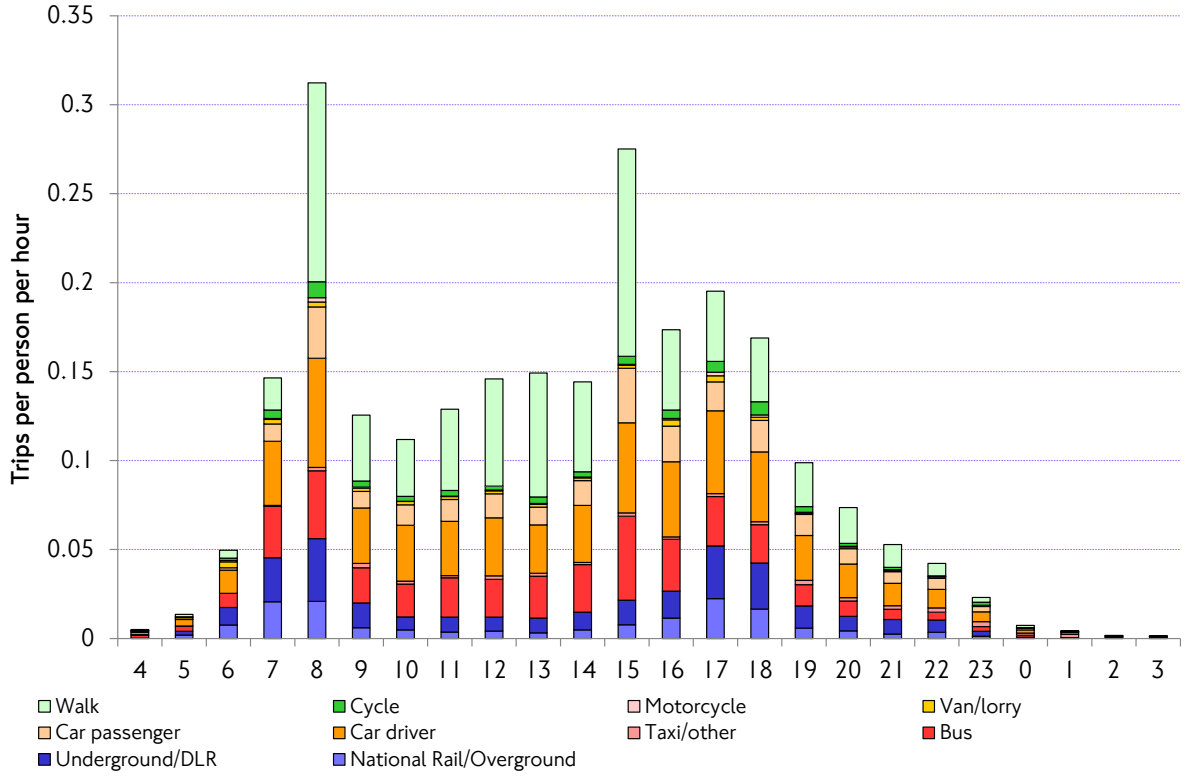


Source: TfL Planning, Strategic Analysis.

How do trip rates vary by time of day?

Variation in trip rates by time of day is another aspect of interest – for example in formulating effective policies to deal with peak levels of demand on the transport network. Figure 2.19 shows the variation in hourly trip rate across the day. The figure relates to an average weekday across the whole of Greater London, and therefore presents a slightly different picture to that usually considered – for example in relation to peak-time travel to and from central London. On weekdays there are three distinct peaks of travel in terms of trip rates by hour. The morning peak occurs between 08:00 and 09:00, with two further peaks in the afternoon. The highest peak in the afternoon occurs between 15:00 and 16:00, representing mostly education trips. There is a second peak in the number of trips per person between 17:00 and 18:00, corresponding with people leaving work to travel home.

Figure 2.19 Trip rates by main mode and start hour (average weekday, 2015/16).

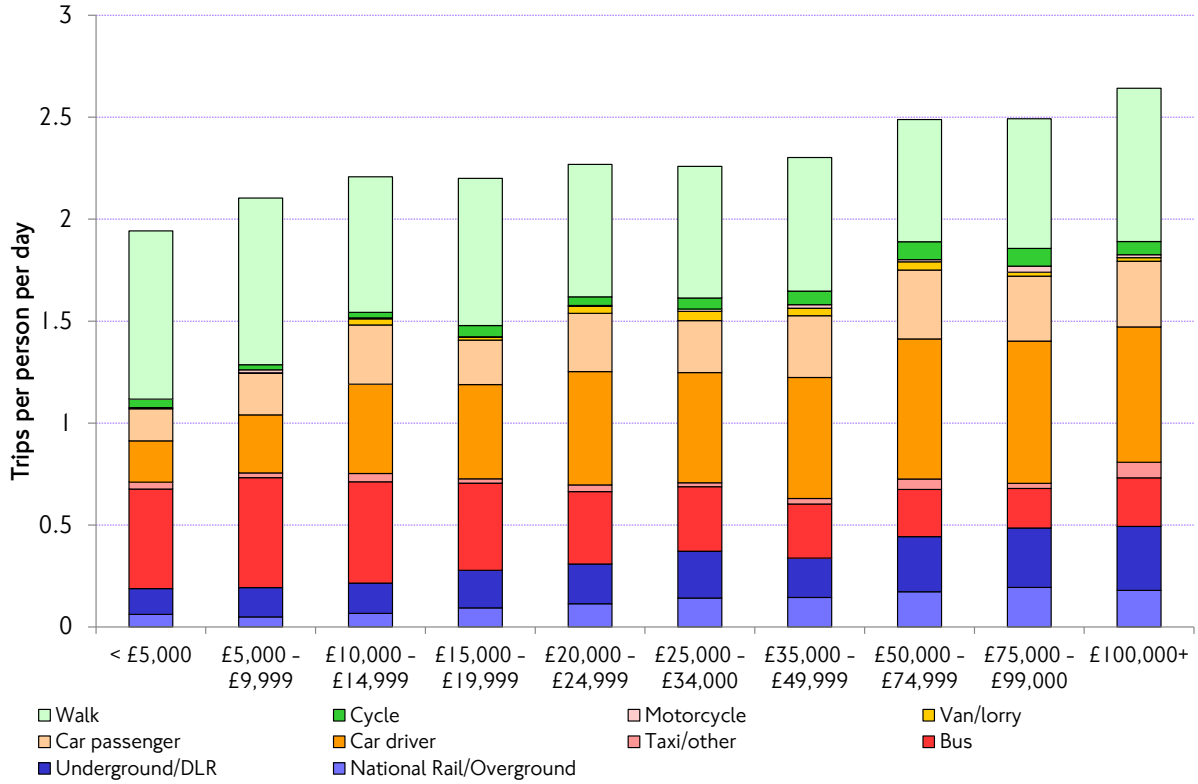


Source: TfL Planning, Strategic Analysis.

How do trip rates vary by household income?

Household income is generally a reflection of economic activity and it is therefore unsurprising that trip rates progressively increase among those living in higher-income households (figure 2.20). However, the increase – from lowest to highest – is relatively modest. What is more interesting about the figure is the relationship to mode of travel. While car use, for example, shows a strong positive relationship to household income, so does cycle use. The inverse is true for bus use although, with the exception of the two lowest-income groups, walk trip rates are generally comparable across the income bands.

Figure 2.20 Trip rates by main mode and household income (average day, seven day week), 2015/16.

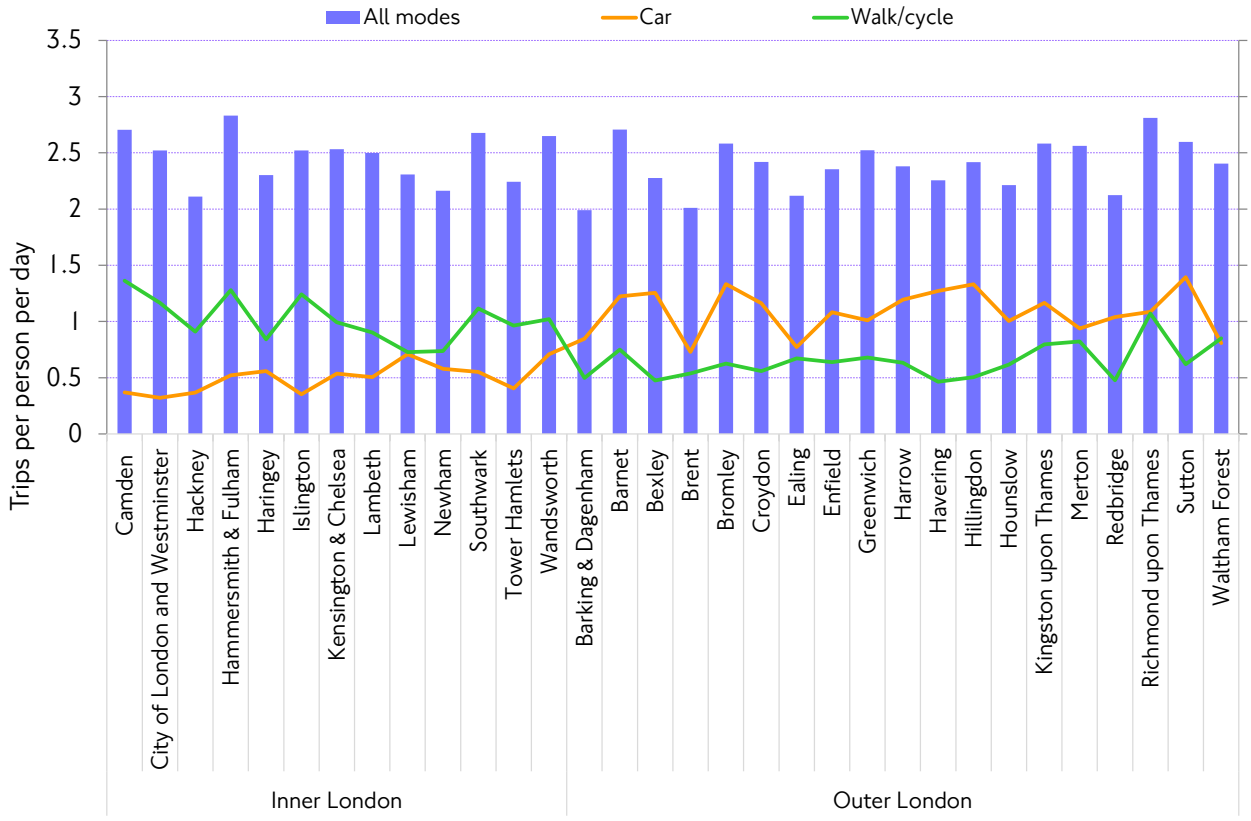


Source: TfL Planning, Strategic Analysis.

How do trip rates vary spatially?

Spatial differences in travel across London are well recognised and are significant – generally reflecting various structural and functional differences between areas, including population structure. Figure 2.21 looks at how overall trip rates compare to car and active travel trip rates by London borough. The graph shows that trip rates vary across the whole of London, however, car trip rates are noticeably higher and active travel trip rates are noticeably lower in outer London compared to inner London.

Figure 2.21 Trip rates by borough of residence. Overall trip rate (all modes), car trip rate and active travel trip rate compared, 2013/14 – 2015/16.

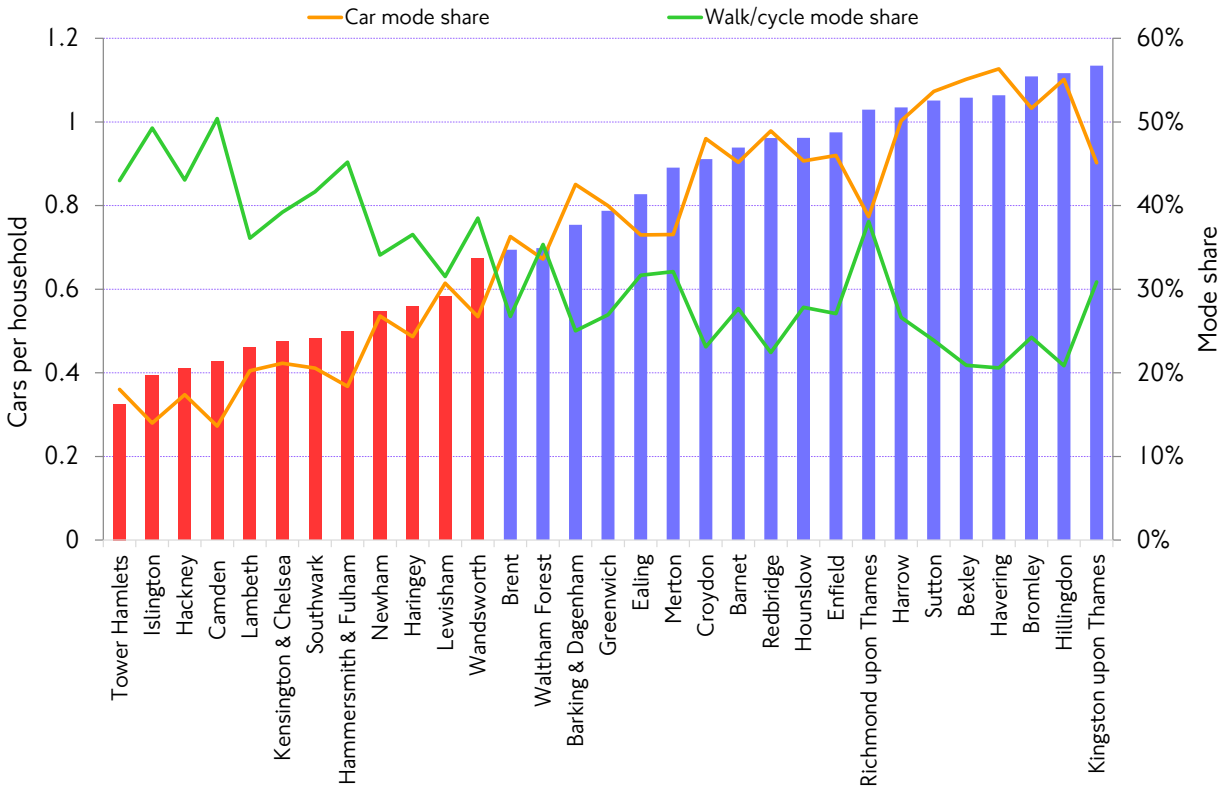


Source: TfL Planning, Strategic Analysis.

Figure 2.21 shows that the number of trips made per person per day varies by borough, ranging from 2.0 to 2.8 trips per person per day. The highest trip rate is by residents of Hammersmith and Fulham (2.83) and the lowest for Barking and Dagenham (1.99), although there is not a clear difference in overall trip rates among inner and outer London boroughs. However, walk and cycle trip rates are higher in inner London compared to outer London, with inner London residents making slightly more than one walk or cycle trip per day and outer London residents making 0.65 walk or cycle trips per person per day on average. The reverse is true for car trip rates, with an average of 0.5 trips per day for inner London residents compared to slightly more than one car trip per day for outer London residents.

Figure 2.22 takes this further, looking at the relationship of car and active travel trip rates to car ownership rates by borough. In this case, boroughs are ranked from left to right according to car ownership rate (average number of cars per household). They are also colour-coded, with inner (including central London) coloured red, and outer London boroughs coloured blue. On the right-hand axis are mode shares for both car travel (as driver and passenger combined) and for active travel (walking and cycling combined).

Figure 2.22 Car ownership rates by borough of residence. Average number of cars per household, car mode share and active travel mode share compared, 2013/14-2015/16.



Source: TfL Planning, Strategic Analysis.

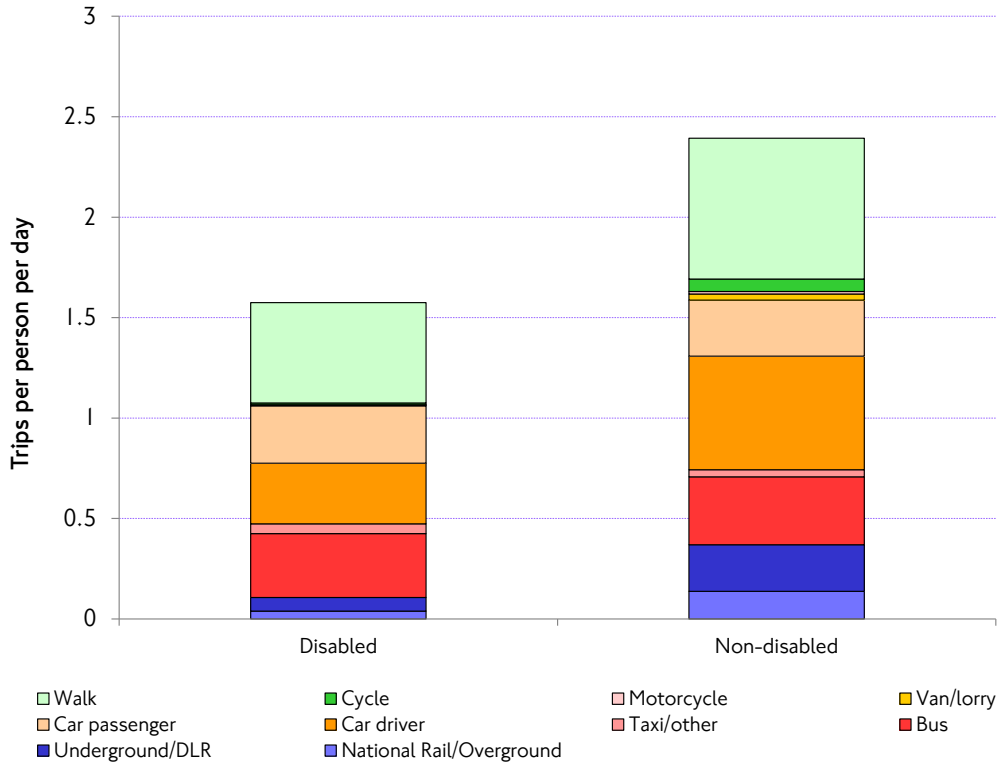
Figure 2.22 shows that car ownership is consistently lower in inner London boroughs compared to outer London boroughs. Tower Hamlets has the lowest car ownership of all London boroughs, with an average of 0.3 cars per household. Inner London boroughs also have a higher walk and cycle mode share and a lower car mode share than outer London boroughs. In general, car mode share increases with greater car ownership, however there are some boroughs which are noticeable outliers. Ealing, Merton and Richmond upon Thames have a lower car mode share than other outer London boroughs with a similar car ownership rate. Richmond upon Thames also has a high walk and cycle mode share (38.1 per cent) compared to other boroughs with a similar car ownership rate. The chart indicates that people in households with higher car ownership are less likely to walk and cycle and have higher car use.

Trip rates among disabled people

One socio-demographic aspect where there are relatively large differences in travel behaviour is that of disability. Figure 2.23 compares average trip rates by mode for those with and without a disability. The most obvious feature is that average trip rates by those with a disability are 34 per cent lower than those without a disability. The second feature is that this difference is reflected across nearly all of the modes of travel – only taxi and car passenger use by disabled people being, on average, slightly more frequent than among non-disabled people. Physical accessibility to the transport system is one of several factors that can act to limit the travel possibilities available to disabled people, but it is one that is being progressively

addressed by TfL – for example, every London bus route is now wheelchair accessible, with automatic ramps and designated wheelchair spaces (see also section 4.6 of this report).

Figure 2.23 Trip rates by main mode for disabled and non-disabled people (average day, seven day week), 2015/16.



Source: TfL Planning, Strategic Analysis.

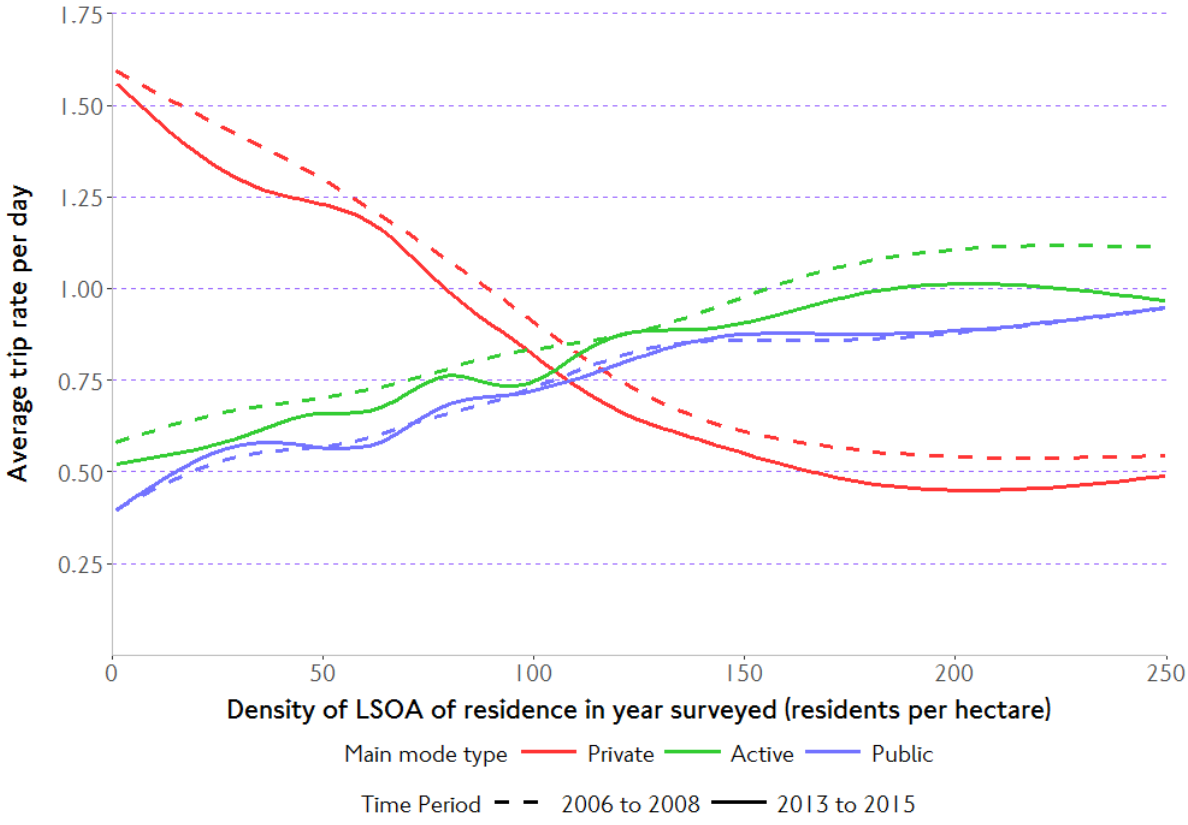
Trip rates and density

LTDS can also be used in conjunction with other datasets to examine specific aspects of travel patterns. One factor considered in the process of defining objectives for strategies for urban development is density. Population density is important because it impacts on the urban form of a city, and it influences the types of activity and travel that take place.

In London, people live at a wide range of residential densities, with around 5 per cent living in Lower Super Output Areas (LSOAs) (small geographical areas used for the reporting of statistics in England and Wales) with densities of less than 20 residents per hectare, in places such as green belt areas of outer London, and around 5 per cent living in LSOAs with densities of more than 200 people per hectare in dense inner city areas.

Figure 2.24 shows average trip rates of residents based on the residential density of the LSOA they live in the year that they were surveyed by LTDS. Trip rates are shown for public modes (ie rail, Tube, bus) private modes (car or van driver or passenger) and active modes (walking or cycling). It can be seen that London residents living at lower densities make more trips per day by private modes than those living at higher densities. The reverse is true for active and public transport modes, with trip rates rising as residential densities increase.

Figure 2.24 Average trip rates of London residents by residential density.



Source: TfL Planning, Strategic Analysis.

It can also be seen in figure 2.24 that trip rates across the spectrum of densities have changed from the period 2006 to 2008 (shown as dashed lines) to the period 2013 to 2015 (shown as solid lines). Private mode trip rates have declined by approximately the same value across people living at all densities, indicating that reduction in vehicle use has been driven by small reductions by people right across the spectrum rather than by larger reductions among people living in specific types of environment. Trip rates by active modes also appear to have reduced by a small amount across the spectrum of residential densities in London, reflecting the general reduction in trip rates over more recent years (see also section 2.4).

Interestingly, public transport trip rates were almost unchanged from the earlier period to the later period at all densities. This suggests that while public transport use has increased, this is largely due to population growth being concentrated in areas of higher density and a continuation of a constant relationship between density and public transport use, rather than due to a shift to more public transport use among people living at any given density.

Relationship of public transport use to public transport supply – PTALs

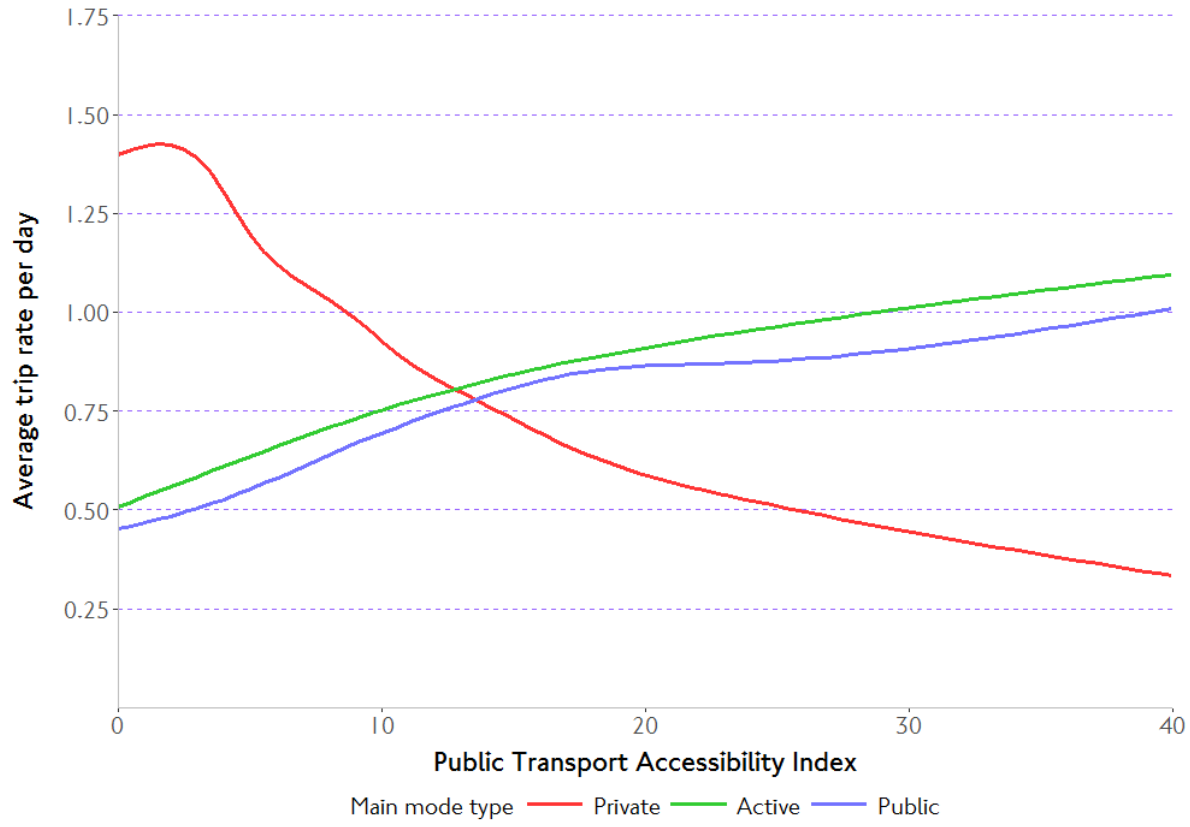
Another dataset that can be examined in conjunction with LTDS is TfL's public transport access index (PTAI), which underpins the more prominent public transport access levels (PTALs). This index quantifies the access to public transport on a small-area basis across London (see also section 4.8 of this report).

Figure 2.25 shows average trip rates of residents based on the public transport access index score of the immediate area they live in. Similarly to the density-related analysis above, trip rates are shown for public modes (ie rail, Tube, bus), private modes (car or van driver or passenger) and active modes (walking or cycling).

PTAI is a continuous measure, and corresponds to the discrete levels of PTAL in bands of five PTAI points per PTAL up to PTAL 5. So PTAL 2 corresponds to a PTAI of between 5 and 10, PTAL 3 between PTAI 10 and 15 and so on. PTAL 6a corresponds to a PTAI of between 25 and 40, while PTAL 6b corresponds to PTAI scores above 40, which are excluded from the data because of a small sample of households captured by LTDS that are situated in PTAL 6b.

It can be seen that London residents living in areas with lower public transport accessibility scores make more trips per day by private modes than those living in better connected areas. Again, as was the case in the density-related analysis, the opposite pattern is evident for public and active modes to that for private modes, with public and active trip rates increasing for people living in better connected areas. In fact, the public and active trip rates remain roughly equivalent for people living at all levels of public transport accessibility.

Figure 2.25 Average trip rates of London residents by public transport access level.



Source: TfL Planning, Strategic Analysis.

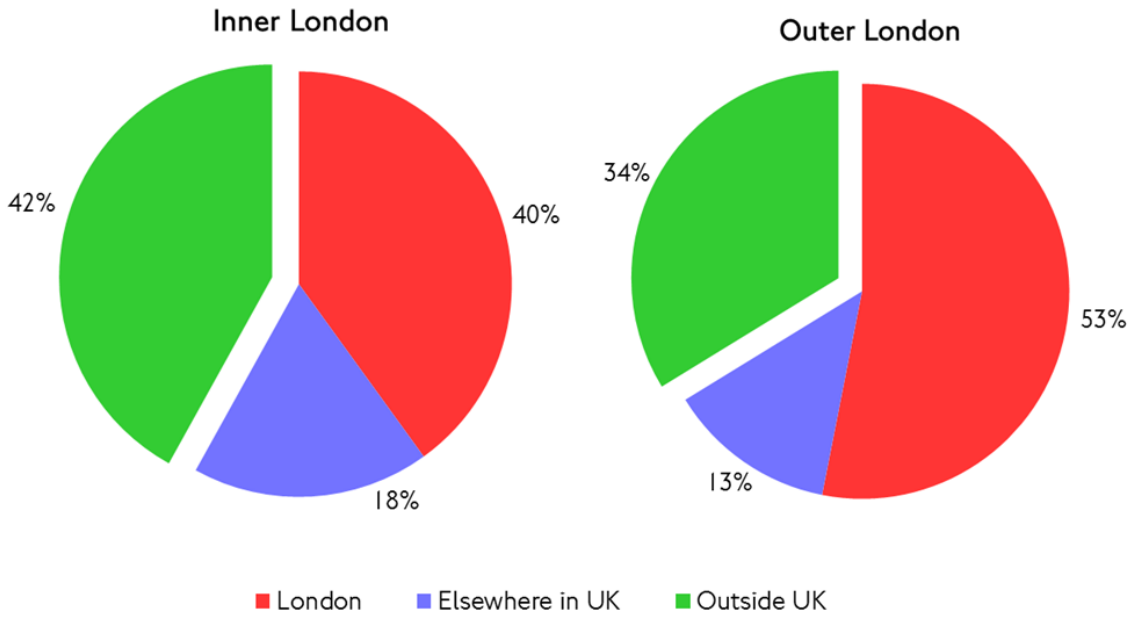
Variations in travel by place of birth of London residents

This section looks at the relationship of the place of birth of London residents to several aspects of travel or the main factors underlying travel demand, such as income and employment.

Population structure

London's role as a multicultural world city is reflected in the make-up of its population (figure 2.26). In inner London there is an equal split between people born in London and people born outside the UK, both accounting for two fifths of the 3.5 million people who live in inner London. Those born elsewhere in the UK also represent a sizeable minority at slightly more than half a million. In outer London, a little more than half of residents were born in London, those born overseas represent around one third of the population, with those from elsewhere in the UK making up 13 per cent of outer London's 5.2 million residents.

Figure 2.26 Population distribution in London by place of birth, 2015/16.

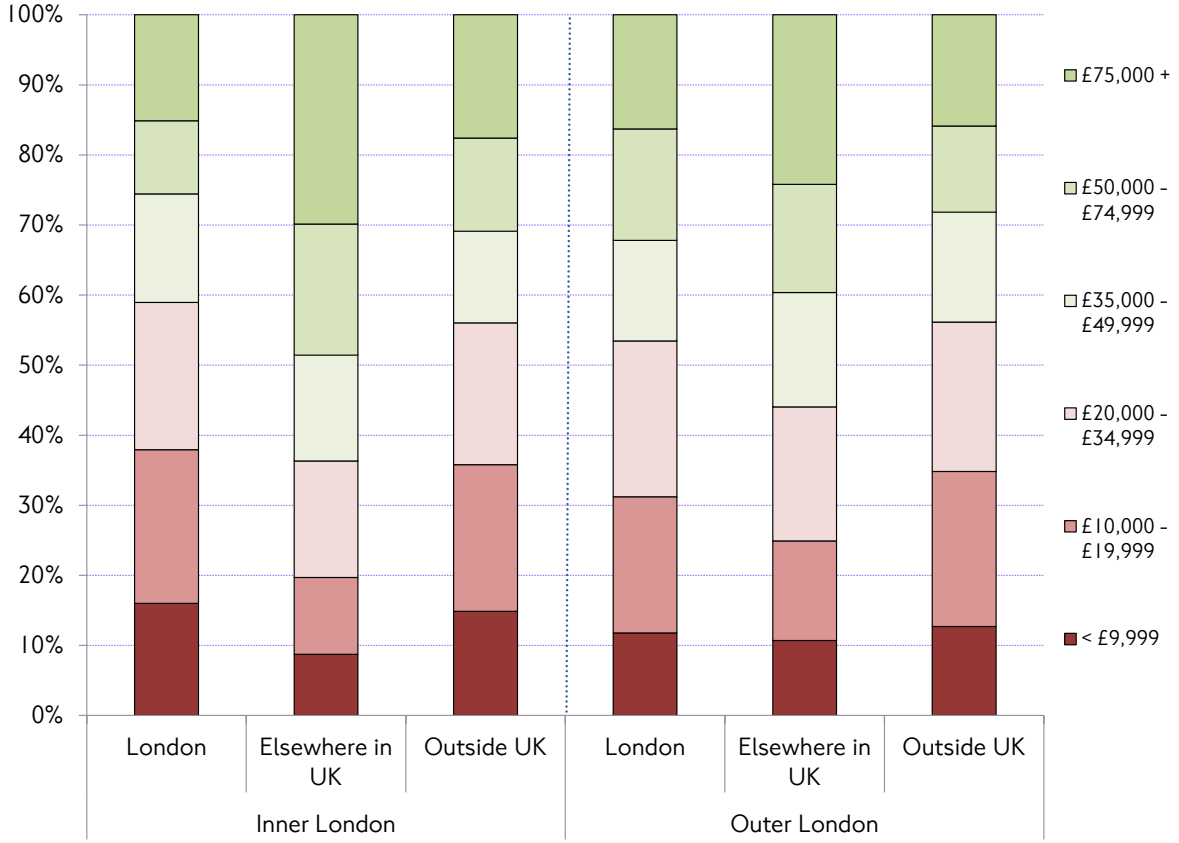


Source: TfL Planning, Strategic Analysis.

Household income by place of birth

Household income is notably higher for those born elsewhere in the UK than those born in London or overseas, and this trend is more marked in inner London than outer London, yet clearly evident in both areas (figure 2.27). Household income for those born overseas is very similar to that of those born in London, although people born in London living in outer London tend to have slightly higher household incomes within this group.

Figure 2.27 Household income distribution by place of birth, 2015/16.

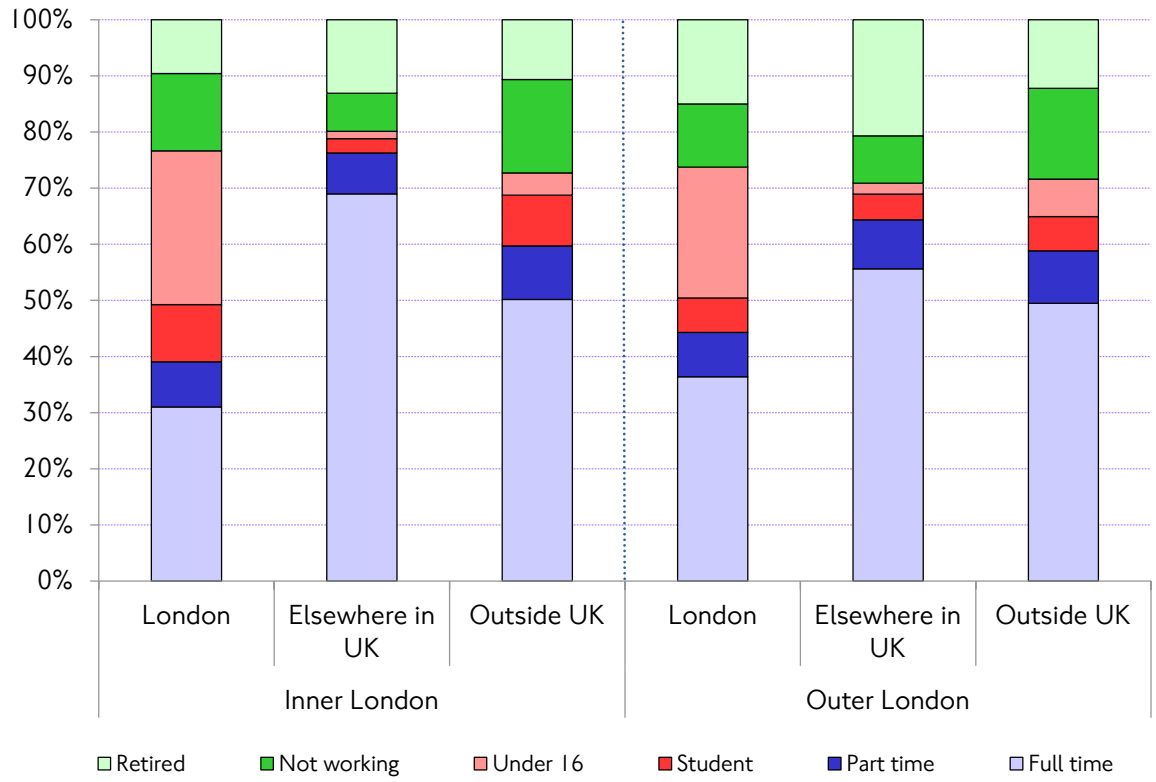


Source: TfL Planning, Strategic Analysis.

Working status by place of birth

The majority of under-16s across London were born in the city. The group with the highest proportion of full-time workers are people from elsewhere in the UK living in inner London (figure 2.28). This feature is also evident in outer London, although much less pronounced. For those born outside the UK around 50 per cent of people were in full-time employment regardless of their area of residence. The lower proportion of people born in London in full-time employment is related to the much higher proportion of young people belonging to this group.

Figure 2.28 Working status by place of birth, 2015/16.

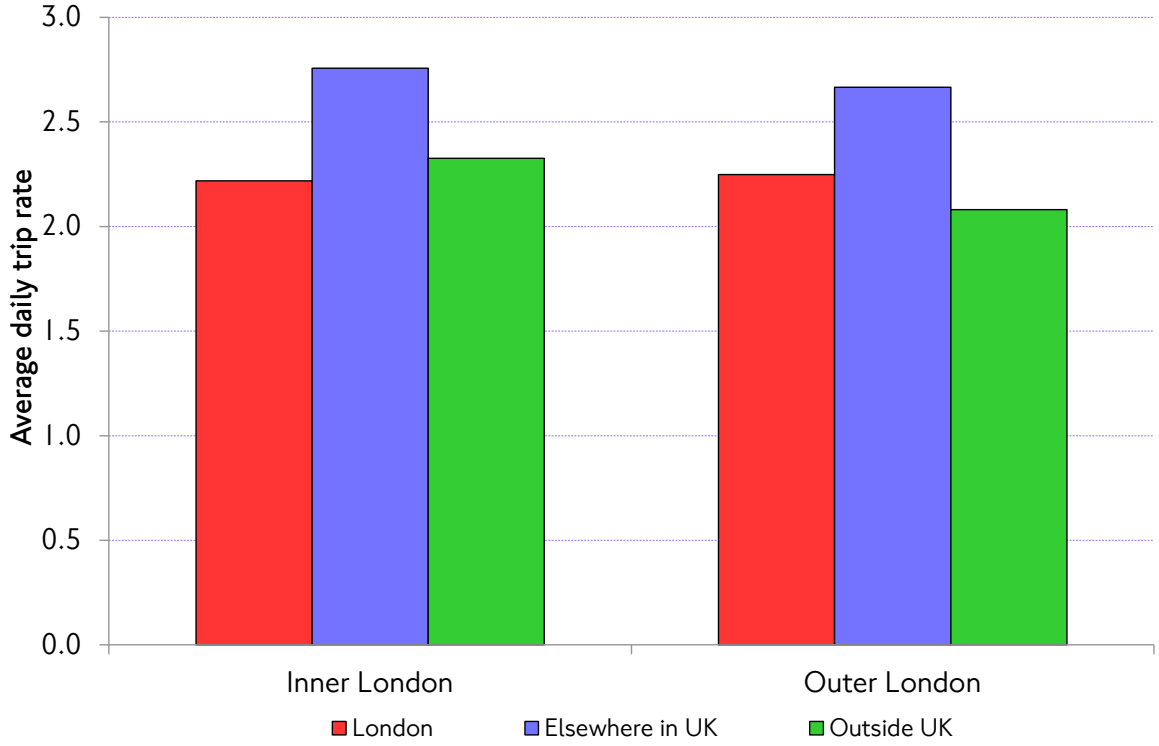


Source: TfL Planning, Strategic Analysis.

Trip rates by place of birth

Those born in the UK outside London also have considerably higher trip rates than average – at 2.76 journeys per day for those living in inner London, and 2.67 in outer London (figure 2.29). There is little difference in the average number of trips between inner and outer London by those born in London (at 2.22 and 2.25 respectively). People from outside the UK have a slightly higher average than their London counterparts in inner London, making an average of 2.33 trips a day, however this drops to 2.08 in outer London, the lowest rate of all groups.

Figure 2.29 Average daily trip rates by place of birth, 2015/16.



Source: TfL Planning, Strategic Analysis.

Trip purpose by place of birth

The distribution in trip purpose by place of birth reflects the working status of Londoners, and those born elsewhere in the UK make the largest proportion of leisure trips (figure 2.30). Of particular interest is the proportion of work-related trips made by people born outside the UK living in outer London and its impact on reduced trips for leisure purposes.

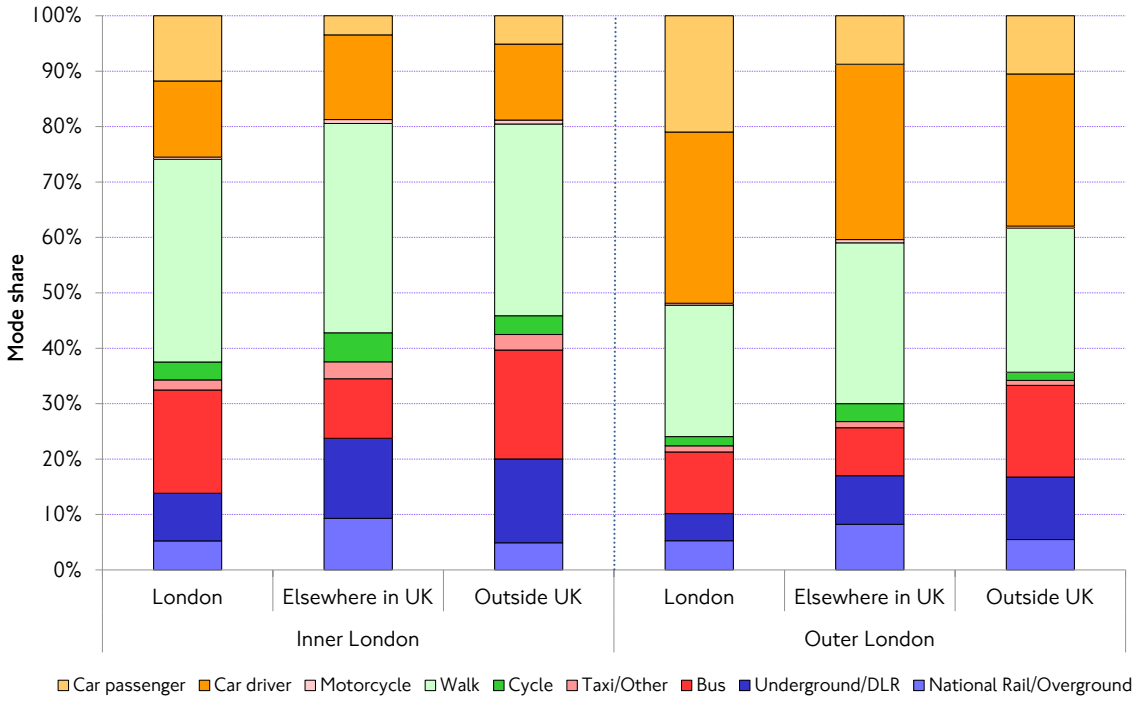
Figure 2.30 Trip purpose by place of birth, 2015/16.

Source: TfL Planning, Strategic Analysis.

Mode share by place of birth

People born in London are much more likely to travel by car, with car mode share at more than 50 per cent for those living in outer London (figure 2.31). Those born elsewhere have the highest rail use and are also most likely to travel by active modes (walking or cycling). People born outside the UK have the lowest car use and highest bus use of all Londoners.

Figure 2.31 Trip based mode share by place of birth, 2015/16.

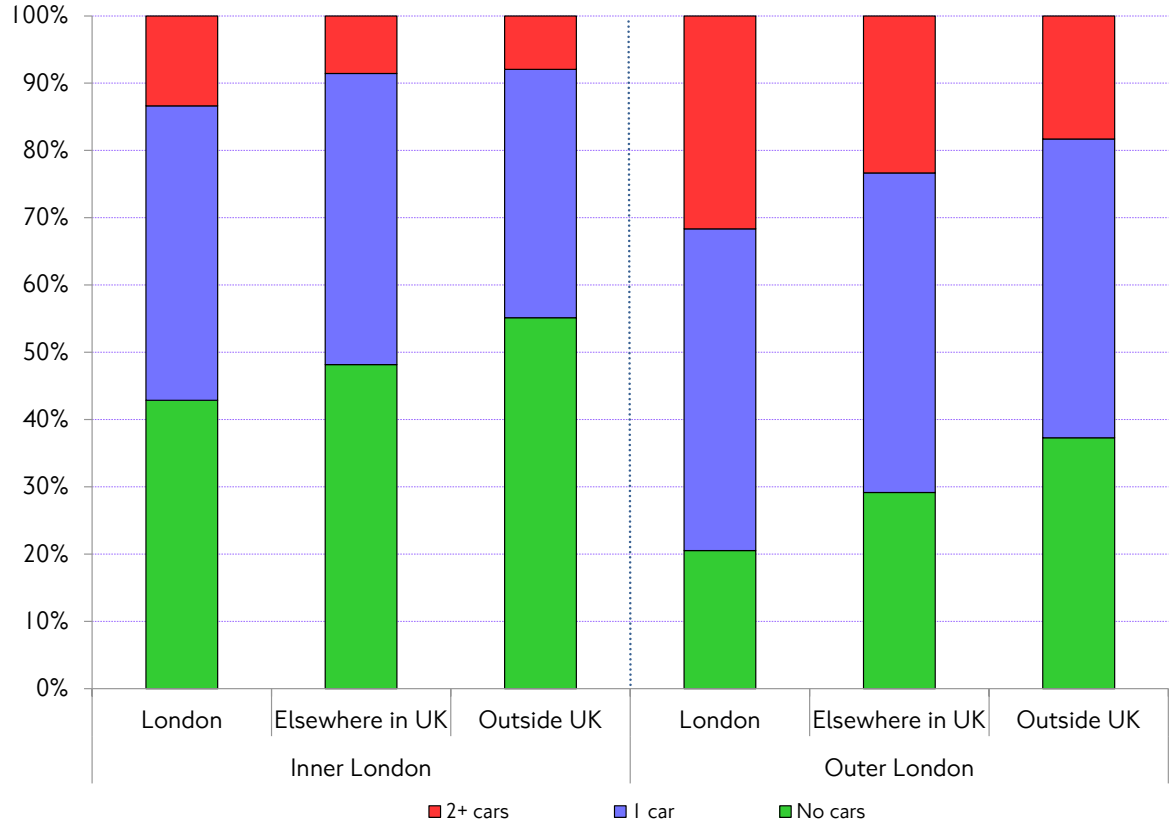


Source: TfL Planning, Strategic Analysis.

Car ownership by place of birth

There is a clear trend of increased car ownership by people who were born in London, followed by people born elsewhere in the UK, with people from outside the UK least likely to live in a car-owning household (figure 2.32). More than 30 per cent of people born in London and living in outer London live in a household which has two or more cars, reflecting the much higher modal share by cars for trips in this area.

Figure 2.32 Percentage shares of household car ownership by place of birth, 2015/16.



Source: TfL Planning, Strategic Analysis.

3. Public transport: Travel demand, service supply and operational performance

3.1 Introduction and contents

Chapter 2 of this report looked at trends in aggregate travel demand and mode shares in London, and considered some of the factors underlying recent changing travel patterns. The overall picture since 2000 is one of strong growth in London's population and travel demand – a pattern that is expected to continue into the foreseeable future. This growth has been at a faster rate than previously envisaged, and has affected the main travel modes in different ways, in particular with a progressive and substantial net shift in mode share towards public transport, walking and cycling over the last 15 years.

This growth in demand has also been accompanied by record levels of investment, to improve the capacity of London's transport networks and also to improve the wider level and quality of service offered.

This chapter focuses on London's public transport network and considers, in turn for each of the public transport modes, the trends in travel demand affecting that mode, and the changes to the level of service offered – looking at both capacity and quality of service. The focus is generally on the period since 2000, although longer-term trends are highlighted where the available data permit.

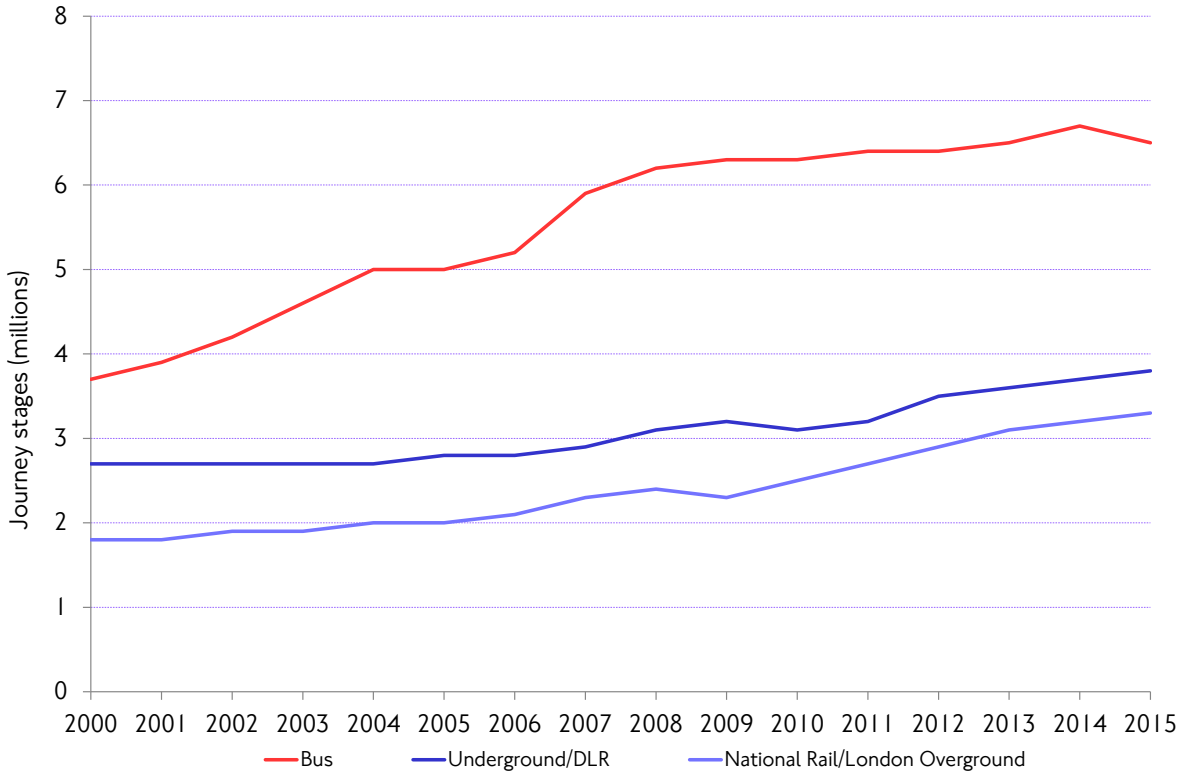
3.2 Summary of trends and key developments since 2000

Travel demand

Considering the period 2000 to 2015, the total demand for public transport in London – measured in terms of journey stages – grew by 65.0 percent. In the longer-term historic context this level of growth was unprecedented. TfL's projections of future travel demand suggest that growth is likely to continue at a similar rate for the foreseeable future.

However, the growth has been focused on particular modes at different points in time. Figure 3.1 shows the demand growth trend for each of the principal modes over this period. The figure is in terms of the absolute number of journey stages per year, and therefore it also illustrates the differences in scale – in terms of the total volume of travel – across these modes.

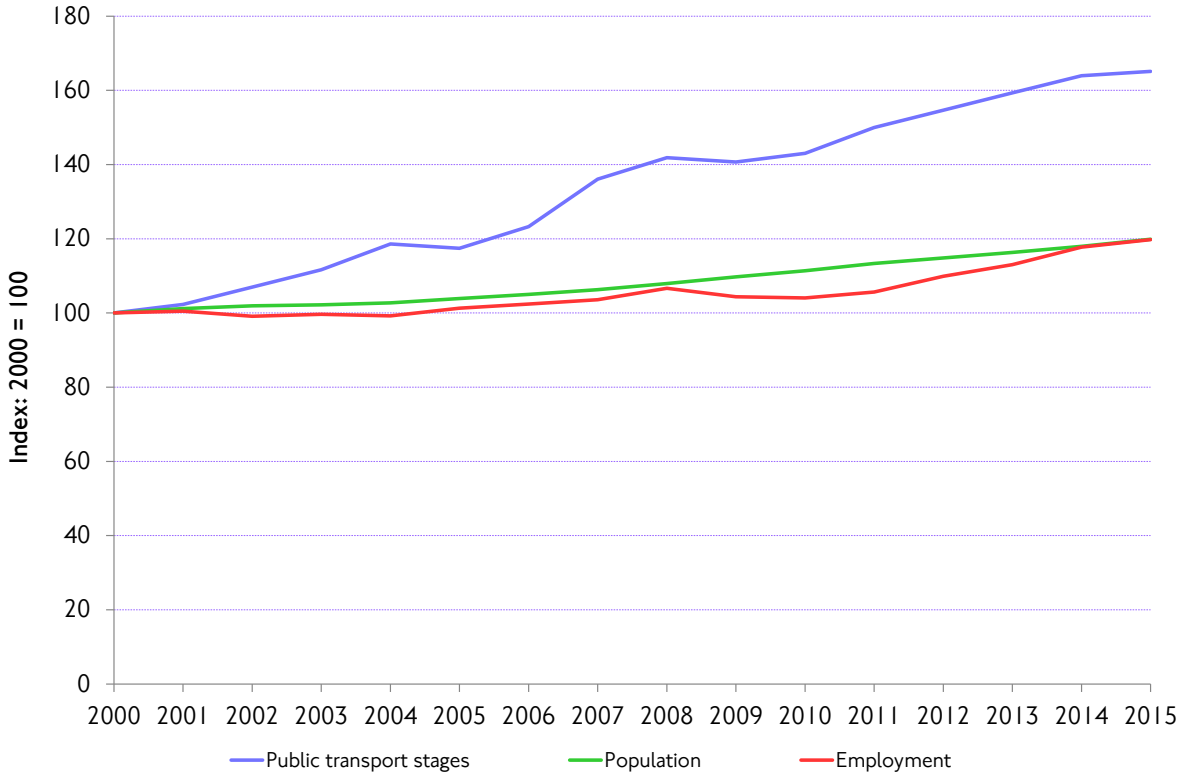
Figure 3.1 Growth in journey stages on selected modes, 2000 to 2015.



All modes have seen a growth in demand between 2000 and 2015, with the greatest growth on rail (81.1 per cent over the period), followed by bus (77.5 per cent) and Underground/DLR (47.6 per cent). However, despite the slower growth rate, the absolute number of journeys made on the bus network is higher than the number of journeys made on rail or Underground/DLR. Rail demand was most noticeably affected by the economic recession, dropping by 2.9 per cent between 2008 and 2009, however rail demand has grown very strongly since 2009, increasing by 42.1 per cent over that period. Growth in bus demand was particularly strong between 2000 and 2008, but has levelled off since then and has seen a decline of 1.8 per cent in the latest (calendar) year. Underground demand has shown steady growth over the period.

The growth in demand for public transport in part reflects London's population growth. However, while population grew by 19.9 per cent between 2000 and 2015, public transport demand grew by 65.0 per cent – this shows that public transport demand is growing much faster than population growth (figure 3.2).

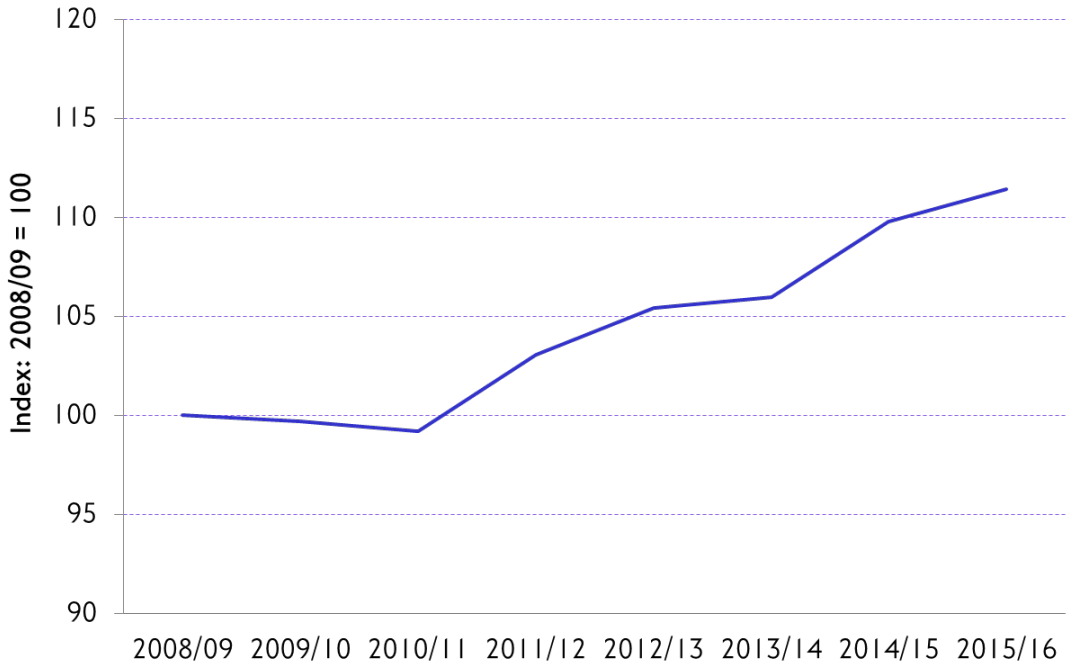
Figure 3.2 Growth in demand on the principal public transport modes compared with growth in population and employment in London, 2000 to 2015.



Capacity of the public transport networks

The growth in demand on public transport has been accompanied, and in part facilitated, by a large-scale investment programme. In the early part of the period in particular, this featured a large-scale expansion of the bus network. In the latter part of the period the Tube upgrade programme featured large-scale capacity improvements on many lines. The development of the London Overground network from the middle part of the last decade, and continued expansion to the Docklands Light Railway, have also been key developments.

Figure 3.3 Growth in capacity on the principal public transport modes (excluding Overground/National Rail), 2008/09 to 2015/16. (Index: 2008/09 =100). Million-place kilometres.



Source: TfL Planning, Strategic Analysis.

Figure 3.3 shows total capacity on the TfL public transport networks, excluding London Overground, over the period since 2008/09 for which consistent figures are available (see also table 3.1). After a slight decline between 2008/09 and 2010/11, in part reflecting temporary closures for the Tube upgrade programme, Underground, DLR, bus and London Trams capacity has steadily increased since 2010/11. This resulted in an overall combined increase of capacity on these modes of 12.3 per cent in the six year period between 2010/11 and 2015/16.

Table 3.1 Total yearly capacity provided by the principal public transport modes. Million place-kilometres.

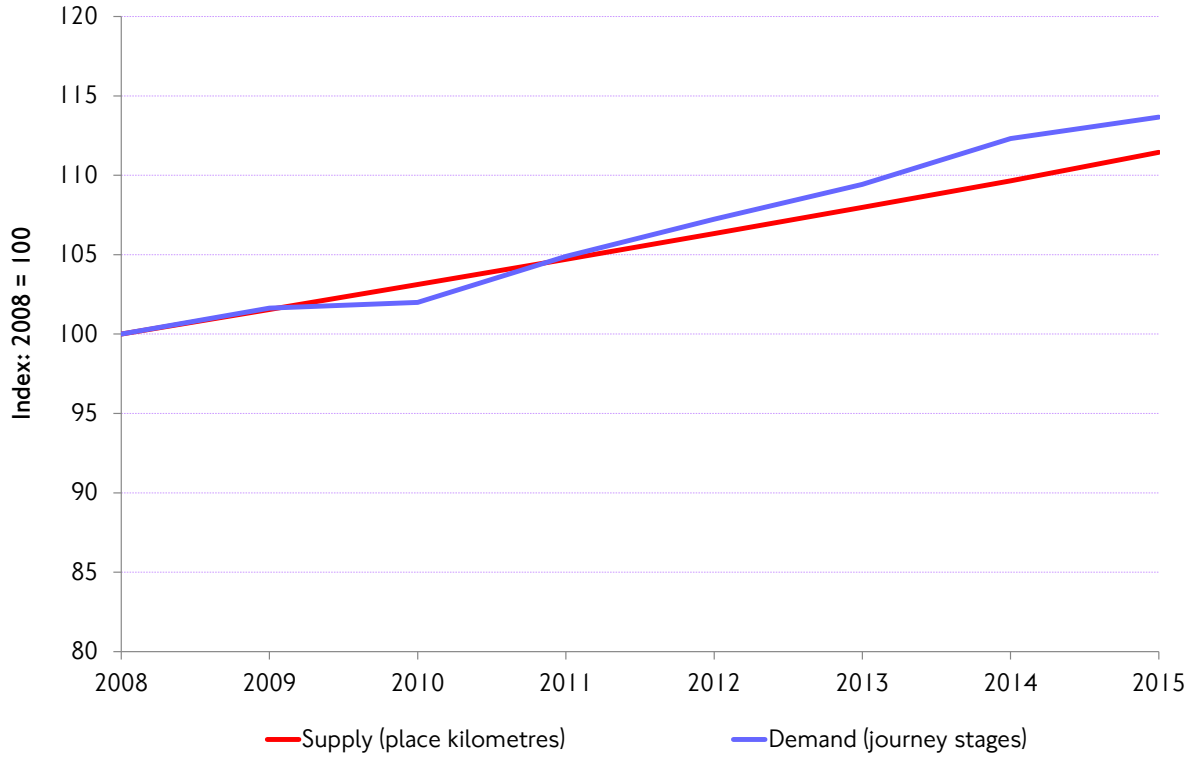
Mode	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
Underground	62,446	65,177	66,888	67,328	70,493	71,804
Bus	29,175	29,804	29,626	29,605	30,057	30,386
DLR	2,338	2,635	3,311	3,401	3,426	3,366
London Trams	564	566	606	632	629	634
Total	94,523	98,182	100,431	100,966	104,605	106,190

Source: TfL Planning, Strategic Analysis.
Notes: Values for Underground have been revised to reflect published London Underground assumptions for standing capacity. The absolute values given in the table reflect these revised assumptions, and are internally consistent. They do differ, however, from equivalent values published in previous Travel in London reports, although the percentage changes between years are the same.

Relationship between public transport demand and supply – short term

Figure 3.4 shows that the demand for public transport (in terms of journey stages) has grown at a faster rate than the supply of public transport (measured as place kilometres). Demand has increased by 13.7 per cent over the period from 2008/09 to 2015/16, compared to an increase in supply of 11.4 per cent over the same period.

Figure 3.4 Comparison of demand and supply trends on the core TfL public transport networks (excluding London Overground), 2008/09 to 2015/16.



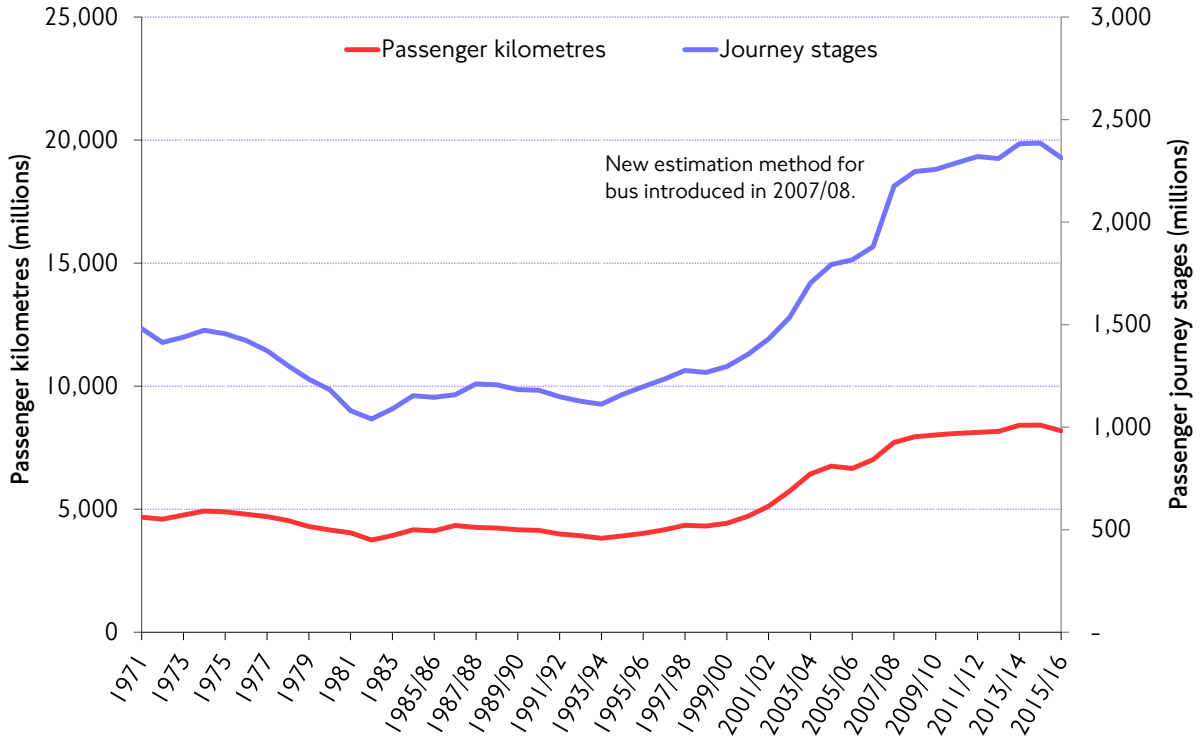
Source: TfL Planning, Strategic Analysis.

3.3 Modal demand trends: Bus

Figure 3.5 shows the long-term trend for bus patronage in London. The bus has been one of London's transport success stories, with the historic pattern of slowly declining patronage being dramatically reversed in the late 1990s to one of strong growth. The rate of growth has stabilised in more recent years, this corresponding to a slowing of the rate of increase in bus services.

However, in the most recent (financial) year, there was a decline of 3 per cent in terms of journey stages and passenger kilometres respectively.

Figure 3.5 Passenger kilometres and journey stages travelled by bus.



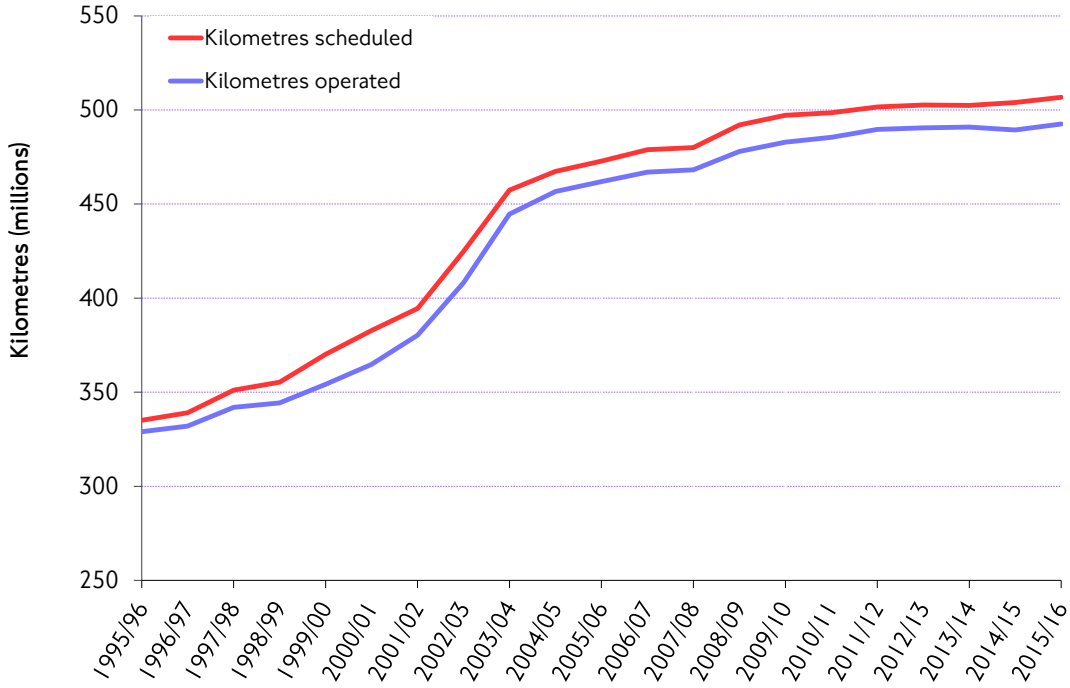
Source: TfL Service Performance data.

3.4 Modal performance trends: Bus

Bus service supply (capacity)

Bus service provision and service quality have both increased substantially since the start of the last decade. Buses in London operated 492.5 million bus kilometres in 2015/16, which represented 97.2 per cent of the scheduled service, and was 35.0 per cent higher than 2000/01 (figure 3.6).

Figure 3.6 Bus service provision – scheduled and operated bus kilometres.



Source: London Buses.

Bus service performance

Table 3.2 shows measures of bus service reliability. In 2015/16, the percentage of timetabled services 'on time' for low frequency bus routes decreased for the third year in a row, following the high in 2012/13, although this is partly due to a substantial expansion in the monitoring of these services.

The average actual waiting time for high frequency services remained the same as last year at 6.0 minutes. This follows the increase in 2012/13, which can be attributed to an expansion of monitoring to cover the period 05:00-24:00 continuously. Scheduled levels of service are lower at times of day not previously monitored such as late evenings and Sunday mornings.

Excess wait time increased slightly to 1.2 minutes for high frequency services in 2015/16, reflecting congestion caused by increased traffic levels and construction affecting the road network. While this shows the network is still very reliable most of the time, there have been isolated locations where reliability has been adversely affected. TfL is continuing to work with bus operators to mitigate the impacts at these locations.

Table 3.2 Indicators of bus service reliability.

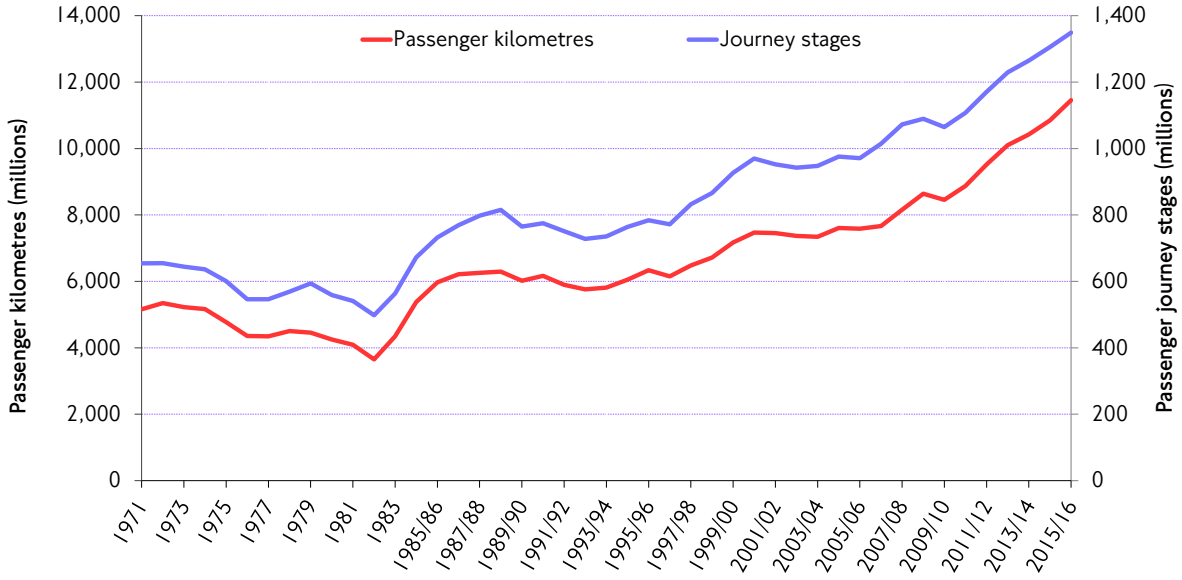
Year	Kilometres scheduled (millions)	Percentage of scheduled kilometres			High frequency services[1]		Low frequency services[2]
		Operated	Lost due to traffic congestion[4]	Lost due to other causes[5]	Average wait time (minutes)[6]		Percentage of timetabled services on time[3,7]
					Actual	Excess	
2000/01	383	95.3	2.1	2.6	6.8	2.2	67.7
2001/02	395	96.4	2	1.6	6.6	2	69.4
2002/03	425	96.1	2.6	1.3	6.4	1.8	70.5
2003/04	457	97.2	1.7	1.1	5.8	1.4	74.6
2004/05	467	97.7	1.6	0.8	5.6	1.1	77.1
2005/06	473	97.7	1.7	0.6	5.6	1.1	77.2
2006/07	479	97.5	1.9	0.6	5.5	1.1	78.1
2007/08	480	97.5	2	0.5	5.5	1.1	79.1
2008/09	492	97	2.3	0.7	5.5	1.1	80.8
2009/10	497	97.1	2.3	0.6	5.5	1.1	80.5
2010/11	499	97.4	2.1	0.5	5.4	1	81.4
2011/12	502	97.6	1.9	0.5	5.4	1	83.2
2012/13	503	97.6	1.7	0.7	5.9	1	83.6
2013/14	502	97.7	1.9	0.4	5.9	1	82.5
2014/15	504	97.1	2	0.9	6	1.1	81.8
2015/16	507	97.2	2.3	0.5	6	1.2	80.6

Source: London Buses.
1. High frequency services are those operating with a scheduled frequency of five or more buses an hour.
2. Low frequency services are those operating with a scheduled frequency of fewer than five buses an hour.
3. Buses are defined as 'on time' if departing between two and a half minutes before and five minutes after their scheduled departure times.
4. Also includes other lost kilometres outside the control of the operator.
5. Includes all lost kilometres within the control of the operator.
6. Results for high frequency routes from 2012/13 reflect the move to a greatly expanded quality of service indicators (QSI) system for monitoring of this group of routes.
7. Results for low frequency routes from 2013/14 reflect the move to a greatly expanded QSI system for monitoring this group of routes.

3.5 Modal demand trends: Underground

The number of people using the Underground in 2015/16 was the highest ever (figure 3.7), with 1,349 million passenger journeys (journey stages), a 3.3 per cent increase on the previous (financial) year. Passenger kilometres increased by 5.6 per cent over the past year. The continued strong growth of recent years, surpassing levels seen in 2012 in association with the London Games, emphasises the strength of the long-term upward trend in Underground patronage.

Figure 3.7 Passenger kilometres and journey stages by Underground.



Source: TfL Service Performance data.

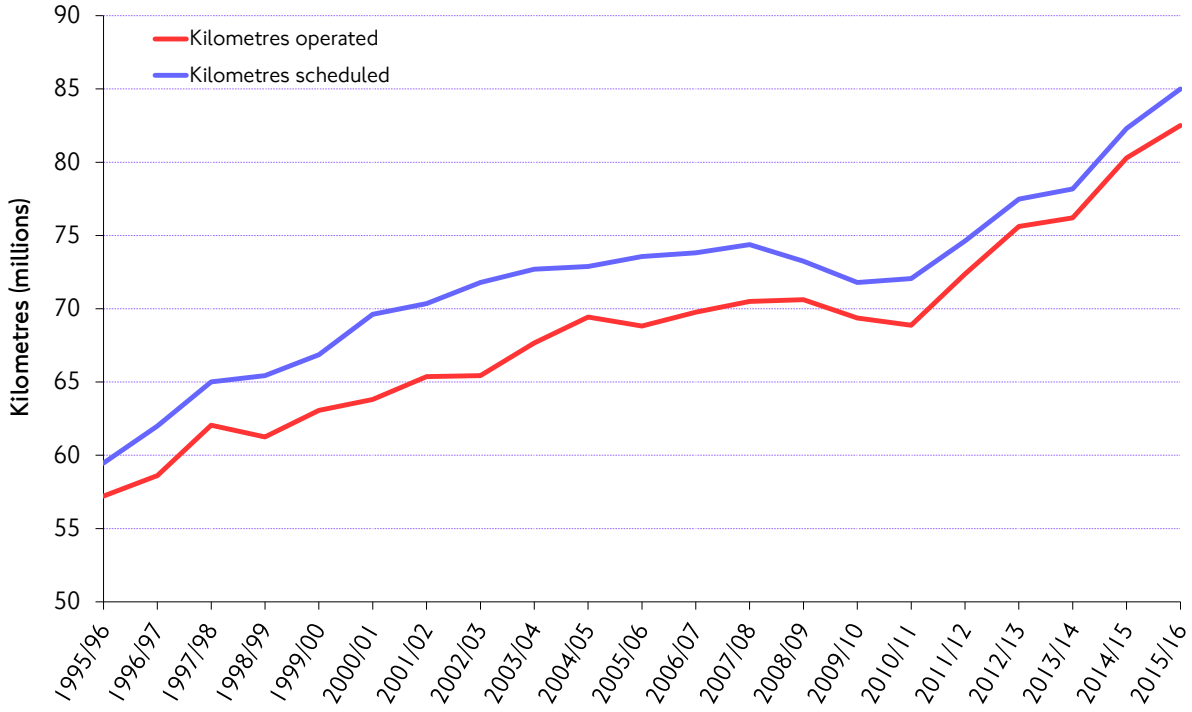
3.6 Modal performance trends: Underground

Underground service supply (capacity)

London Underground has substantially increased its service offering over the last decade – in the context of a largely static physical network in terms of its extent. This reflects the success of the Tube upgrade programme, providing the ability to increase both capacity and service reliability.

Underground train kilometres scheduled in 2015/16 were 3.2 per cent higher than in 2014/15 and the number of train kilometres operated was 2.7 per cent higher. This continued the strong upwards trend visible since 2010/11 (figure 3.8), with kilometres scheduled in 2015/16 22.0 per cent higher than in 2000/01, and kilometres operated 29.3 per cent higher.

Figure 3.8 London Underground: Train kilometres scheduled and train kilometres operated.



Source: London Underground.

Figure 3.8 shows two other significant features. The three years 2008/09 to 2010/11 saw small falls in both measures (note the origin point of the graph, the actual fall was quite modest). This largely reflects the impact of the Tube upgrade plan itself, in the form of planned closures of parts of the network at the weekends for upgrade work.

Underground service performance

The second feature is that the gap between the service scheduled and that actually operated has tended to narrow – reflecting a more reliable service. In 2015/16, 97.1 per cent of scheduled train kilometres were operated, which is very slightly lower than in 2014/15.

Underground reliability can also be expressed in terms of customer-focused measures such as average journey time and excess journey time. The latter is the additional time that customers have to wait over and above that implied by the schedule as a result of unreliability in the service. Excess journey time remained at 4.6 minutes as in 2014/15, the same as the previous year, which was the lowest recorded. The progressive improvement of this measure over the period since 2000/01 is reflected in the fact that the applicable value for 2000/01 was 8.6 minutes (table 3.3).

Table 3.3 London Underground – service reliability and journey times.

Year	Train kilometres scheduled (millions)	Percentage of scheduled kilometres operated	Average actual journey time (minutes)	Average generalised (weighted) journey time (minutes)	Excess journey time (weighted) (minutes)	Excess as % of generalised journey time
2000/01	69.6	91.6	28.6	45.7	8.6	18.9
2001/02	70.4	92.9	28.3	45.2	8.1	18.0
2002/03	71.8	91.1	29.1	46.7	9.7	20.7
2003/04	72.7	93.1	27.9	44.3	7.4	16.8
2004/05	72.9	95.3	27.7	44.0	7.2	16.4
2005/06	73.6	93.6	27.8	44.3	7.5	16.9
2006/07	73.8	94.5	28.0	44.7	8.1	18.0
2007/08	74.4	94.8	27.8	44.5	7.8	17.4
2008/09	73.2	96.4	27.5	43.9	6.6	15.1
2009/10	71.8	96.6	27.7	44.1	6.4	14.5
2010/11	72.1	95.6	28.0	44.6	6.5	14.6
2011/12	74.6	97.0	27.5	45.1	5.8	12.9
2012/13	77.5	97.6	26.8	43.6	5.3	12.1
2013/14	78.2	97.5	26.8	43.4	5.2	12.0
2014/15	82.3	97.6	26.5	42.3	4.6	11.0
2015/16	85.0	97.1	26.3	41.7	4.6	11.0

Source: London Underground.
1. Excess journey time is the difference between actual journey time and that expected if services run to time, and weighted to reflect how customers value time.

3.7 The Night Tube – some early feedback

Rationale for Night Tube

Since the year 2000, late night Tube usage had increased at double the rate of daytime trips, and demand for travel on night buses had risen by more than 170 per cent. With more than half a million users of the Tube after 22:00 on Fridays and Saturdays, it was clear that Londoners were travelling later and overnight more and more often. In response to these volumes, a weekend Night Tube service was planned to be introduced in September 2015. An industrial relations dispute meant that this was delayed until 2016. Reflecting London's status as a global city, the Night Tube will play a vital role in opening up London's night-time economy, supporting almost 2,000 permanent jobs and boosting the economy by £360m.

Phased introduction

It was agreed with Trades Unions to recruit part-time train operators for Night Tube. This meant that new operators have been trained throughout 2016. The Night Tube service has been introduced as sufficient new operators have been trained for each line. The initial service on the Central and Victoria lines offered services on an east-west and north-south axis from 19th August 2016. The Jubilee and Northern lines followed on 7th October and 19th November respectively, and

the Piccadilly line, with the longest lead times for training, completed the first phase of Night Tube on Friday 16th December 2016.

Early feedback on patronage

It is too early to draw any conclusions about the demand for Night Tube, as the phased introduction means some lines have only been operating for a few weeks, and Underground services generally have a three to four year ramp up period to recognise full forecast demand. However early indications have been extremely positive. With just the Central and Victoria lines operating Night Tube, demand was around 50 per cent ahead of forecast. Particular spikes in ridership have been seen around Halloween (when there were lines operating) where demand was double the forecast ridership of 82,000, and in the run up to Christmas.

The millionth journey was made on Night Tube over the weekend of 21/22 October (when the Central, Jubilee and Victoria lines were operational), and the two-millionth journey was made six weeks later over the weekend of 9/10 December 2016. It is forecast that 4.37 million journeys will be made in the 2016/17 financial year and 11.9 million in 2017/18.

The forecast and actual lines have been narrowing as further lines are introduced. Many customers were using the first Night Tube lines for part of their journey, completing by bus or taxi, until a more convenient line started operation, at which point they transferred. A good example of this is at Oxford Circus, which was seeing 14,000-18,000 users per weekend initially, but this reduced to around 10,000 once the Northern line commenced Night Tube, and more convenient stations for the West End such as Leicester Square opened.

Oxford Circus remains the busiest station on Night Tube, while the second busiest is Stratford, which is almost exclusively customers exiting the station. There is a high degree of interchange between lines being observed at Waterloo, Green Park and Bond Street, while stations such as Euston, Victoria and King's Cross St Pancras are much quieter than during the day. Liverpool Street is an anomaly to this rule, where a high walk-in demand from the Shoreditch area is being seen.

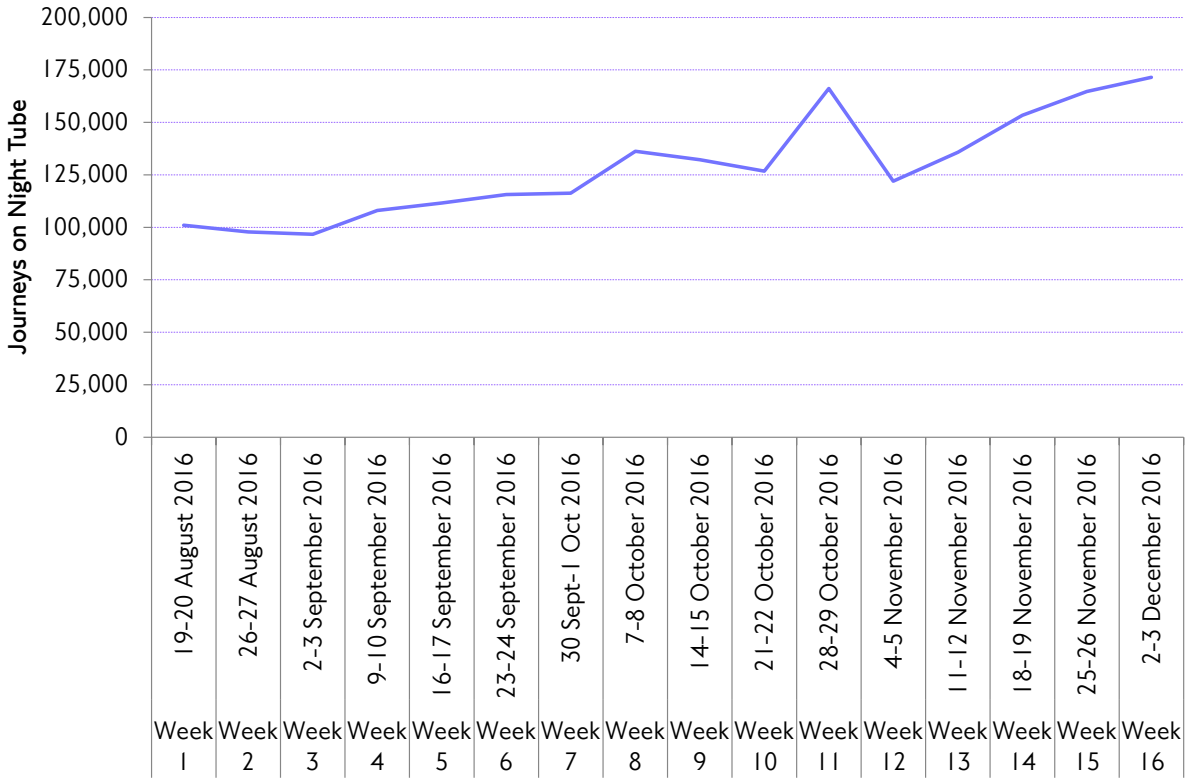
The operation of Night Tube has very quickly become 'business as usual' on London Underground. Operational performance is in line with, or bettering, that seen over the rest of the weekend, and while the service is less frequent, it means that service recovery following an incident is much easier. There are no particular trends emerging regarding the cause of any service perturbation. However, one trend is becoming evident and that is consistently more than 99 per cent of timetabled trains are being operated and 95 per cent of trains or more are consistently operating within three minutes of their planned headway.

Night Tube connects with many of London's night bus routes, including 17 new weekend night bus routes that have been introduced to directly complement and feed Night Tube. Again it is too early to draw long-term conclusions but ridership is consistently doubling on some suburban feeder routes and there are more than 4,000 journeys per weekend on the 17 new routes. Of course, ridership is declining on some night bus routes that parallel Night Tube, and TfL will be reviewing the frequencies of these in 2017.

Figure 3.9 shows the number of journeys made on Night Tube each weekend since 19th August 2016. The number of journeys has been increasing, although this is

expected as a result of the phased introduction of Night Tube. The highest number of journeys was made on the weekend of 28-29th October 2016, corresponding with Halloween.

Figure 3.9 Number of journeys on Night Tube.



Source: TfL Service Performance data.

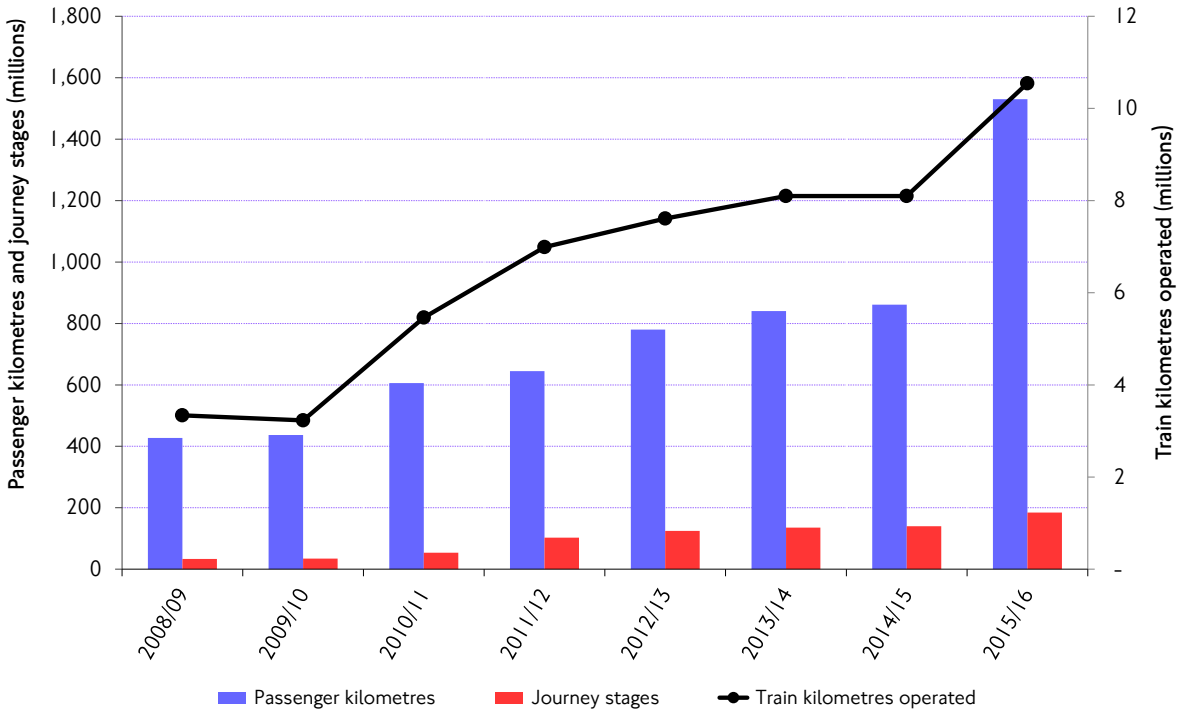
3.8 Modal demand trends: London Overground

Since the first full year of operation of the London Overground, in 2008/09, to 2015/16, passenger kilometres have increased by 258 per cent, with a 455 per cent increase in passenger journey stages and a 216 per cent increase in train kilometres operated. This reflects the progressive expansion of the network coupled with a shortening of journey stage lengths following the extensions of the network to a number of main travel interchanges, such as Clapham Junction.

The London Overground network commenced with the adoption of National Rail lines formerly operated under the Silverlink franchise in 2007. In May 2010, the East London line became part of the network when the phase one extension was completed. In February 2011, the East London line was extended to Highbury & Islington from Dalston Junction. This was followed by a major infrastructure upgrade project in 2011/12 which led to the introduction of the May 2011 timetable providing four peak trains an hour from Stratford to Richmond together with four peak trains an hour from Stratford to Clapham, and a 'turn up and go' service of eight trains an hour in the central section of the North London line. In December 2012, the South London line extension of the network from Surrey Quays to Clapham Junction opened, completing the orbital route. In May 2015, London Overground took over the operation of services between Liverpool Street and Enfield Town, Cheshunt (via Seven Sisters) and Chingford as well as those on the Romford to Upminster line. This accounts for the greater increases in passenger

kilometres and journey stages in the last year compared to 2014/15. In 2015/16, passenger kilometres increased by 77.6 per cent on the previous year, to 1,530 million, and passenger journey stages increased by 31.8 per cent to 184 million (figure 3.10).

Figure 3.10 Passenger kilometres and journey stages by London Overground.



Source: TfL Service Performance data.

3.9 Modal demand trends: National Rail in London

National Rail travel has grown strongly at the national level over the past decade, with only a brief slowdown during the recent recession. This pattern is reflected for travel on services defined by the Office of Rail and Road (ORR) as 'London and South East' (L&SE) operators. Passenger kilometres and passenger journeys increased for the fifth year in a row with increases of 2.5 per cent in passenger kilometres and 2.4 per cent in journeys. Comparing 2015/16 with 2000/01, there has been a 58.1 per cent increase in passenger kilometres and a 78.1 per cent increase in the number of journey stages (table 3.4).

Table 3.4 Passenger kilometres and passenger journey stages by National Rail – operators classified by ORR as London and South East operators.

Year	Passenger kilometres (billions)	Year-to-year percentage change	Passenger journeys (millions)	Year-to-year percentage change
2000/01	19.2	4.4	664	4.0
2001/02	19.3	0.3	663	-0.1
2002/03	19.8	2.8	679	2.4
2003/04	20.1	1.7	690	1.6
2004/05	20.5	1.9	704	2.1
2005/06	20.7	1.1	720	2.2
2006/07	22.2	7.1	769	6.9
2007/08	23.5	6.1	828	7.7
2008/09	24.2	2.9	854	3.1
2009/10	23.8	-1.8	842	-1.4
2010/11	25.0	5.2	918	9.0
2011/12	26.4	5.3	994	8.3
2012/13	27.3	3.4	1,032	3.9
2013/14	28.6	4.9	1,107	7.2
2014/15	29.6	3.4	1,155	4.3
2015/16	30.3	2.5	1,183	2.4

Source: Office of Rail and Road.

3.10 Modal performance trends: National Rail including London Overground

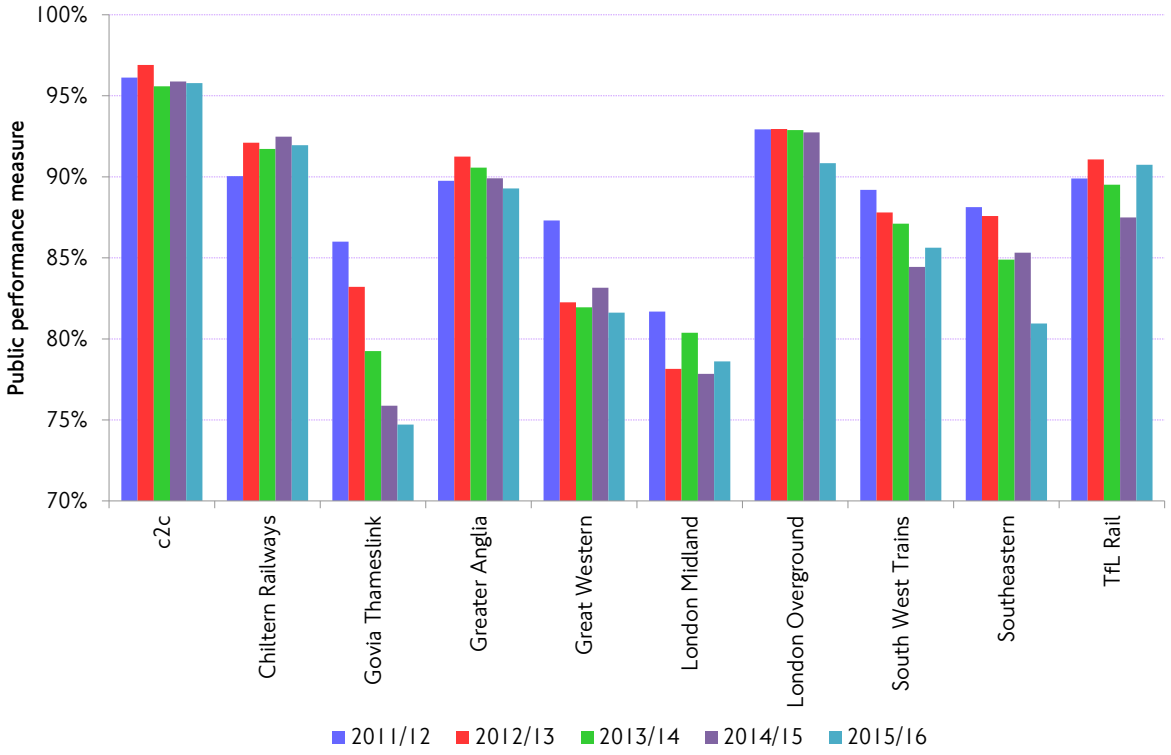
There are several ways of measuring the operational performance of National Rail services in London. For this purpose London Overground is considered as part of the National Rail network.

Reliability

The reliability of National Rail services is measured through the public performance measure (PPM), which combines figures for punctuality and reliability into a single measure. The PPM is therefore the percentage of trains 'on time' compared to the number planned. A train is defined as 'on time' if it arrives no later than five minutes after the planned destination arrival time for services defined by the ORR as L&SE and regional operators, or not later than 10 minutes for long-distance operators.

Figure 3.11 shows PPM measures for all services operated by L&SE operators over the last five years. The general trend over the most recent year was mixed – services of some operators showing an improvement balanced by others whose PPM measure had fallen. The most notable changes in the last year were for TfL Rail which increased from 87.5 per cent in 2014/15 to 90.8 per cent in 2015/16 and Southeastern, which decreased from 85.3 per cent in 2014/15 to 80.9 per cent in 2015/16. c2c (services from London Fenchurch Street) maintained its position as the best performing L&SE operator on this measure for the last five years.

Figure 3.11 National Rail – public performance measure for London and South East operators (moving annual average as at quarter four each year).



Source: Office of Rail and Road.

National Rail capacity

Capacity of National Rail services relevant to London is measured in terms of loaded train kilometres scheduled. This is available from the ORR website (http://orr.gov.uk/).

National Rail crowding

Crowding on National Rail is monitored using the Department for Transport's (DfT's) passengers in excess of capacity (PiXC) measure. This compares planned capacity on services arriving in or departing from central London against actual demand, with PiXC being the difference between the two. The observations relate to trains departing their last stop before arrival at the relevant London terminal.

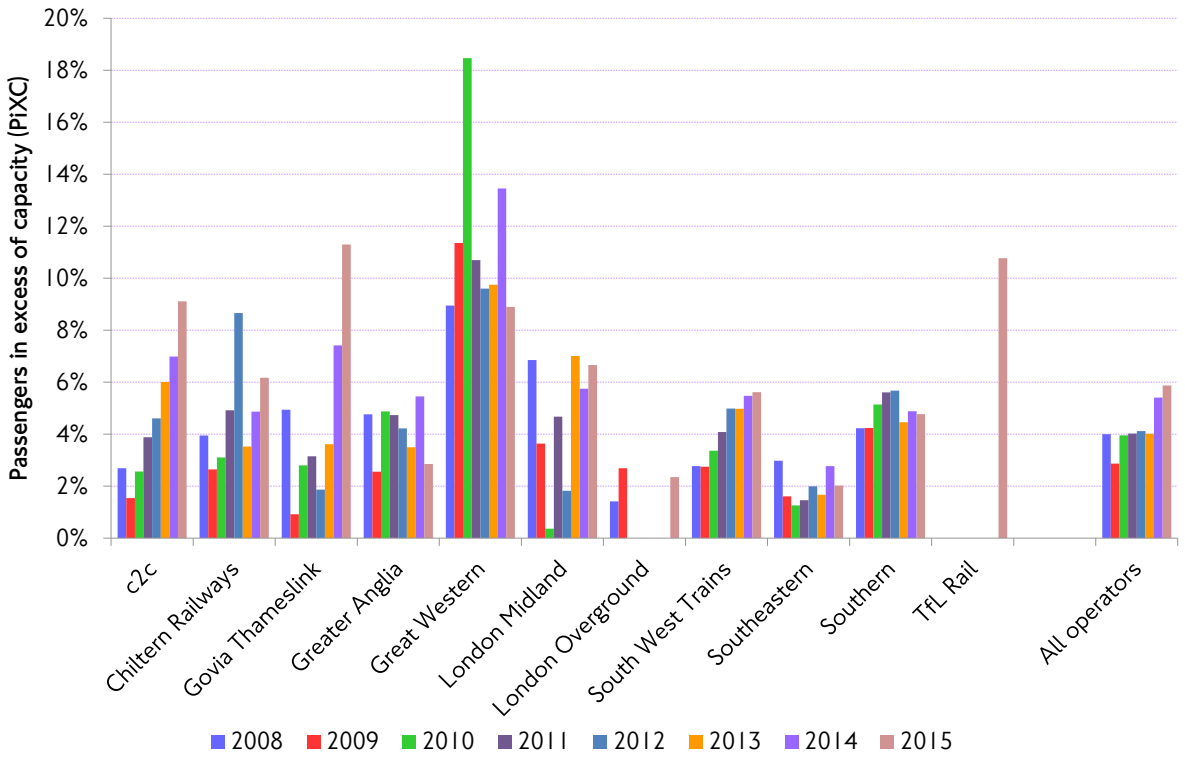
Figure 3.12 shows PiXC results (for the morning peak period only) from 2008 by train operator. In 2015 the PiXC value across all operators (combined) increased to 5.9 per cent, up slightly from 2014. Four operators saw a reduction in crowding in the most recent year, the largest decrease was for Great Western, followed by Greater Anglia then Southeastern and Southern.

In the context of continuing strong growth in demand for rail services, significant reductions in PiXC values for individual operators are usually associated with the acquisition of new rolling stock and/or the provision of new services. Likewise, where the network is relatively static, demand growth from year-to-year would tend to drive a corresponding increase in PiXC values.

The first non-zero value for London Overground since 2009 reflects TfL's assumption of responsibility for certain short-distance services from London's Liverpool Street station, effective from May 2015. This also partly explains the reduction in PiXC values for the Greater Anglia group of services, under which the London Overground services formerly operated.

Govia Thameslink services had the highest morning peak PiXC values in the latest year, with the PiXC value increasing to 11.3 per cent in 2015 from 7.4 per cent in 2014.

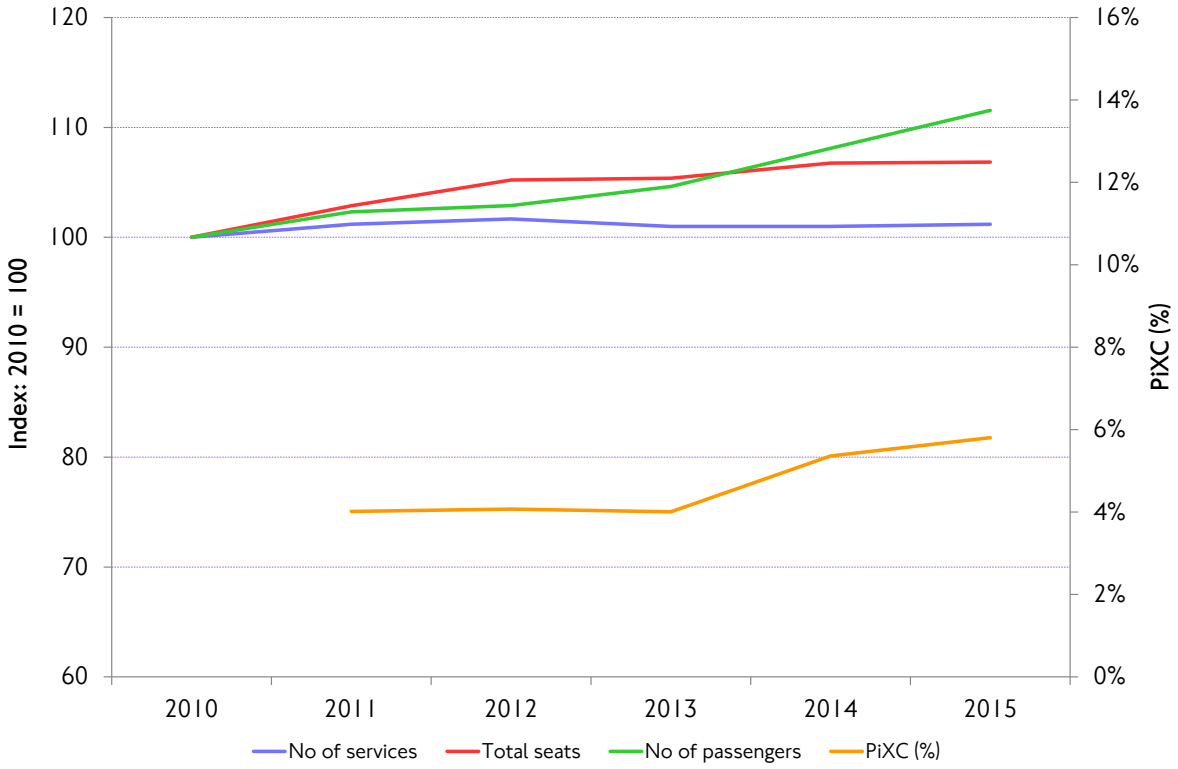
Figure 3.12 Passengers in excess of capacity (PiXC) for National Rail operators in London during the weekday morning peak.



Source: Department for Transport.

Figure 3.13 shows the trend in the overall London PiXC value for the period 2010-2015, and sets this against the equivalent trend for demand and the basic elements of supply – loaded trains and seats provided. It is seen that passenger demand has grown consistently over this period, but that the growth in the number of train services has been less. This reflects recognised capacity issues at many main London terminal stations, which limit the ability of train operators to introduce more frequent services in the weekday AM peak. In many cases, the operator response has been to lengthen trains through the addition of extra coaches, to maximise passenger throughput in the context of limited train 'paths' – particularly on Great Western services into Paddington and South West Trains services into Waterloo. This means that the number of 'seats' (a proxy for total passenger capacity) have increased at a more rapid rate, although the overall PiXC trend is edging upwards, and there are also limits to the extent to which train lengths can be extended.

Figure 3.13 National Rail – measures of capacity, demand and passengers in excess of capacity for services approaching London terminals during the weekday AM peak.



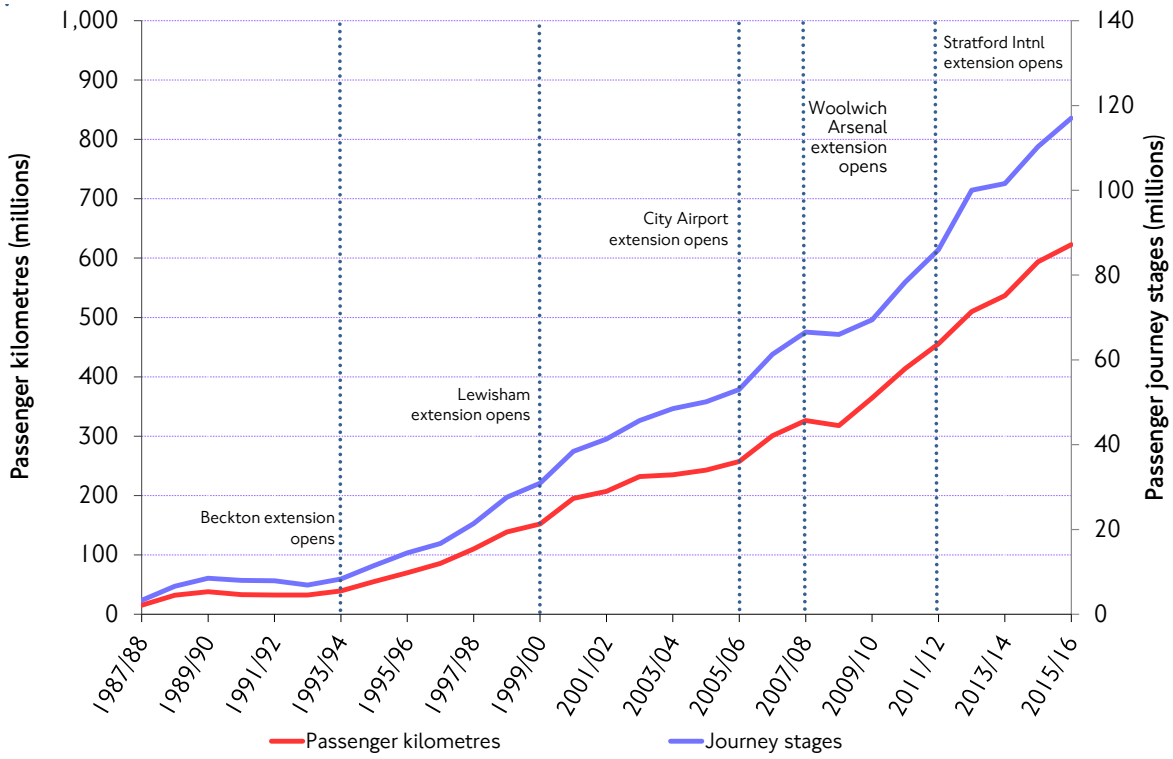
Source: Department for Transport.

3.11 Modal demand trends: Docklands Light Railway

Figure 3.14 shows the trend for travel by DLR since its initial opening in 1987. Patronage has grown steadily over this period as the network has progressively expanded. Principal milestones in the development of the network are shown in the figure to aid interpretation.

In 2015/16, 623 million passenger kilometres were travelled on the DLR, equivalent to 117 million journey stages. The number of passenger kilometres has increased by 4.9 per cent since 2014/15 while the number of journey stages has increased by 6.1 per cent since 2014/15. Again, this trend continues the strong growth seen over recent years, and on the other rail-based transport networks in London.

Figure 3.14 Passenger kilometres and journey stages by DLR.



Source: TfL Service Performance data.

3.12 Modal performance trends: Docklands Light Railway

Since 2000/01 the number of train kilometres operated on the DLR has increased from 2.9 million to 5.9 million, as shown in table 3.5 – reflecting both network expansion and enhanced service levels. The percentage of scheduled services operated was 98.5 per cent, a slight decline on 2014/15 as a result of a two-day strike in November 2015. To bring the DLR in line with other TfL modes, in 2014/15 the 'percentage of trains on time' measure was replaced by a measure of excess waiting time (EWT), which has been back-cast to 2011/12 for comparison. The year 2015/16 saw a EWT figure of 0.09 minutes, a slight increase on 2014/15.

Table 3.5 DLR service provision and reliability.

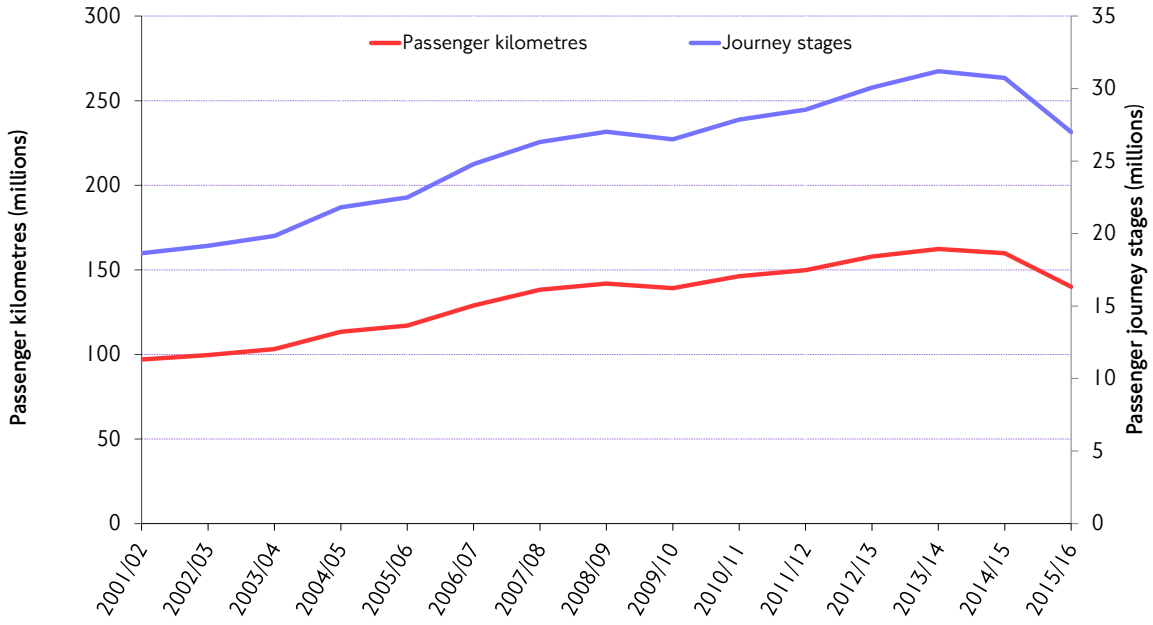
Year	Kilometres operated (millions)	Percentage of scheduled services operated	Percentage of trains on time	Excess waiting time (EWT)
2000/01	2.9	98.2	96.3	
2001/02	2.9	98.3	96.6	
2002/03	3.2	98.1	96.3	
2003/04	3.4	98.2	96.6	
2004/05	3.3	98.5	97.1	
2005/06	3.6	98.7	97.3	
2006/07	4.3	99.2	97.8	
2007/08	4.4	99.1	97.3	
2008/09	3.9	98.4	94.6	
2009/10	4.6	97.2	94.8	
2010/11	4.7	97.5	97.4	
2011/12	4.9	97.7	97.5	0.23
2012/13	5.7	98.5	98.8	0.14
2013/14	5.8	99.2	99.3	0.08
2014/15	5.8	99.3	n/a	0.07
2015/16	5.9	98.5	n/a	0.09

Source: Docklands Light Railway.

3.13 Modal demand trends: London Trams

London Trams initially opened in 2000 and the network has been relatively stable in extent since, albeit with a service restructuring in 2006. Figure 3.15 shows steady patronage growth averaging 4 per cent for passenger kilometres and journey stages over the period since opening although journey stages did decrease slightly, from 31.2 million in 2013/14 to 30.7 million in 2014/15. This decline in journey stages and passenger kilometres has continued into 2015/16, decreasing by 12.2 per cent and 12.4 per cent respectively. This was due to part closures of the lines as a result of town centre pedestrian ambience works as well as line improvement works.

Figure 3.15 Passenger kilometres and journey stages by London Trams.



Source: TfL Service Performance data.

3.14 Modal performance trends: London Trams

London Trams operational performance improved in 2015/16 compared with 2014/15, with 99.0 per cent of scheduled services being operated, up from 97.9 per cent in 2014/15.

Table 3.6 London Trams service reliability.

Year	Scheduled kilometres (millions)	Operated kilometres (millions) [1]	Percentage of scheduled services operated
2001/02	2.44	2.41	99.1
2002/03	2.49	2.46	98.9
2003/04	2.50	2.48	99.0
2004/05	2.49	2.42	97.2
2005/06	2.50	2.44	97.4
2006/07	2.57	2.54	98.7
2007/08	2.60	2.57	99.0
2008/09	2.70	2.66	98.5
2009/10	2.62	2.60	99.2
2010/11	2.72	2.70	99.2
2011/12	2.74	2.71	98.9
2012/13	2.98	2.90	97.3
2013/14	3.06	3.03	98.9
2014/15	3.03	3.01	97.9
2015/16	3.07	3.04	99.0

Source: London Trams.
1. Operated kilometres exclude replacement bus services operated during period of track repair works.

3.15 Modal trends: River Services

Passenger traffic on the Thames

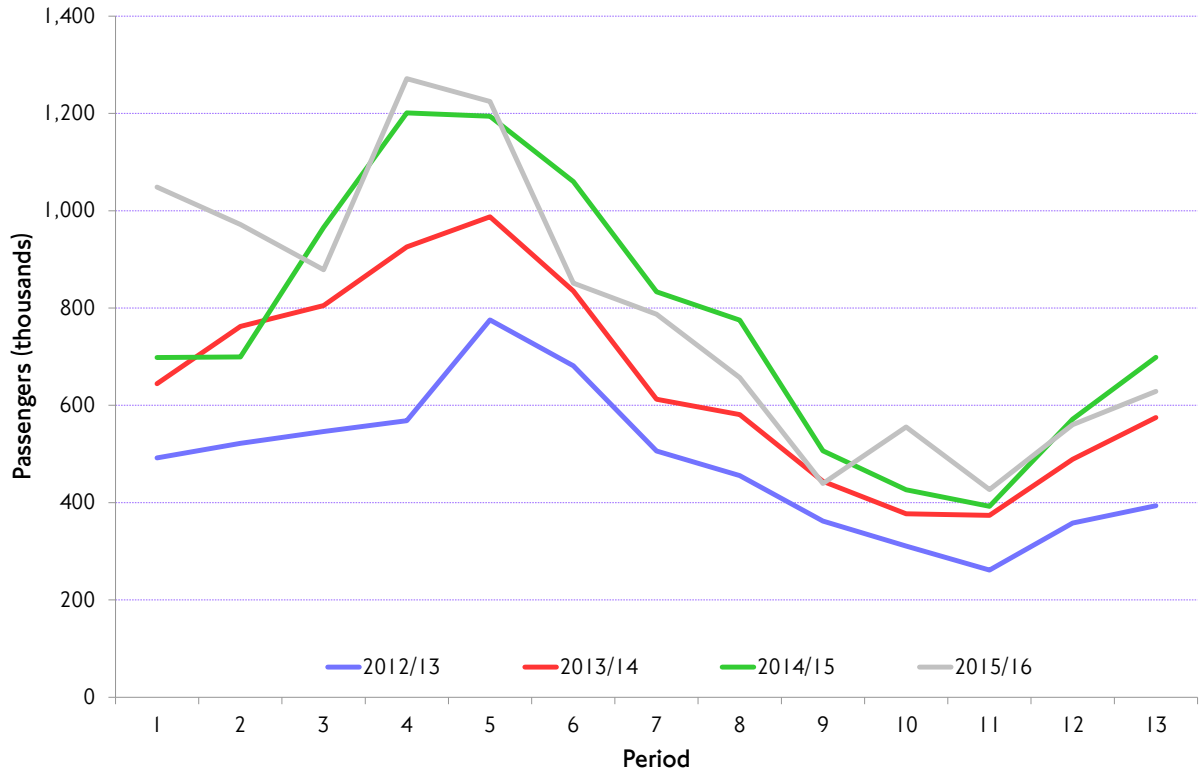
Patronage on TfL's River Services has seen strong growth in recent years, with more than 10 million passengers carried in 2015/16.

At the start of 2013/14, a new method of counting passengers was introduced that is intended to give more accurate information based on a full count of boarders and persons alighting at each pier, rather than previous data based partly on boarders and partly on ticket sales. This means that patronage numbers for 2013/14 are not directly comparable with those from previous years.

Figure 3.16 shows data for the whole of 2012/13, based on the previous system of counting, and data for 2013/14, 2014/15 and 2015/16 based on the new system. On a comparable basis, there was a 2.8 per cent increase in passengers in 2015/16 over the previous year.

In 2015/16, 99.0 per cent of licensed river services operated on time and the Woolwich Ferry operated at 96.6 per cent reliability, a small increase on 2014/15.

Figure 3.16 Passengers using TfL's River Services.



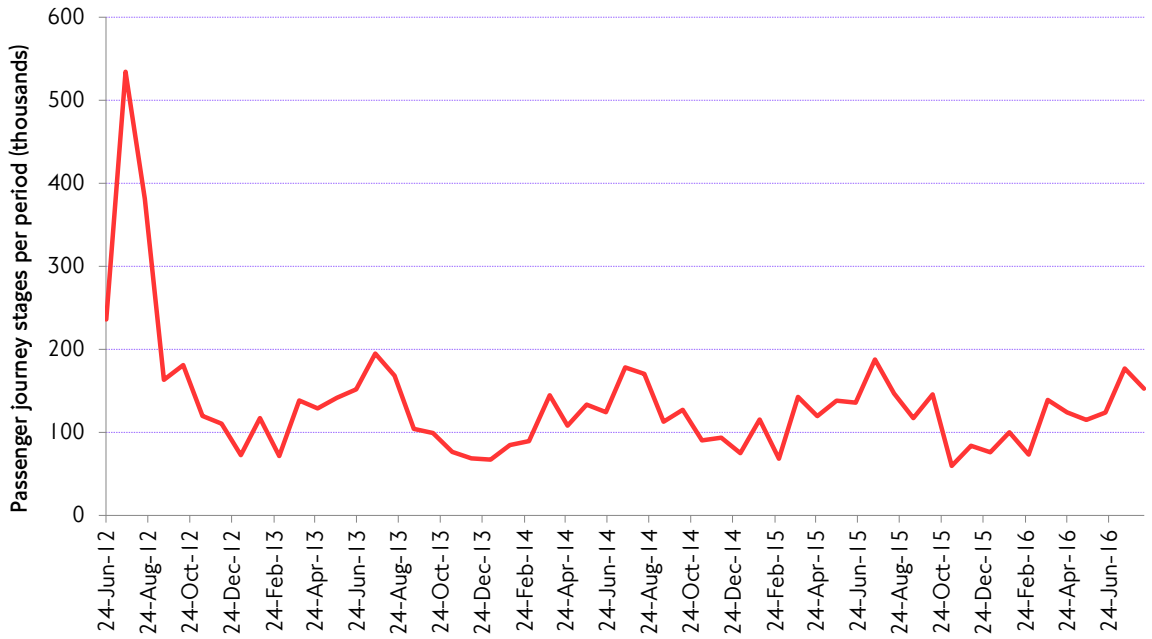
Source: TfL River Services.

3.16 Modal trends: Emirates Air Line

The Emirates Air Line, providing a cable car service across the Thames between the Greenwich Peninsula and the Royal Docks, opened in June 2012, just prior to the London 2012 Games. During the Games themselves, the geographic proximity of the Air Line to Games-related tourism and the 'novelty factor' combined to see patronage exceed 750,000 people in the first two (four-week) periods of operation.

Figure 3.17 shows that, following the exceptional conditions of summer 2012, the Emirates Air Line has settled into a more regular pattern of use, typically between 80,000 and 200,000 passengers per four-week period, with more passengers seen during school holidays. In 2015/16, 1.53 million journeys were undertaken on the Emirates Air Line, similar to the previous year.

Figure 3.17 Number of journey stages by Emirates Air Line.

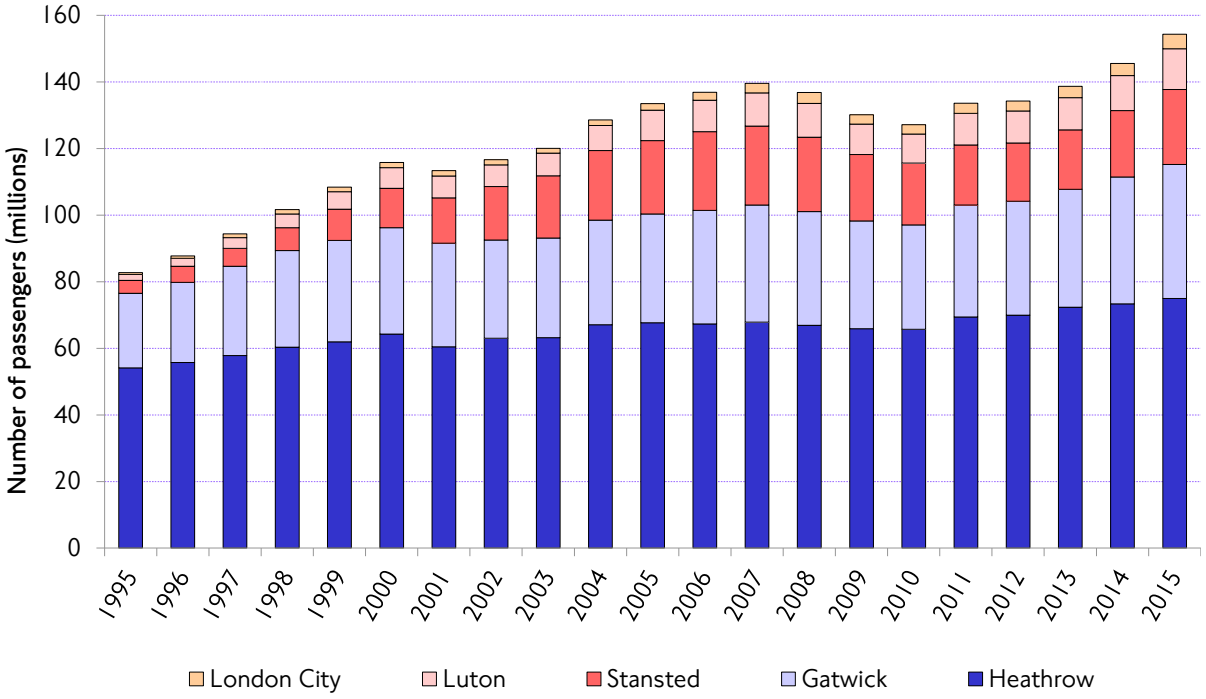


Source: TfL Service Performance data.

3.17 Passenger demand through London's airports

Demand for air travel through London's airports continues to grow strongly year-on-year, reflecting a recovery from the recession in the latter part of the last decade. There were a total of 154.3 million terminal passengers passing through London's four main airports in 2015 – up 6.0 per cent on 2014. Heathrow airport accounted for 48.6 per cent of the total, with Gatwick accounting for 26.1 per cent (figure 3.18).

Figure 3.18 Number of terminal passengers by London area airport.



Source: Civil Aviation Authority.

3.18 Key reference statistics

Travel demand

Table 3.7 brings together indicators of travel demand across the principal modes of transport, covering change over the most recent year, as well as giving a longer-term perspective in terms of change since 2000.

Table 3.7 Summary of key indicators of travel demand for principal public transport modes in London.

Mode and indicator	Units	2000 or 2000/01	2014 or 2014/15	2015 or 2015/16	Difference (%) 2015 or 2015/16 vs 2000	Difference (%) 2015 or 2015/16 vs 2014/15
Public transport (PT)						
Total PT passenger kilometres	Millions per year	12,374	20,879	21,363	72.6	2.3
Total PT journey stages	Millions per year	2,362	3,971	3,991	69.0	0.5
Bus passenger kilometres	Millions per year	4,709	8,417	8,188	73.9	-2.7
Bus journey stages	Millions per year	1,354	2,385	2,314	70.9	-3.0
Underground passenger km	Millions per year	7,470	10,847	11,458	53.4	5.6
Underground journey stages	Millions per year	970	1,305	1,349	39.1	3.3
DLR passenger kilometres	Millions per year	195	594	623	218.8	4.9
DLR journey stages	Millions per year	38	110	117	204.7	6.1
London Trams passenger kilometres	Millions per year	n/a	160	140	n/a	-12.4
London Trams journey stages	Millions per year	n/a	31	27	n/a	-12.2
London Overground pass. km	Millions per year	n/a	861	1,530	n/a	77.6
London Overground journeys	Millions per year	n/a	140	184	n/a	31.8
National Rail pass. km (L&SE)	Millions per year	19,190	29,593	30,336	58.1	2.5
National Rail journeys (L&SE)	Millions per year	664	1,155	1,183	78.1	2.4

Other modes

Airport terminal passengers	Millions	115.8	145.6	154.3	33.2	6.0
River Thames passengers	Millions per year	n/a	10.0	10.3	n/a	2.8
Licensed taxis	Vehicles (thousand)	n/a	22.5	21.8	n/a	-3.1
Licensed taxi drivers	Number (thousand)	n/a	25.2	24.9	n/a	-1.4
Licensed private hire	Vehicles (thousand)	n/a	62.8	77.7	n/a	23.8
Licensed private hire	Drivers (thousand)	n/a	78.7	100.7	n/a	28.0

Source: TfL Planning, Strategic Analysis.

Service supply

Table 3.8 below summarises key service supply and operational performance indicators for the most recent three years, these are also compared to the position in 2000/01.

Table 3.8 Key indicators of public transport service provision and performance since 2000/01. Summary of typical values.

Mode	Measure	2000/01	2013/14	2014/15	2015/16
Service provision					
Buses	Kilometres operated	365 million	491 million	489 million	493 million
London Underground	Train km operated	64 million	76 million	80 million	83 million
DLR	Train km operated	2.9 million	5.8 million	5.8 million	5.9 million
London Trams	Kilometres operated	2.4 million	3.0 million	3.0 million	3.0 million
London Overground	Train km operated	n/a	8.1 million	8.1 million	10.5 million
Service performance					
Buses	Excess wait time	2.2 min	1.0 min	1.1 min	1.2 min
London Underground	Excess journey time	8.6 min	5.2 min	4.6 min	4.6 min
DLR	Reliability	98%	99%	99%	99%
London Trams	Reliability	99%	99%	98%	99%
National Rail	ORR L&SE PPM	78%	90%	89%	88%
London Overground	ORR PPM	n/a	96%	95%	94%

Source: TfL Planning, Strategic Analysis.

Operational performance

This section brings together and summarises key reliability statistics for the principal public transport modes in London, including National Rail. Values for each mode are shown separately in table 3.9 below. Values for the most recent year are either at, or close to, their long-term historic highs, indicating that high levels of performance on the public transport networks are being sustained.

Table 3.9 Indicators of public transport service provision and performance by mode.

Service and indicator	Units	2000 or 2000/01	2014 or 2014/15	2015 or 2015/16	Difference (%) 2015 or 2015/16 vs 2000/01	Difference (%) 2015 or 2015/16 vs 2014/15
Underground						
Level of service scheduled	Million train km	69.6	82.3	85.0	22.1	3.3
Level of service operated	% of schedule	91.6	97.6	97.1	6.0	-0.5
Service reliability	Standardised journey time	45.7	42.3	41.7	-8.8	-1.4
Service reliability	Excess journey time	8.6	4.6	4.6	-46.5	0.0
Bus						
Level of service scheduled	Million bus km	382.8	504.0	506.7	32.4	0.5
Level of service operated	Per cent	95.3	97.1	97.2	2.0	0.1
Service reliability	Excess waiting time	2.2	1.1	1.2	-45.5	9.1
DLR						
Level of service operated	Million train km	2.9	5.8	5.9	103.4	1.7
Level of service operated	% of schedule	98.2	99.3	98.5	0.3	-0.8
Service reliability	Excess waiting time	n/a	0.07	0.09	n/a	28.6
London Trams						
Level of service scheduled	Million train km	n/a	3.03	3.07	n/a	1.1
Level of service operated	% of schedule	n/a	97.9	99.0	n/a	1.2
National Rail						
Service reliability – all L&SE operators (peak)	ORR PPM (% peak only)	n/a	83.5	82.2	n/a	-1.6
Service reliability – all L&SE operators	ORR PPM (% all services)	77.6	89.0	87.8	14.7	-1.3
Service reliability – London Overground	ORR PPM (% all services)	n/a	95.0	94.4	n/a	-0.6

Source: TfL Planning, Strategic Analysis.

4. Public transport: The customer experience

4.1 Introduction and contents

This chapter addresses topics around the general theme of improving public transport. For each, it sets out core evidence and insight and reviews recent trends in the principal indicators. The following topics are covered:

- Public transport fares.
- Public transport customer experience.
- Equalities, inclusion and public transport.
- Physical accessibility to the public transport system.
- Connectivity provided by public transport.
- Safety, crime and anti-social behaviour on public transport.

4.2 Public transport fares – some recent trends

Introduction

The following two sections provide a comparative interpretation of trends for public transport fares in London, looking firstly at changes in fares over recent years, and then looking at Londoners' average expenditure on fares and holding of various types of public transport concession. Finally, some initial feedback is given on the introduction of the 'Hopper' bus fare, from September 2016.

Real fares trends

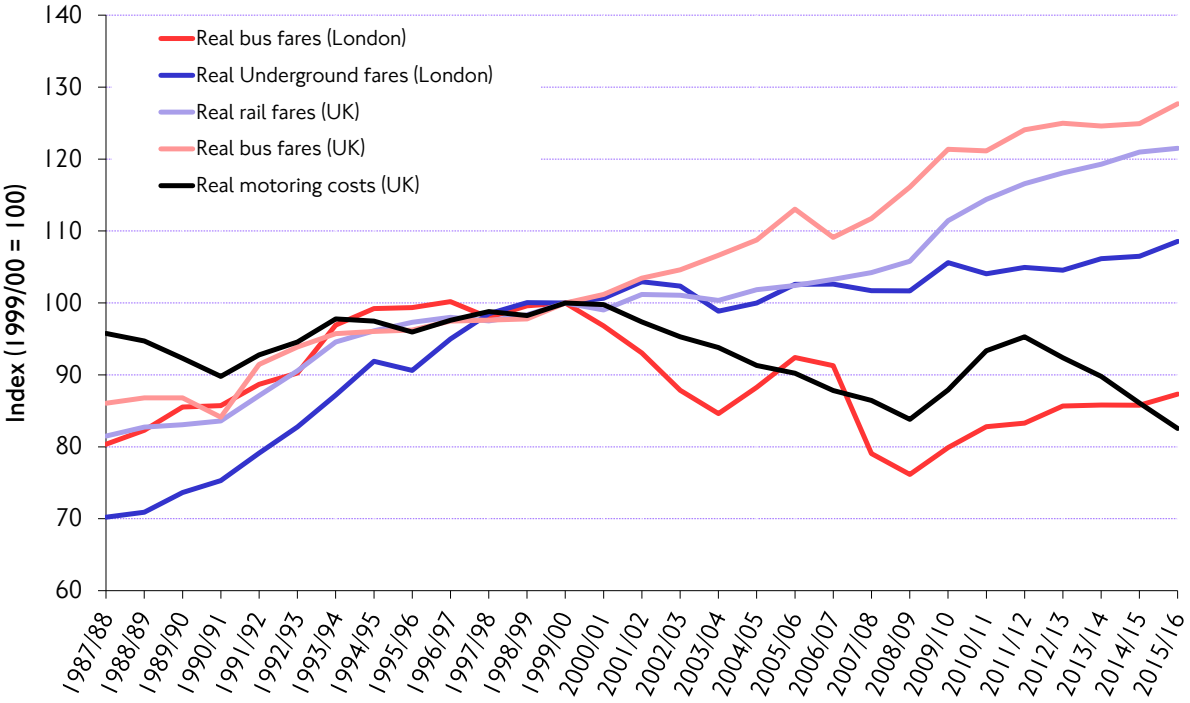
Figure 4.1 shows indexed real public transport fares in London (deflated by the Retail Prices Index) alongside national public transport fares and motoring costs for comparison. It is seen that, generally over the past two decades, public transport fares in London have compared favourably with those at the national level.

While bus fares in London have been increasing since 2009/10, they still (in 2015/16) remain 12.7 per cent lower than in 1999/2000 in real terms following a sharp fall between 1999/2000 and 2003/04. In contrast, real bus fares in the UK as a whole increased steadily over the last decade and have only recently levelled off at about 28 per cent higher than 1999/2000. Similarly, while Underground fares have remained relatively constant in real terms (currently standing 8.6 per cent above the value for 1999/2000), real rail fares in the UK as a whole have increased by 21 per cent.

The trend for motoring costs has been much more variable. Real costs declined steadily between 1999/2000 and 2008/09, eventually bottoming out at 16 per cent below the 1999/2000 value. They have since fluctuated, rising to within five percentage points of the 1999/2000 value in 2011/12 before falling again. This fall has been driven by a large fall in petrol costs and a smaller decline in the costs of vehicle purchase since 2010/11.

These indices are adjusted for inflation. When looking at the unadjusted data, motoring costs have risen at a slower rate than overall inflation, whereas national bus and rail fares have increased at a faster rate than inflation since 2000.

Figure 4.1 Public transport fare trends – London and UK compared. Index: 1999/00 = 100.



Source: TfL Customer Experience.

Real fares levels

A real fares level indicator is available that measures the average actual fare paid in London per kilometre travelled. It is a composite measure, covering bus and Underground only, calculated as the total actual fares revenue for passengers paying full adult fares, adjusted for inflation and divided by corresponding actual bus and Underground passenger kilometres. The trend from 2009/10 is shown in table 4.1. In 2015/16, the average adult composite bus and Underground fare was 20.9 pence per kilometre, slightly higher than in the previous two years where it was 20.7 pence per kilometre. This indicator has been relatively stable for the past six years, with a 3.0 per cent increase in real terms between 2009/10 and 2015/16.

Table 4.1 Real fares levels public transport (pence, 2015/16 prices).

2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16
20.3	20.4	20.5	20.6	20.7	20.7	20.9

Source: TfL Customer Experience.

4.3 Public transport fares – affordability

Transport expenditure as a proportion of total expenditure

The Family Spending survey conducted by the Office for National Statistics (ONS) captures information about household spending broken down into many categories, and is available at regional level. Using this resource it is possible to explore what proportion of Londoners' expenditure is on transport, and on what aspects of transport. Data from the Family Spending survey is reported in three-year periods, with the latest currently available being for 2012-2014.

In 2014, 15 per cent of London households' total expenditure was on transport, having increased from a low of 11 per cent in 2009. This increase was driven by growth in the proportion of household expenditure on the purchase and use of private motor vehicles rather than public transport fares, and in fact the share of total household expenditure on public transport fares reduced slightly between 2009 and 2014. As noted in section 4.2, the DfT's motoring cost index indicates that per-unit motoring costs have decreased in recent years, so the increase in London households' expenditure on motoring suggests that Londoners are purchasing or using vehicles more, or possibly purchasing 'superior' vehicles eg new rather than second hand.

The 15 per cent share of total expenditure on transport of London households in 2014 is the same as that of households in the South East, but is one percentage point higher than that of England as a whole. This represents a change in the comparative burden of transport expenditure between London and the rest of England versus recent years: in all years from 2002 to 2012 London households' share of expenditure of transport was consistently 1 to 2 percentage points lower than the share for households in England as a whole. This recent change is due to the share of expenditure on purchase and operating costs of private vehicles having increased in London while remaining the same for England as a whole.

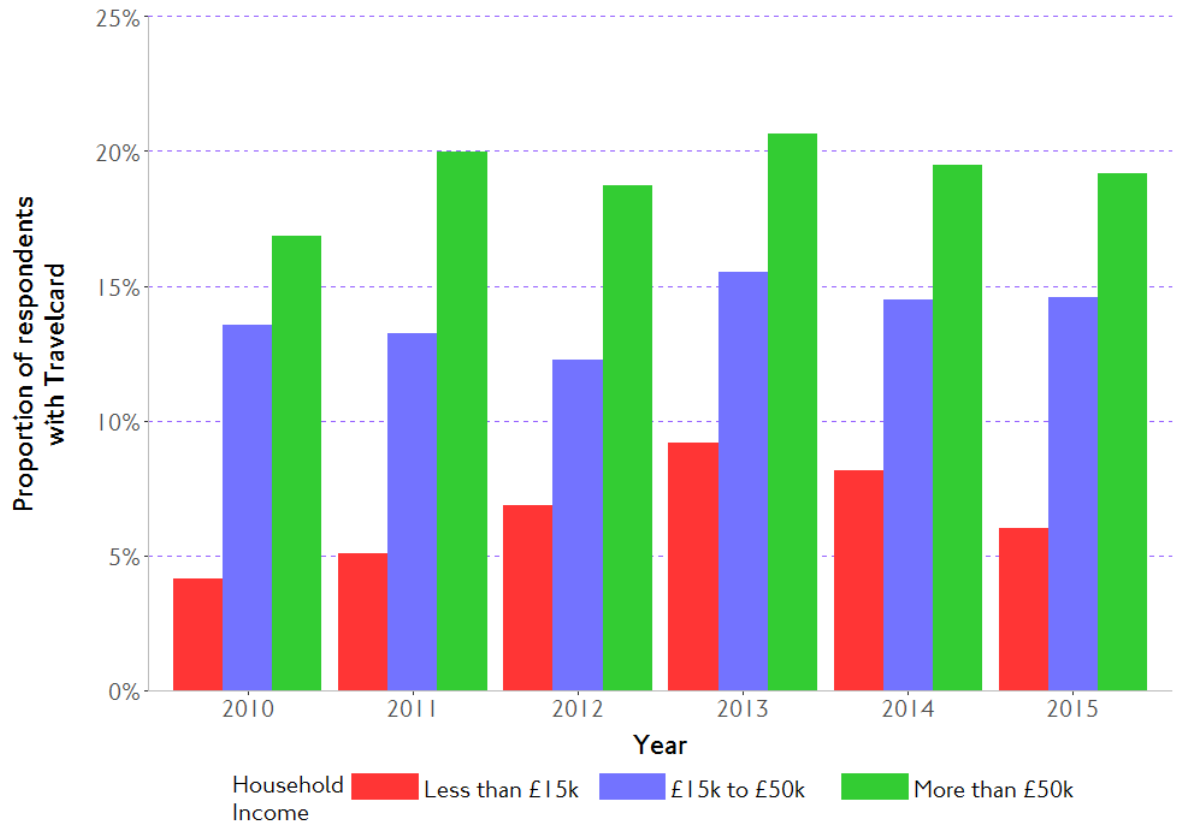
Travelcard holding by personal and household characteristics

TfL's LTDS survey records information about respondents' ticket holding, including whether they hold season tickets for public transport. This section explores relationships between the possession of a Travelcard (for any period and zones) and some personal and household characteristics.

Figure 4.2 shows Travelcard holding by household income group for the years 2010 through to 2015. From this it can be seen that there is a clear relationship between household income and Travelcard holding, with around 20 per cent of members of the highest income households holding a Travelcard in comparison to 15 per cent of members of middle income households and between 5 and 10 per cent of members of low income households.

The decline in Travelcard holding among low income households in 2014 and 2015 may be in part due to the introduction of weekly capping on contactless payment in September 2014. As noted below, the most common duration of Travelcards held in low income households is weekly, and with the introduction of weekly capping on contactless payments many of those who previously held weekly Travelcards may have decided to use contactless payment instead.

Figure 4.2 Rate of Travelcard holding among Londoners aged 18 to 59 by household income group.



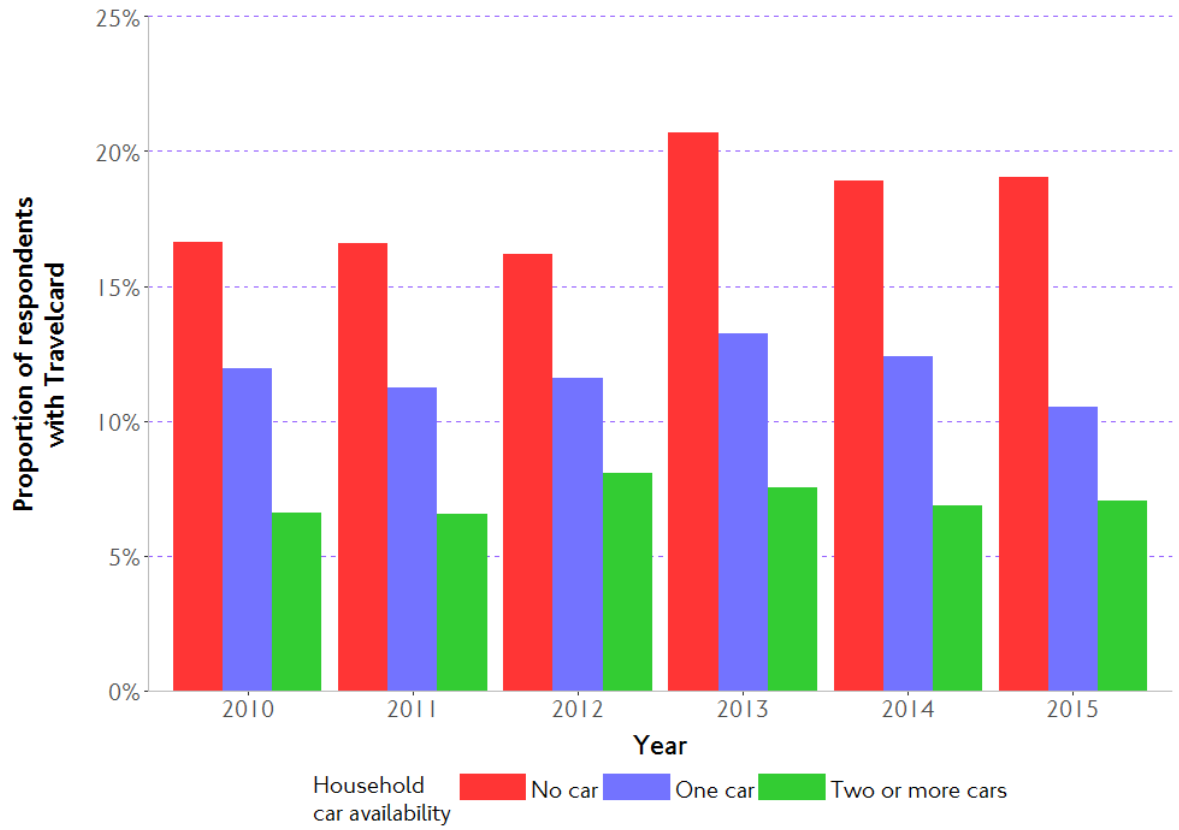
Source: TfL Planning, Strategic Analysis.

Figure 4.3 shows the rate of Travelcard holding by household car availability. While it is the case that household car ownership is positively correlated with household income, it can be seen that the relationship of Travelcard holding with household car availability is very different to that with household income.

Travelcard holding is highest among members of households with no car available, with around 20 per cent of members of these households holding a Travelcard in the period 2013 to 2015 in comparison to around 12 per cent of members of one-car households and around 7 per cent of members of households with two or more cars.

This suggests that holding a Travelcard and owning a car each reduce the utility of the other, with the effect that although members of higher income households are both more likely to have access to a car and are more likely to possess a Travelcard, it is not correspondingly more likely that they both have access to a car and possess a Travelcard. Public transport season tickets and private cars could therefore be considered substitute goods in economic terms.

Figure 4.3 Rate of Travelcard holding among Londoners aged 18 to 59 by household car availability.

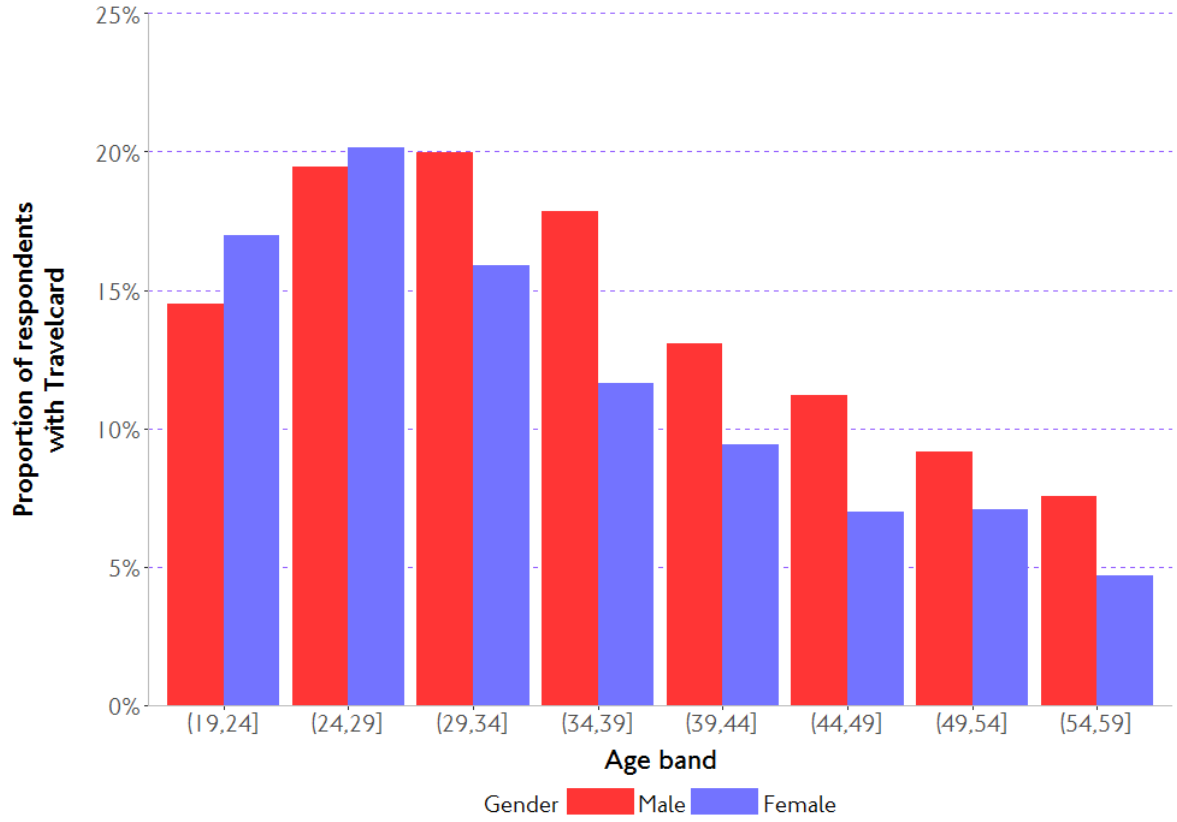


Source: TfL Planning, Strategic Analysis.

Figure 4.4 shows rates of Travelcard holding by age and gender. Among people of both genders aged 25 to 29 the rate of Travelcard holding is around 20 per cent. After this, while Travelcard holding rates generally decline as age increases for both genders, the pattern of this decline is different for men and women.

Men's Travelcard holding rates increase slightly for those aged 30 to 35 to peak at 20 per cent, while women's Travelcard holding rates decline by four percentage points to 16 per cent from ages 25 to 29 to ages 30 to 34. The gap that this creates between men's and women's Travelcard holding rates then persists through the age bands, though the difference in rate by gender diminishes with age. One likely explanatory factor for this difference in Travelcard holding rates by genders that appears from the 30-34 age band onward is the effect of childcare, with women who are not in full-time work due to childcare being less likely to hold Travelcards.

Figure 4.4 Rate of Travelcard holding among Londoners aged 20 to 59 by household by age and gender, 2013-2015.



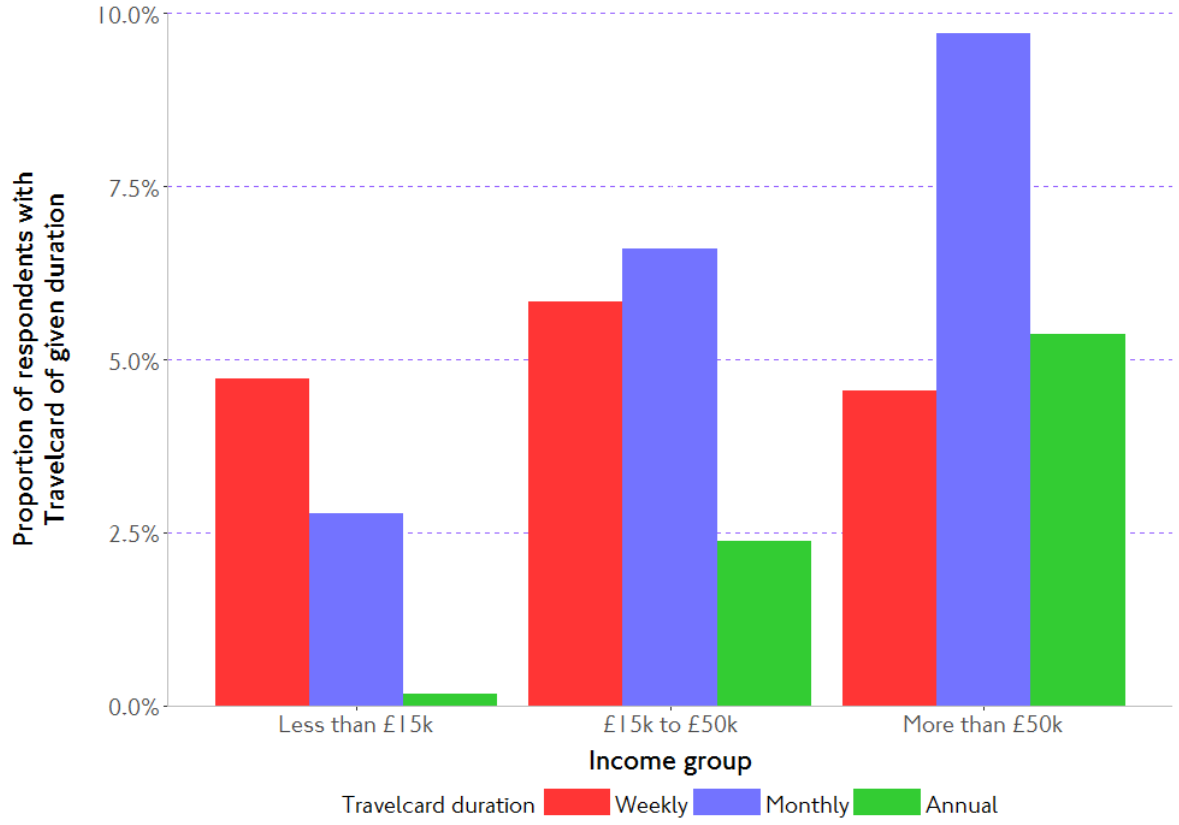
Source: TfL Planning, Strategic Analysis.

LTDS also records the validity period of respondents' Travelcards, making it possible to explore differences in rates of holding Travelcards of different durations by personal and household characteristics.

Figure 4.5 shows the rates of holding weekly, monthly and annual Travelcards by household income group. From this it is apparent that in addition to members of lower income households having a lower rate of holding any Travelcard, their rate of holding annual Travelcards is very low – at less than 1 per cent. Weekly Travelcards are most prevalent among members of low income households. One reason for this is likely to be the higher up-front cost of purchasing a Travelcard for a longer period.

Monthly Travelcards are most prevalent among members of middle and high income households, and for high income households the rates of possession of annual Travelcards is greater than that of weekly ones.

Figure 4.5 Rate of holding Travelcards of weekly, monthly or annual periods among Londoners aged 18 to 59 by household income group.



Source: TfL Planning, Strategic Analysis.

Public transport fares – availability of concessions

A range of fare concessions are available to people aged 18 and above travelling in London (in addition to the availability of free and half-rate fares for children under 18). Among others, these include:

- The Freedom Pass, offering free travel and available to older or disabled travellers living in London.
- The 60+ London Oyster photocard, offering free travel and available to people aged 60 or over living in London who are not old enough to qualify for a Freedom Pass.
- The 18+ Student Oyster photocard and Apprentice Oyster photocard, each offering 30 per cent off adult rate season tickets and available to students or apprentices living in London.
- The Jobcentre Plus Travel Discount Card and Bus & Tram Discount photocard, offering half price or child rate fares on a range of services for people receiving specific benefits.

From 2010 onward LTDS has captured information from respondents about whether they hold any free or discounted travel passes. Over the three years from 2013 to 2015, 32 per cent of respondents to LTDS aged 18 or over held some form of reduced or free travel pass, with the majority of these being people aged 60 or over holding a Freedom Pass or 60+ London Oyster photocard. Of LTDS respondents aged between 18 and 59, 13 per cent reported holding some form of reduced or free travel pass.

Availability of concessions in relation to household and personal characteristics

The availability of fare concessions to LTDS respondents aged 18 and above can be analysed in relation to other personal and household characteristics that are recorded by the survey. One such characteristic of interest is household income.

Figure 4.6 shows the proportion of individuals that held any free or reduced travel concession broken down into three household income groups for the years 2011 through to 2015.

The upper threshold of the lowest of these annual household income bands, £15,000 per year, is roughly equivalent to the salary of someone working full-time at the London Living Wage (which in 2011 was £8.30 per hour, rising to £9.40 per hour by 2015). Within this lower income group, which represents about 28 per cent of respondents to LTDS, around 50 per cent of people have some fare concession available to them.

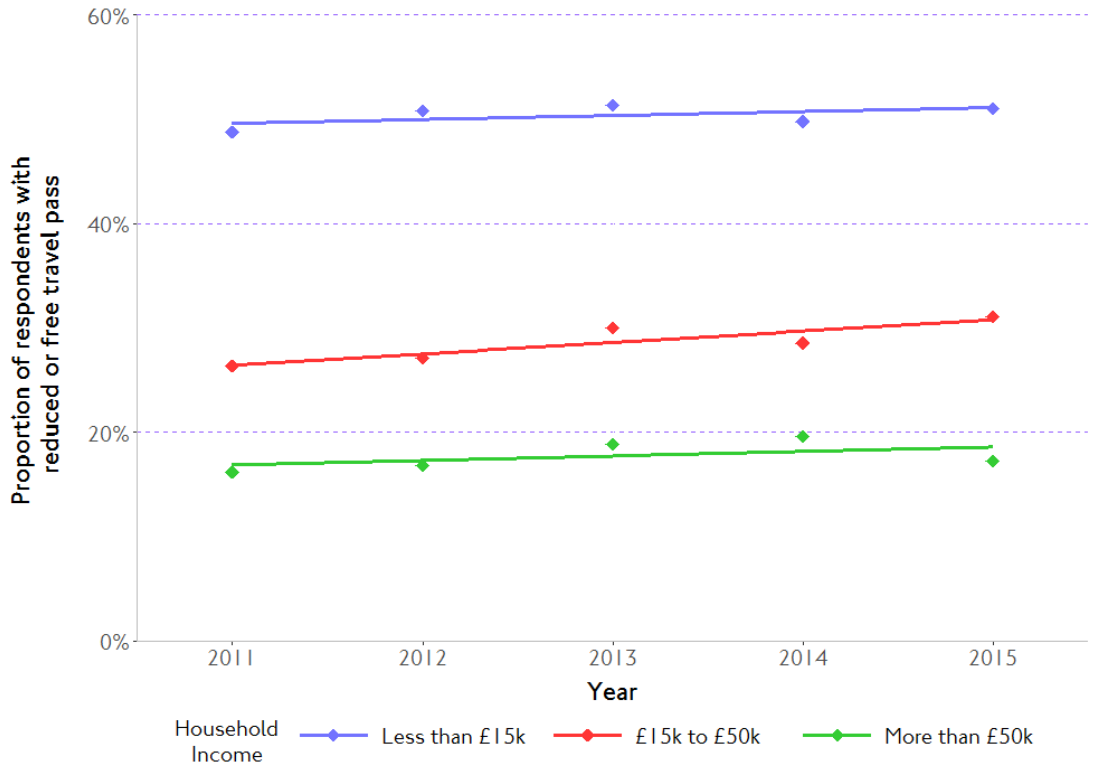
Fare concession holding rates are lower among middle and high income households than among the low income group, but there has been an increasing trend in the rate of concession holding among residents of both middle and high income households in recent years, with the rate of concession holding in middle income households growing faster than that for low or high income households. This may be due to a growing number of London residents in middle income households becoming eligible for 60+ or Freedom Pass concessions over time.

A breakdown of fare concession holding by working status as well as income provides further insight. Figure 4.7 shows that, for London residents who are working either full-time or part-time, the rate of concession availability does not differ significantly by household income group, with around 10 to 15 per cent of working residents holding some concession across the three income groups.

For non-working residents (such as those who reported being a student, unemployed, unable to work, retired or looking after family), however, the rate of concession holding differs by household income group. Again, residents of lower income households who are not working have the highest rate of concession holding at more than 60 per cent.

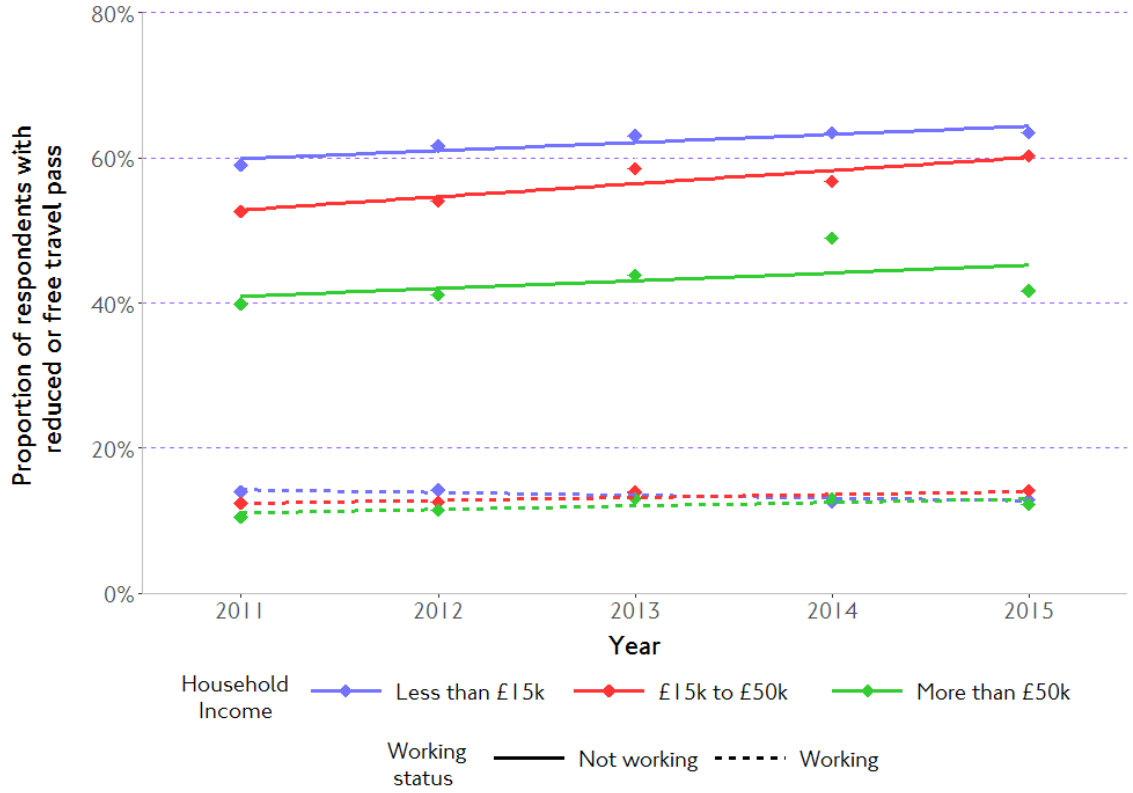
Non-working residents of households with middle incomes had rates of concession holding of around 60 per cent from 2013 onward, while non-working residents of high income households had rates of concession holding of between 40 and 50 per cent. In both cases, the rate of concession holding among these non-working residents of high and middle income households is around 2.5 to 4 times the rate of concession holding among working members of low income households.

Figure 4.6 Trend in holding of fare concessions among LTDS respondents by income group with linear trend lines.



Source: TfL Planning, Strategic Analysis.

Figure 4.7 Trend in holding of fare concessions among LTDS respondents by income group and working status with linear trend lines.

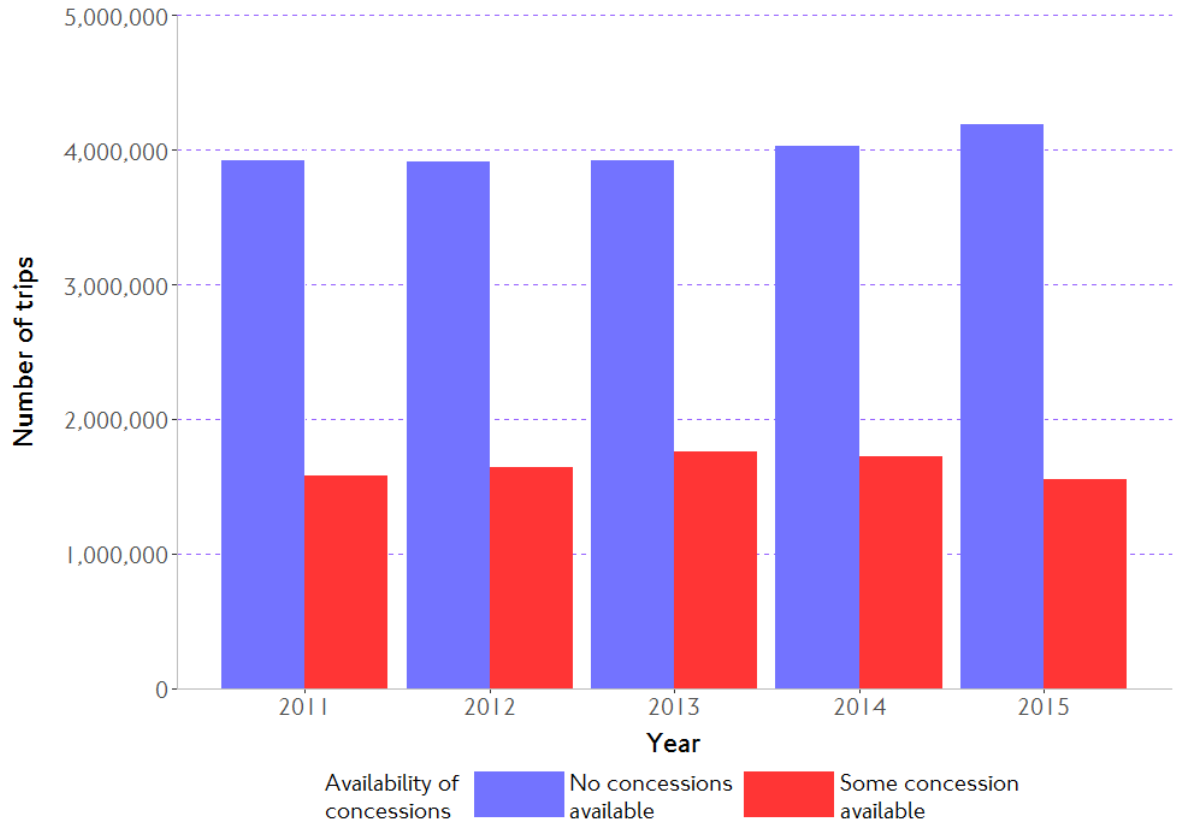


Source: TfL Planning, Strategic Analysis.

Volume of travel made by concession holders and non-holders

As shown in figure 4.8, around 1.5 million public transport trips are made each day by Londoners aged 18 and above with some concession available to them (though the concession available may not apply for all of these trips, for example, holders of a Bus & Tram Discount photocard making trips by rail or Underground). This represents 27 per cent of all public transport trips made by adult London residents each day. The proportion of public transport trips made by concession holders is lower than the proportion of people holding a concession, reflecting that trip rates are lower among concession holders.

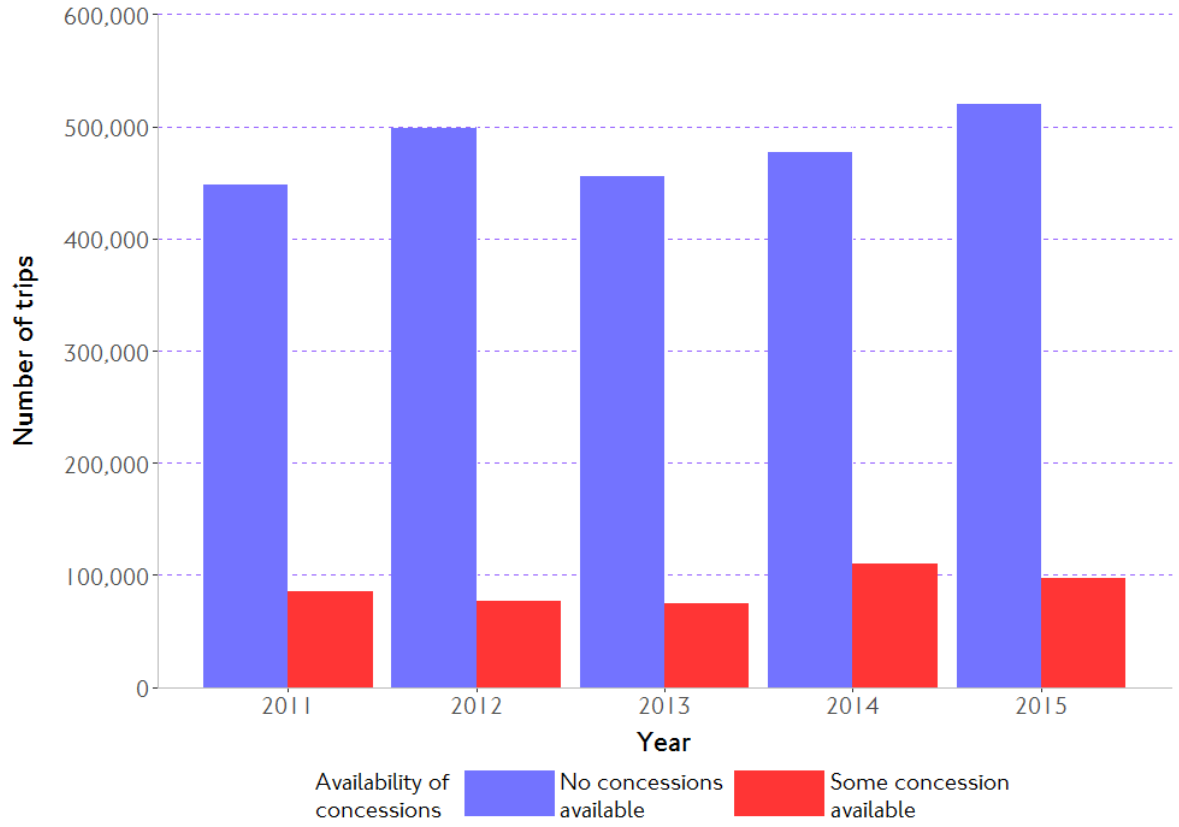
Figure 4.8 Volume of adult London residents' daily travel on public transport modes by fare concession status.



Source: TfL Planning, Strategic Analysis.

The proportion of public transport trips made by holders of concessions can be seen to vary by time of day. Figure 4.9 shows the number of public transport trips made by Londoners aged 18 and above to central London during the weekday AM peak by concession holding status. For this time period, around 1 in 6 trips are made by people who hold some concession (again, not necessarily a concession that applies to the trip being made).

Figure 4.9 Volume of adult London residents' travel on public transport modes to central London during the weekday morning peak by fare concession status.



Source: TfL Planning, Strategic Analysis.

The Hopper bus fare – some initial feedback

Introduced in September 2016, the 'Hopper' fare allows passengers making a bus or tram journey to change on to another bus or tram within an hour of touching in at no extra cost. Within 11 weeks of rolling out the scheme, 21 million Hopper journeys had been made across the Capital.

4.4 Public transport customer service

Some general principles

Post the European Union Referendum, London must demonstrate to the world that it remains entrepreneurial, international, full of creativity and possibility, and welcoming. Without a continued focus on transport this will not be possible, because transport keeps the city working and growing, and plays a crucial role in the quality of daily life for everyone in London.

In a city as successful as London the demands on its transport network are significant. Increasing demand leads to crowded public transport services and congested roads and at the same time TfL's customers want to feel cared for, valued and welcome. That is why we need to place the emphasis on making the customer experience more consistent.

In today's climate of uncertainty and limited public funds, TfL has to be accountable for every penny it spends on improving the customer experience, so it must listen to its customers and focus on the areas that really matter. In practice TfL needs to focus on removing day-to-day frustrations (such as a lack of information during disruption, poor customer service from staff or unexpected traffic congestion) that can easily undermine a generally good experience. Addressing this inconsistency will reduce customers' frustration and make them feel more welcome and cared for on the transport network.

In conjunction with focusing on what really matters to customers, TfL also recognises the need for keeping costs down – in other words, doing more with less. There can be done in a number of ways, including making data available to third parties to develop apps or tackle tricky transport issues; and creating simpler, personalised experiences for customers to improve efficiency and make their lives easier. This approach will enable TfL to minimise its costs while improving the customer experience at the same time. This is true for roads customers as well as those using public transport.

Improving consistency

TfL's customer model, as outlined in Travel in London report 8, is used to shape customer strategy and provides a framework for our Business Plan, underpinning our approach to delivery. We have identified what customers want from us and what is important in providing good customer service.

The five aspects are:

- That TfL is the one-stop shop for all types of transport. We listen to our customers, see things from their point of view, and understand that every journey matters.
- That the experience consistently meets customer needs. TfL gets the basics right and supports them when things go wrong.
- TfL continuously innovates and improves.
- That customers feel they are getting good value for money.
- That customers trust us.

We can learn a great deal from other organisations, across a range of transport and other sectors, that demonstrate better customer service by improving consistency:

- **Fully engaged staff.** One of our recent initiatives is to create a buzz via a small innovation programme for staff to develop new ways of tackling these everyday frustrations, and think beyond their day-to-day roles.
- **Support customers when things go wrong.** We know from benchmarking that the key is how we respond when things go wrong – that gives us the chance to turn the customer's perception around. We understand the human emotions around travel disruption: anxiety, stress, anger and so on. Providing up-to-the-minute information about what is happening, keeping customers in the picture and providing guidance on how to continue their journey helps to alleviate the problem. We now have our first ever pan-TfL customer information strategy, to make sure customers get real-time information to help them navigate disruption.
- **Explain our purpose and be open and honest.** Our Road Modernisation Plan communications campaign is an example of a campaign that aims to do both. Being open and honest about the disruption, while giving context and explaining why we are doing it.
- **Reinvestment to allow continuous improvement.** We reinvest all of our income in numerous projects, from building the new Elizabeth line, running the Tube through the night, modernising the roads to helping customers to plan their journeys and keep them up-to-date with live travel information.

Overall customer evaluation of public transport

TfL regularly measures aspects of customer perception and satisfaction relating to public transport in London. Feedback from these surveys identifies and drives a range of improvements – the result of which over recent years has been a general improvement in the 'overall evaluation' of customers with each of the main public transport modes. These surveys also look at the customer evaluation of a range of more specific aspects, for example, the quality of the vehicle environment and the provision of information. This section looks at the recent trend in overall satisfaction scores, and exemplifies the wider content of these surveys in terms of recent trends in customer satisfaction for specific aspects of each of the main modes. We also track customer satisfaction with the Transport for London Road Network (TLRN) – see section 6.7 of this report.

Trend in overall customer evaluation scores

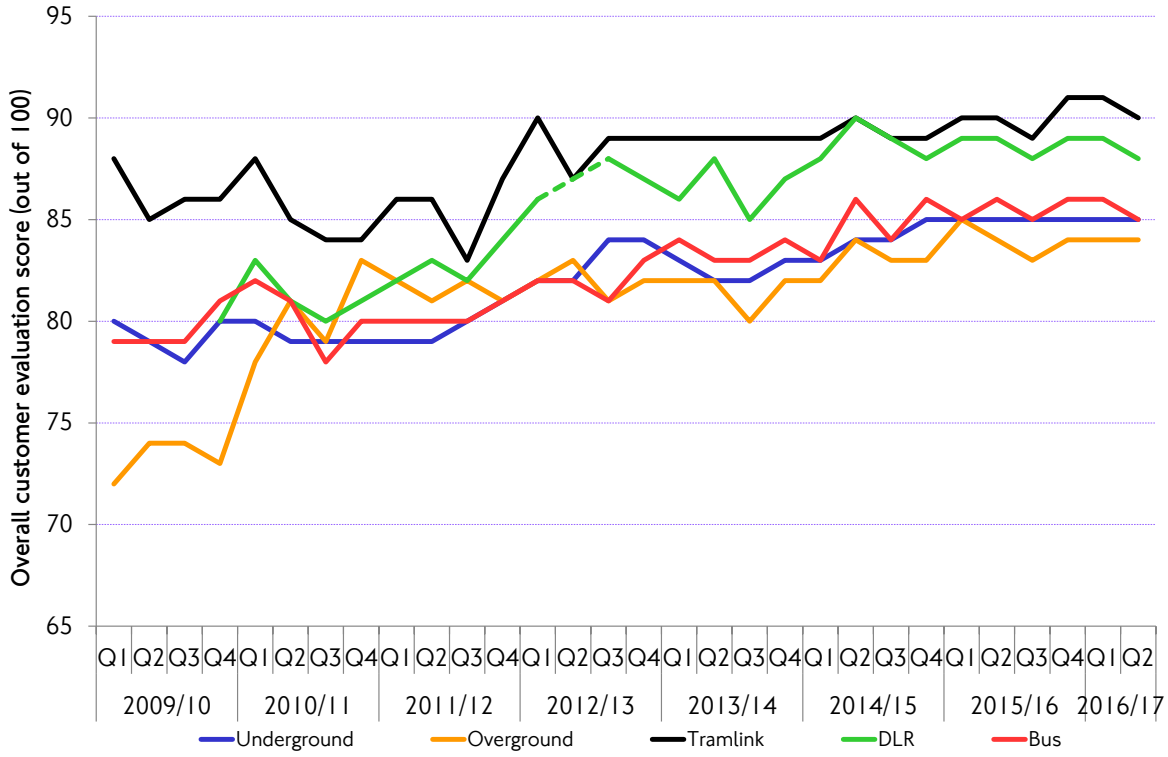
Figure 4.10 shows overall customer evaluation scores for each of the principal public transport modes. These are scores out of 100, but are not percentages.

The overall trend since 2009/10 has been one of steady improvement across all modes. The scores for London Trams and the DLR reflect the relatively high satisfaction with these self-contained networks, which are reasonably new. Trends for the longer-established and more complex bus and Underground networks have also been decisively upwards over the period covered, reaching the highest level since surveys began.

There is scope for further improvement but one feature of measures such as these is that once a certain standard is reached, it tends to be considered 'the norm' by customers – who, in this context, would be looking for the next step-change in quality. Therefore, it becomes progressively harder to improve these scores towards the top end of the possible range. On the other hand, the notable jump in scores associated with the early stages of the creation of the London Overground

network, with associated radical improvements in train frequency and service quality, is clearly visible.

Figure 4.10 Overall customer evaluation scores for each of the main public transport modes.



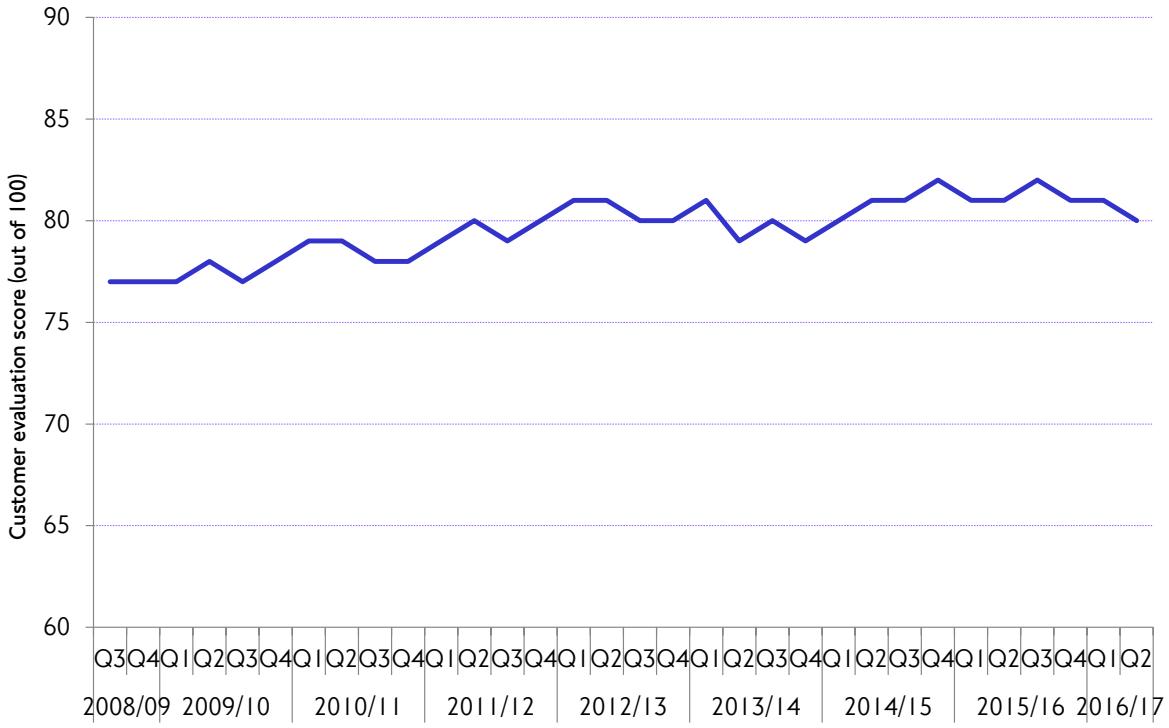
Source: TfL Customer and Employee Insight.

Examples of customer evaluation scores for specific aspects of the public transport experience

Overall satisfaction with bus services has risen steadily – reaching an all time high of 86 and while reliability has recently been poor for some, customers have seen improvements in other important areas such as information and ways to pay for their journey.

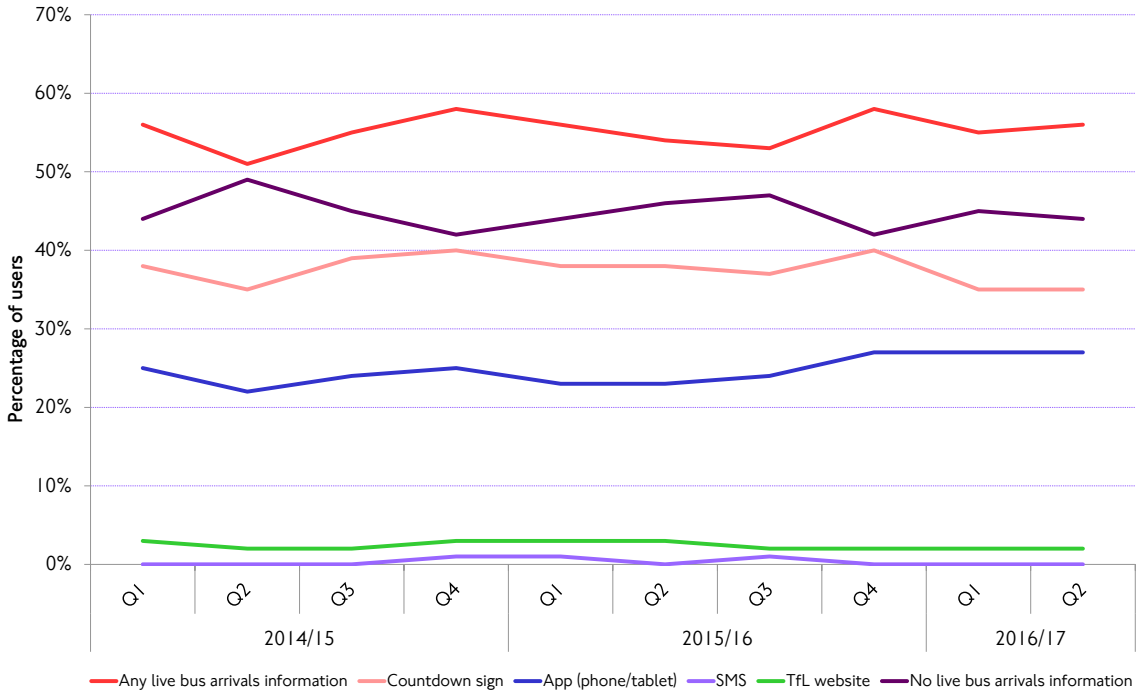
Real-time information is provided through countdown signs at bus stops and live bus information apps. These use TfL open data to provide customers with the information about how their services are running and allow them to make informed choices about their travel. Satisfaction with information provided at stops and shelters (figure 4.11) has risen from being considered 'fairly good' in 2008/09 to 'good' (according to TfL's norms for assessing these scores) and, currently, 56 percent of bus customers use live bus arrival information – helping them to feel more in control of their journeys (figure 4.12).

Figure 4.11 Satisfaction with information provided at bus stops and shelters.



Source: TfL Customer and Employee Insight.

Figure 4.12 Customer usage of live bus information by channel.



Source: TfL Customer and Employee Insight.

There are many ways to pay for journeys on public transport services. Customers can use Oyster, contactless payment by card, mobile phone or other devices. On the buses customers are increasingly satisfied with the ease of paying for their journey (figure 4.13).

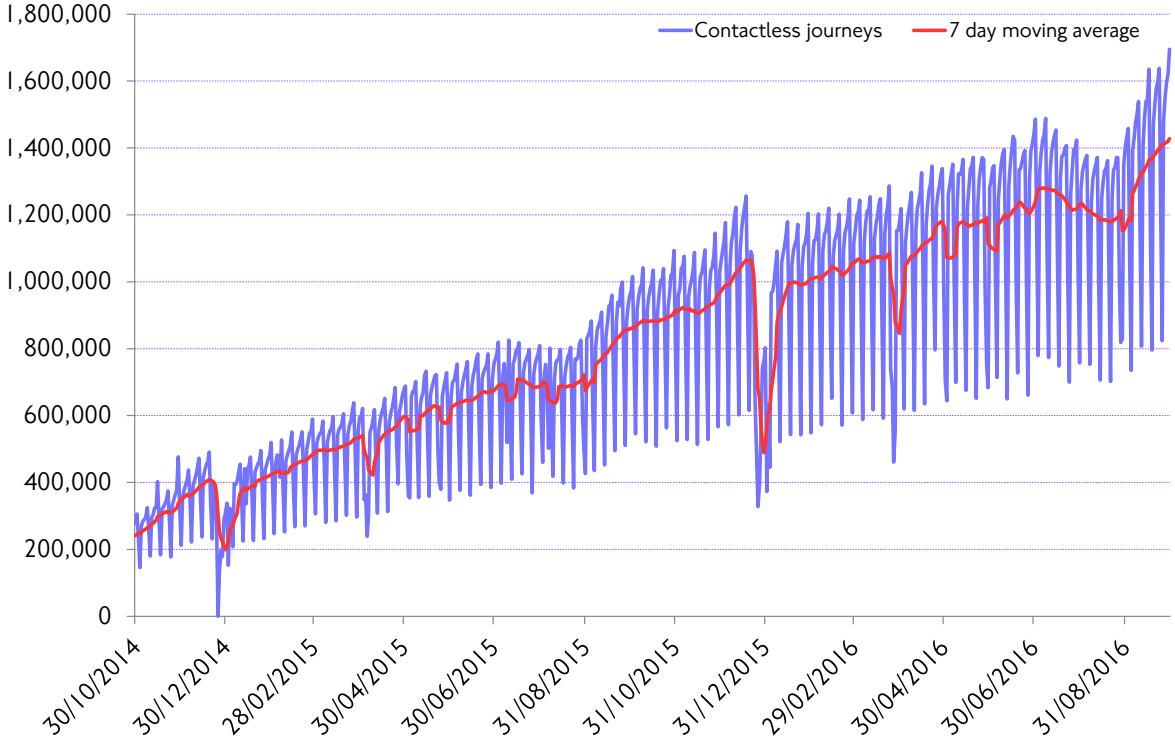
Figure 4.13 Trend in customer evaluation of 'ease of paying for a bus journey'.

Source: TfL Customer and Employee Insight.

Most recently, on the buses, if customers use pay as you go with Oyster cards or contactless payments they will automatically be given the Hopper fare. This will allow them to make an extra bus journey for free, as long as it is within one hour of touching in on the first bus. This will particularly benefit Londoners on lower incomes, who often rely on the bus network to get around.

Figure 4.14 shows the growth in the use of contactless payment cards (CPCs) on the TfL network. Between October 2014 and October 2016, the number of journeys made using CPCs on the bus, Tube and rail network increased by almost 800 per cent.

Figure 4.14 Number of journeys processed by TfL using contactless payment card (CPC).



Source: TfL Customer Experience.

4.5 Embedding equality and inclusion in the planning and operation of transport

Introduction and scope

Travel in London report 8 provided an overview of the travel needs and travel characteristics of London's diverse communities, framed in terms of seven 'equalities groups'. A clear example of these specific needs, which also illustrates their importance for planning and delivering transport and their implications for the individual, is that people who require step-free access to public transport to access the network often face longer journey times by being restricted to routes and stations where these facilities are available. However, there are many less obvious examples where groups of Londoners can feel discouraged from using public transport or disadvantaged when doing so. For example, cost may be a particular barrier to low income people, while lesbian, gay, bisexual or transgendered (LGBT) people may experience specific types of antisocial behaviour when travelling, and feel less able to seek help from the general public than other groups.

The Equality Act 2010 requires TfL to have due regard for the needs of all of London's communities when developing our services, and this idea is embodied in the Mayor's thinking, as illustrated by the consultation document 'A City for all Londoners' (https://www.london.gov.uk/get-involved/have-your-say/all-consultations/city-all-londoners). This section provides an overview of 'Understanding the travel needs of London's diverse communities', a fuller document which sets out in detail a collection of research and insight, looking from

a customer perspective: (http://content.tfl.gov.uk/understanding-the-travel-needs-of-london-diverse-communities.pdf).

Seven 'equalities groups'

Figure 4.15 shows the seven 'equalities groups' and their current prevalence in the population of London. Of these, women comprise 51 per cent of the London population, while black, Asian and minority ethnic groups (BAME) comprise some 40 per cent. Older and younger people currently account for 11 and 32 per cent of the population respectively. However, as explained in section 7.2 of this report, London's population is expected to undergo significant change over the next two decades. The proportion of Londoners who are BAME is expected to rise to 51 per cent by 2041, and London's population is expected to age in relative terms. In 2041, older people are projected to comprise 15 per cent of London's population, with a corresponding fall in the proportion of younger people to 29 per cent. To put this in perspective, today 680,000 people aged 70 and over live in London. In 2041 this will be around 1.26m; an increase of 85 per cent, or a total roughly equivalent to the population of Glasgow in 2014.

Figure 4.15 Equalities groups in London.

Source: TfL Planning.

Less obviously, in 2011 there were 1.1 million people in London with some form of disability that affects their daily activity – 14 per cent of the population. By 2041 this figure is expected to rise – by 56 per cent to 1.8 million – 17 per cent of the population. Some 36 per cent of Londoners are considered to be 'low income', and an estimated 2.5 per cent of Londoners are thought to be lesbian, gay, bisexual or transgendered. Each of these groups can face barriers to their daily travel, whether it reflects factors such as physical access, affordability, personal safety or language barriers.

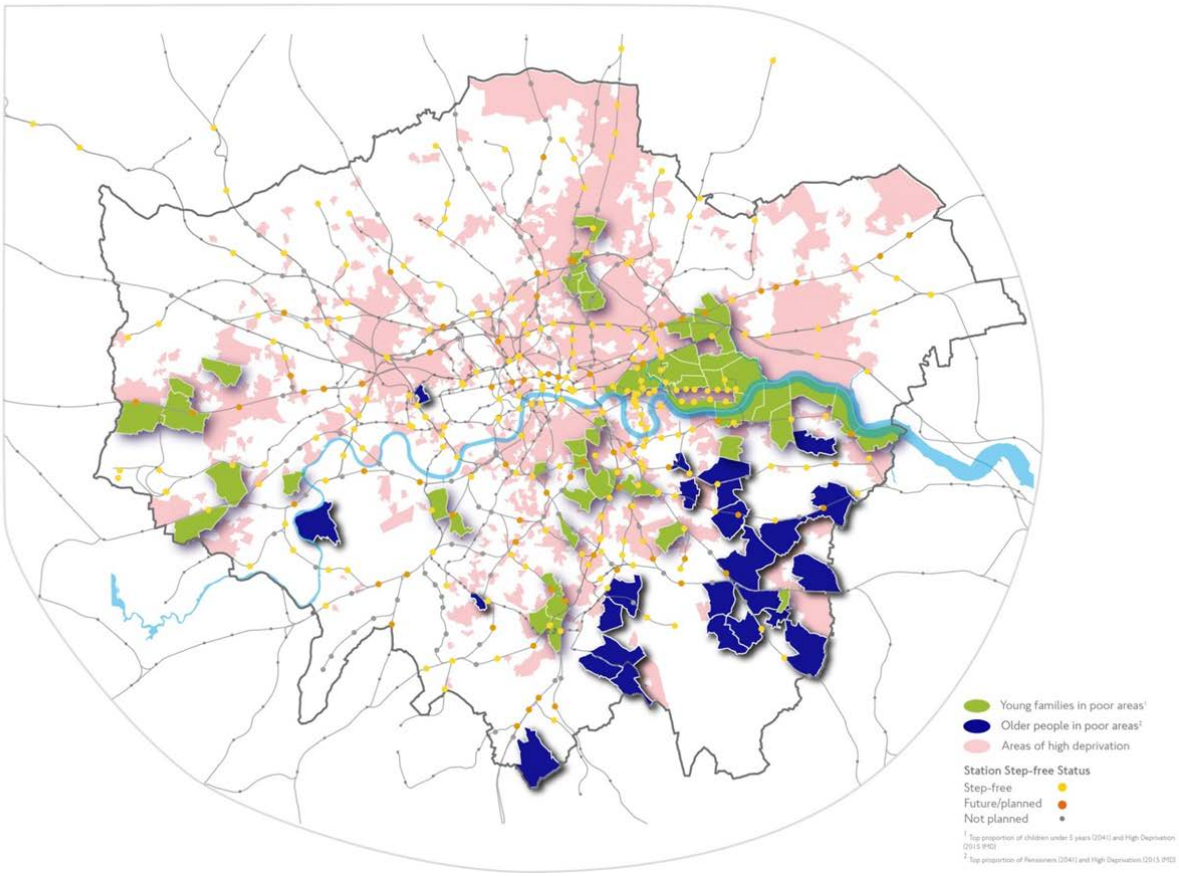
Furthermore, individuals can be members of more than one group, and there is evidence that in some cases membership of one group is disproportionately associated with membership of another. For example, 65 per cent of older people

and 69 per cent of disabled people are considered to be on low incomes, compared to the London average of 36 per cent, while 47 per cent of younger people are BAME.

Equalities groups, travel and geography

One factor affecting the travel behaviour of equalities groups, and having relevance to the development of policies to address inequalities, is the geographical distribution of these groups. Figure 4.16 shows the current distribution of areas of high deprivation, overlaid with areas with high numbers of young families and older people. It is seen, for example, that younger families living in deprived areas are particularly concentrated along the river in east London, while southeast London features high concentrations of older people living in areas of relative deprivation. The coverage of the transport networks in part determines the travel patterns, in particular the modal choice, of these groups, as, for example, there is no Underground coverage in southeast London.

Figure 4.16 Areas of high deprivation, young families and older people.



Source: TfL Planning.

Equalities groups tend to make fewer trips than average for the whole population, and tend to make more local trips. For equalities groups overall, walking is the most frequently used mode of transport with bus the second most frequently used. They are less likely to use the Underground, are less likely to drive and less likely to cycle than the general population.

Within the groups however there are also some notable features. Women make more trips than men and make more shopping and personal business trips. Older

Londoners make fewer trips, especially Londoners over 70 years of age, and tend to walk or catch the bus more than average. But 45 per cent of older people also drive a car at least once a week.

Use of cars among BAME Londoners is lower than for white Londoners. Use of buses is particularly high among black Londoners, with 77 per cent catching the bus at least once a week. For people on low incomes, although cost of tickets is cited as a particular barrier for some, people belonging to this group often have other characteristics that mean that they are eligible for free or reduced rate travel, for example, through having a Freedom Pass.

By projecting forward on the basis of current travel behaviour and expected population change, TfL can identify significant implications for future planning. For example, the future growth in numbers of older people is expected to occur disproportionately in outer London, with lower levels of public transport coverage relative to the rest of London.

4.6 Physical accessibility to the public transport system

This section looks at the infrastructural aspects of physical accessibility to London's transport networks.

Modal composite physical accessibility indicator

Previous Travel in London reports have set out statistics describing the physical accessibility status of key elements of the transport infrastructure. These have been combined into a 'physical accessibility' indicator expressed in terms of a weighted percentage score across the public transport modes. This indicator expresses the proportion of the public transport network (rail and bus) that is accessible, weighted by the relative use that is made of these modes.

The trend in this indicator since it was first measured in 2008 has been upwards, rising from a value of 36 per cent in 2007/08 to 59 per cent in 2015/16 (table 4.2). This change has reflected continuous investment, including making the bus fleet 100 per cent accessible from 2005, increasing the number of accessible bus stops as well as several major station upgrade projects. However, the fact remains that on the basis of this indicator, more than 40 per cent of the public transport network in London is not fully accessible. Furthermore, this indicator is purely infrastructure-based, and does not take into account either actual trip patterns (spatial), or what these trip patterns might be were the network fully accessible – given that the travel patterns of disabled people are to some extent constrained by the available infrastructure.

Table 4.2 Modal composite physical accessibility score – public transport.

Year	Composite physical accessibility score (%)
2007/08	(36)
2008/09	(36)
2009/10	37
2010/11	38
2011/12	44
2012/13	46
2013/14	50
2014/15	54
2015/16	59

Source: TfL Planning, Strategic Analysis.
Note TfL: values prior to 2009/10 are based on a dataset that differs in minor respects to that used from 2009/10.

Part of the reason for this is the 'heritage' nature of much of London's rail infrastructure, where necessary infrastructure work to make some stations fully accessible is both relatively costly and best included in a wider programme of works, such as station refurbishments when these fall due, for example, those completed in recent years at Green Park and King's Cross.

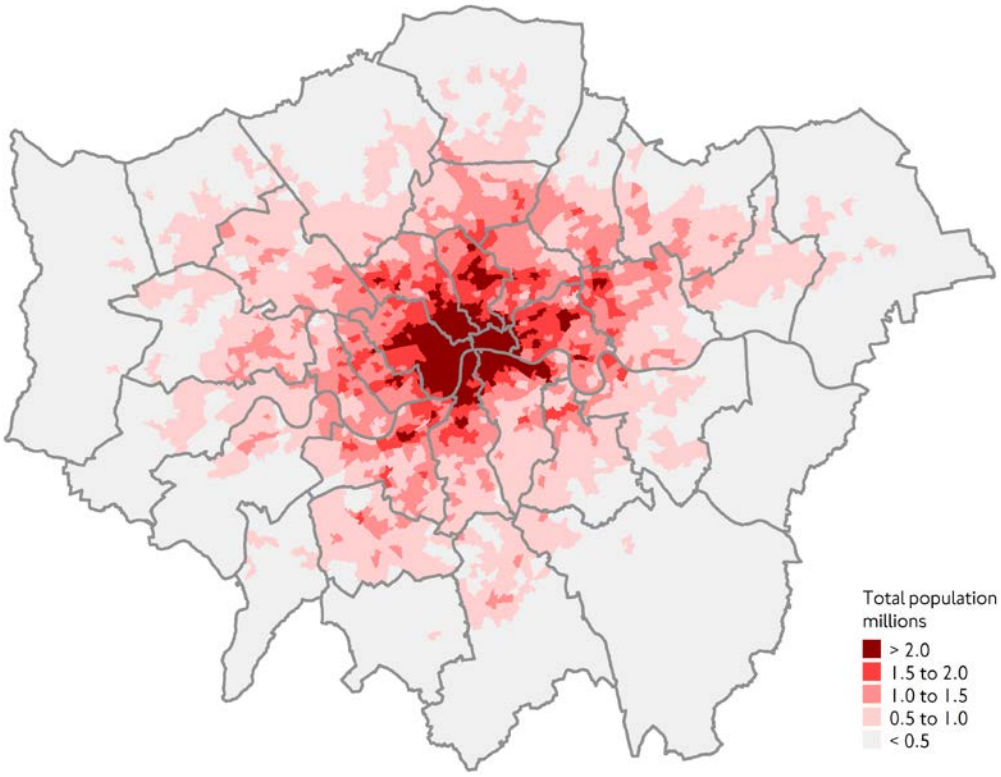
4.7 The impact of physical accessibility on journey opportunities

An appreciation of the impact of incomplete physical accessibility to the public transport system on journeys can be gained by considering how the connectivity provided across London varies if travel options are only confined to the step-free network. Figures 4.17 and 4.18 compare this in terms of access to jobs and services, while figures 4.19 and 4.20 compare it in terms of access to town centres. Because the bus network is 100 per cent step-free, these comparisons look at connectivity offered by the rail networks only.

It is immediately clear from both comparisons that the degree of accessibility provided by the step-free rail network is considerably less than with the full network, and that this difference applies fairly uniformly across Greater London.

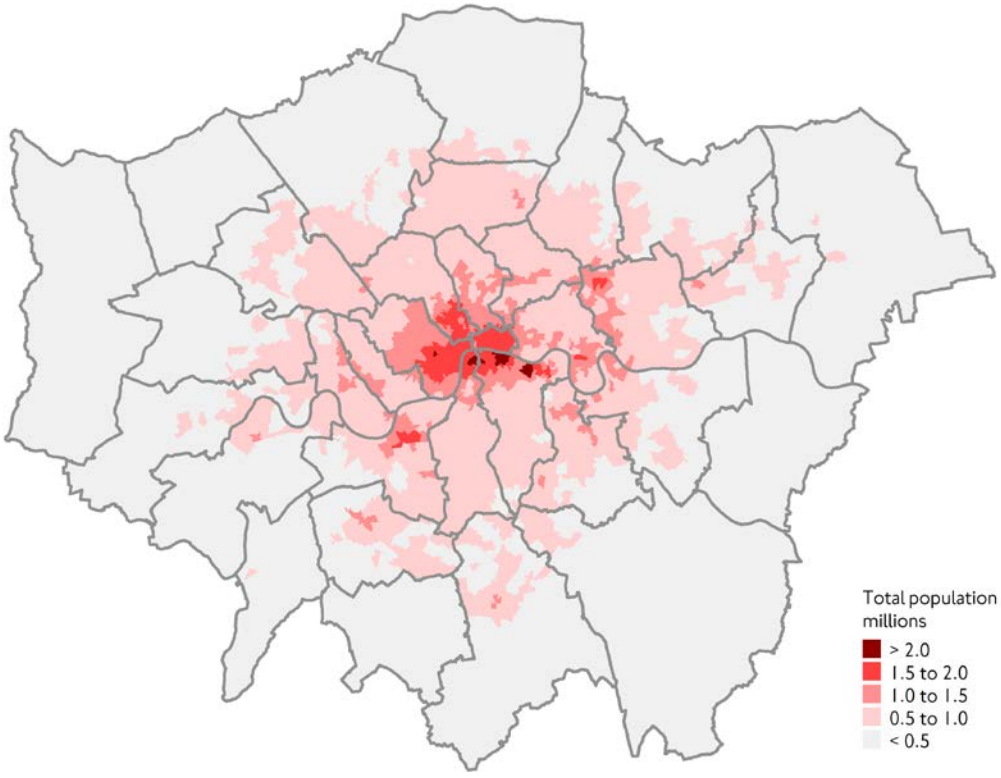
Conversion of further stations to step-free access will progressively reduce these differences over time. It is also important to note that step free facilities do not just benefit those with a disability. Features such as lifts and level platforms are beneficial to those carrying heavy loads, such as suitcases, as well as those with children in buggies, for example. In this way, initiatives primarily directed at one group of the population also deliver benefits for the wider population as a whole.

Figure 4.17 Number of people who can reach any location in London within 45 minutes. Full rail network assumption.



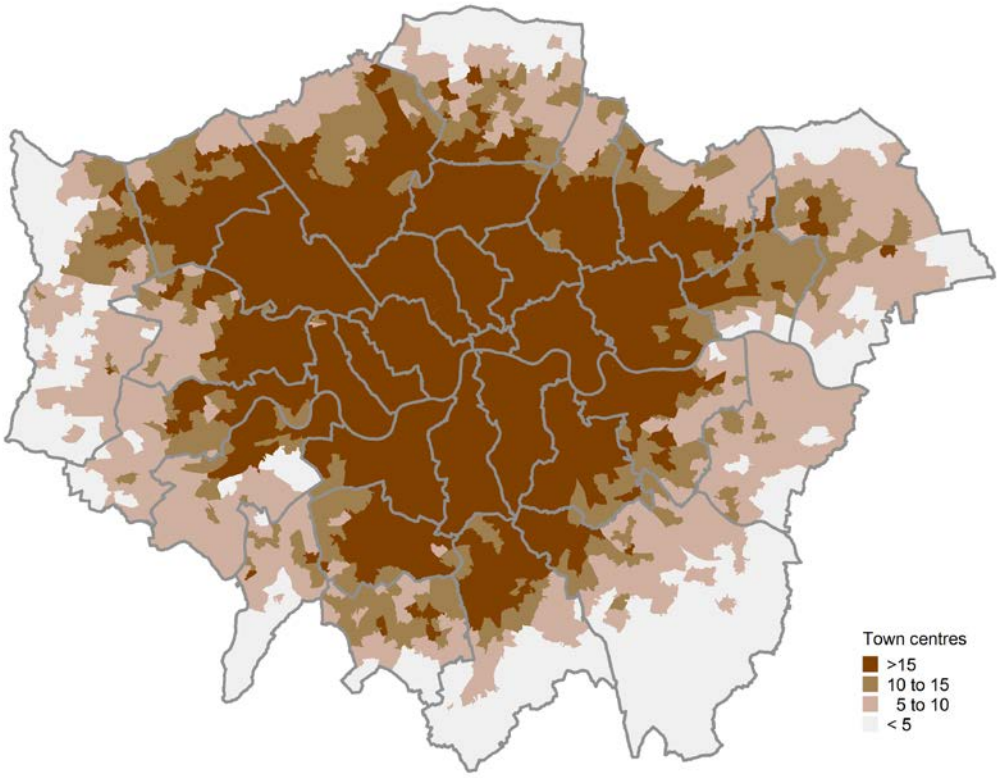
Source: TfL Planning, Strategic Analysis.

Figure 4.18 Number of people who can reach any location in London within 45 minutes. Step-free rail network assumption only.



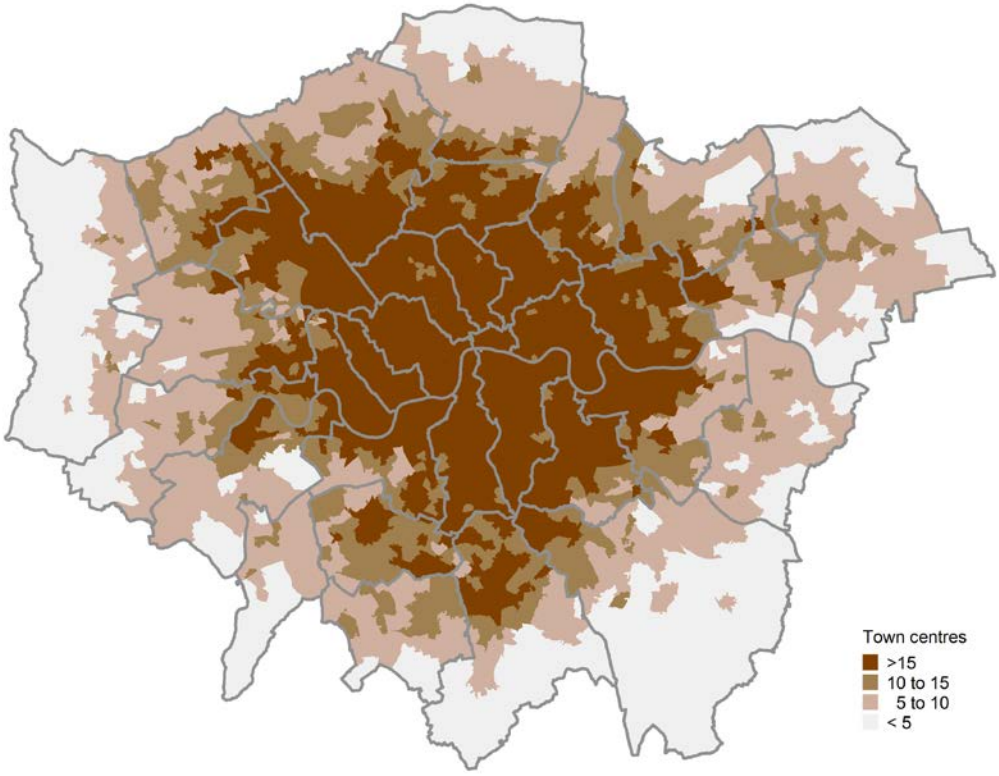
Source: TfL Planning, Strategic Analysis.

Figure 4.19 Number of town centres within 45 minutes of any location in London. Full rail network assumption.



Source: TfL Planning, Strategic Analysis.

Figure 4.20 Number of town centres within 45 minutes of any location in London. Step-free rail network assumption only.



Source: TfL Planning, Strategic Analysis.

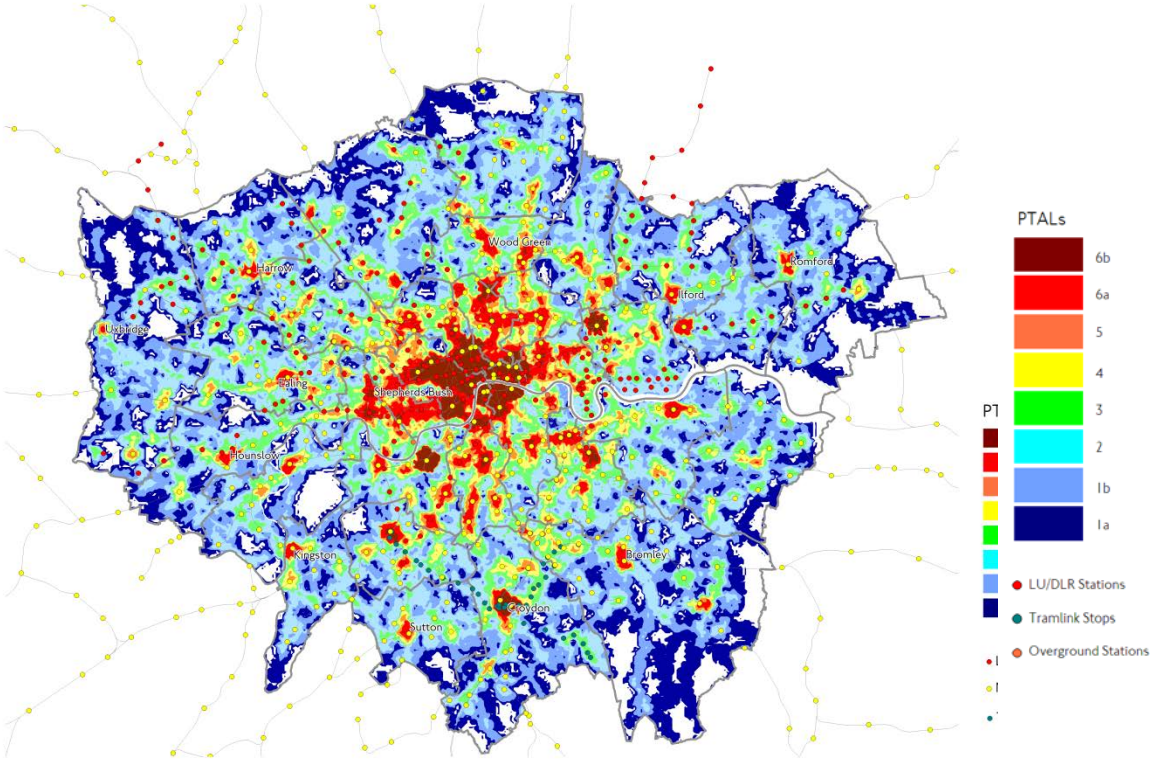
4.8 Connectivity provided by public transport

Public transport access levels across Greater London (PTAL scores)

PTALs (public transport access levels) quantify relative connectivity to the public transport network for any location in London. The term 'connectivity to the network' indicates that the PTAL measure focuses on the proximity to public transport services, and not on where these services actually take people to or indeed how accessible they are to all members of the population.

Figure 4.21 shows Greater London PTALs for 2015. As would be expected, central London features high PTAL values, as do other metropolitan town centres, such as Croydon, Kingston and Harrow, where many locations have close proximity to public transport access points. The predominantly radial orientation of the main public transport corridors is also visible in the figure. Note that PTAL values are on a scale from 1 to 6, with 6 representing the highest connectivity level.

Figure 4.21 Public transport access level, 2015.



Source: TfL Planning, Strategic Analysis.

Despite frequent incremental improvements to the public transport networks, the overall pattern of PTAL scores changes only slowly at the Greater London level. However, specific additions to the networks, such as the opening of the East London line, and 2012 Games-related improvements around Stratford, can make a substantial difference locally, as has been illustrated in previous Travel in London reports.

PTALs are relatively simple calculations because they only measure access to the public transport network, and ignore what happens once a passenger has 'entered'

this network. They do not consider aspects of the journey such as the final destination, vehicle capacity or service quality. For this reason PTALs should not be used to estimate how many people will actually use public transport. Two sites with the same PTAL scores will most likely offer different levels of public transport service.

Travel in London report 8, section 8.5, summarised the trends in PTAL scores over recent years, and reviewed how they were expected to change in the future. It also gave details of TfL's WebCAT tool, which can be used to access these data (for planning purposes etc). See: https://tfl.gov.uk/info-for/urban-planning-and-construction/planning-with-webcat/webcat.

Furthermore, the spatial pattern of PTAL scores, illustrated by figure 4.21, can be used in conjunction with other datasets, such as the LTDS survey, to examine aspects of how they influence travel behaviour. Examples of this form of analysis are given in section 2.7 of this report.

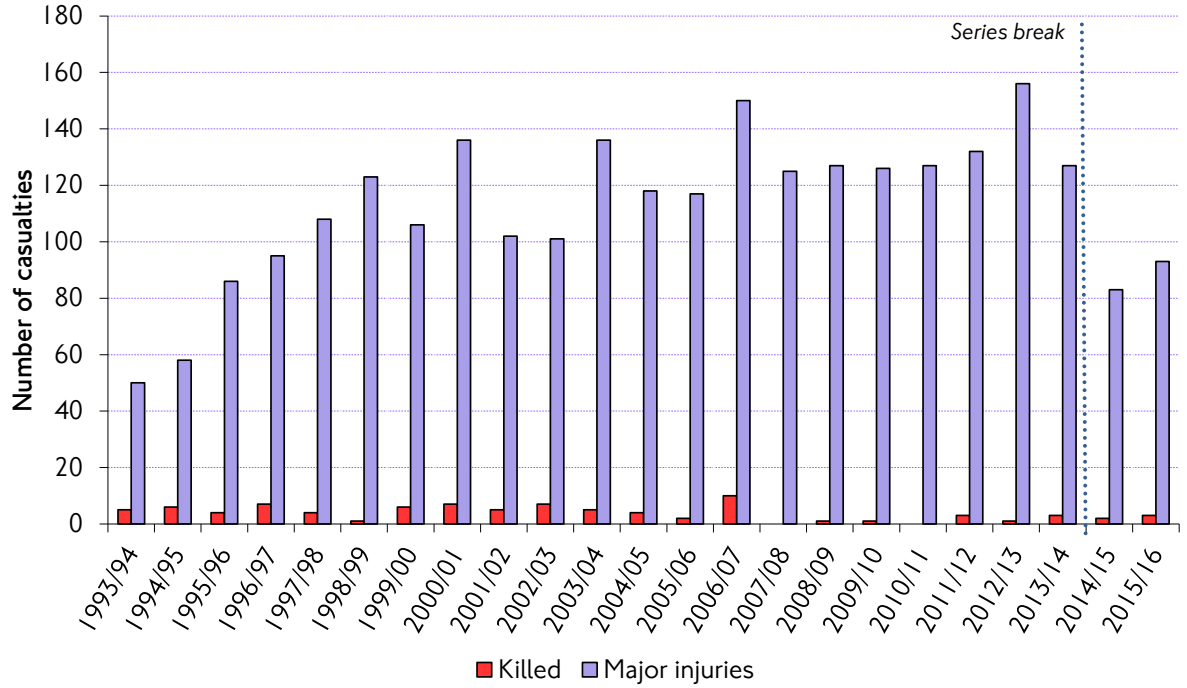
4.9 Safety, crime and anti-social behaviour on the public transport network

Figures 4.22 and 4.23 show the trend in passenger injuries and fatalities on the principal public transport networks up to the 2015/16 financial year. Figure 4.22 shows the trend for London Underground (excluding other rail modes) and figure 4.23 shows the trend for bus and coach occupants.

- On the Underground during 2015/16 there were 93 passenger injuries and three fatalities. This was slightly higher than the previous year, but it should be noted that the statistical definitions of this series changed in 2014/15.
- In 2015, 71 bus or coach occupants were injured in London, with one fatality. These casualty numbers exclude pedestrian and other vehicle users who might have been injured in collisions involving buses or coaches – these are included in the statistics described in section 6.6 of this report. Figure 4.23 shows a consistent trend of improvement in bus or coach passenger injuries over the last decade.

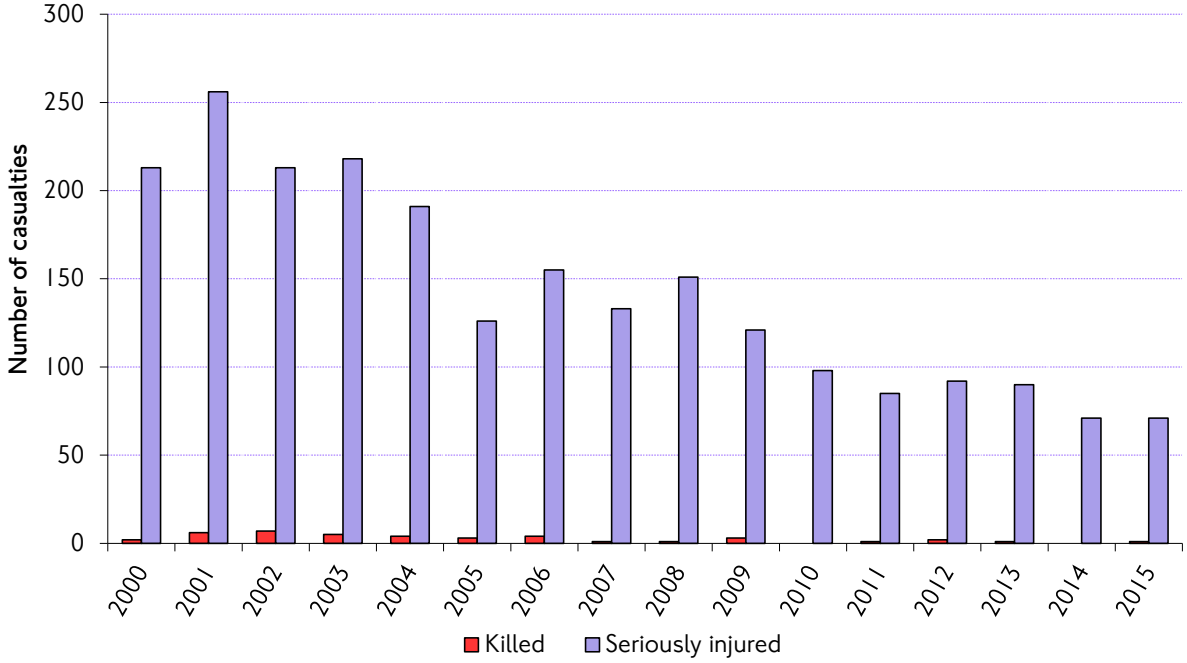
These trends should also be evaluated in the context of rising public transport patronage in London.

Figure 4.22 Number of people killed or injured while travelling on London Underground.



Source: London Underground. Excludes suicides and victims of assault and terrorist activity.

Figure 4.23 Number of bus/coach occupants killed or seriously injured in London.



Source: TfL Surface Transport – Strategy & Outcome Planning.
Excludes suicides and victims of assault and terrorist activity.

Crime and antisocial behaviour

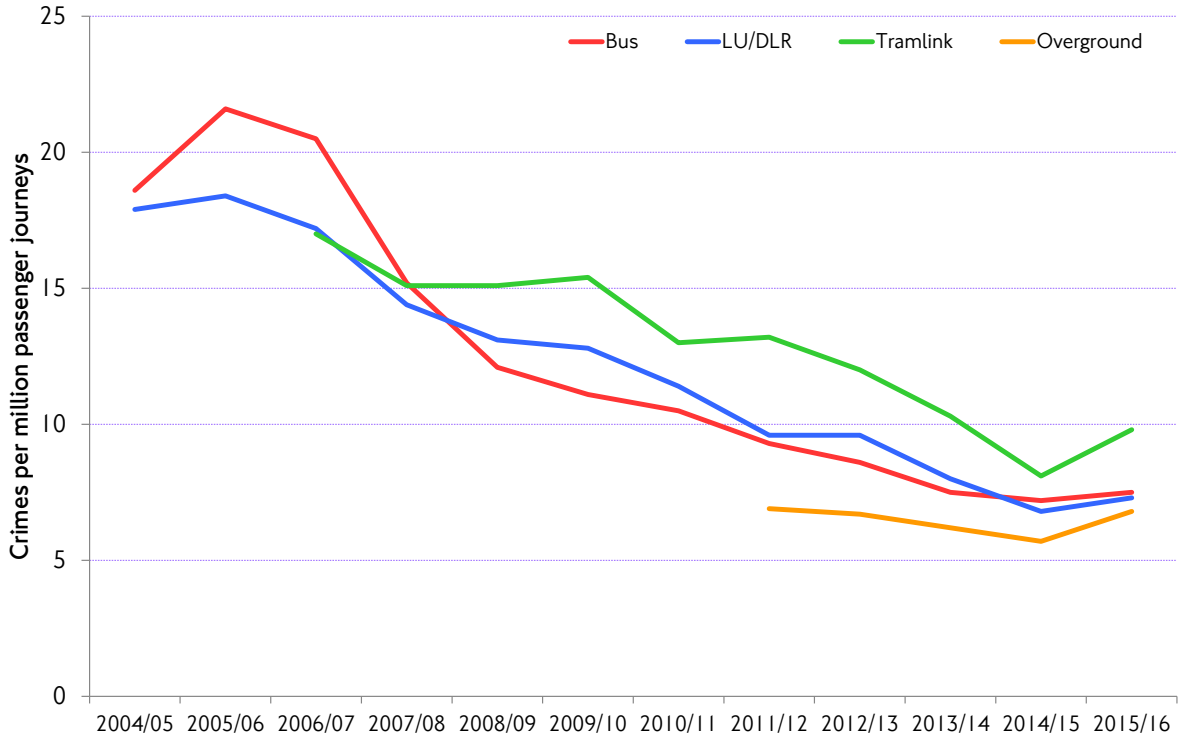
Levels of recorded crime on TfL's transport system have increased in 2015/16 – up by 6.7 per cent on 2014/15, while the rate of crime has increased to 7.4 crimes per million passenger journeys, up from 7.0 in 2014/15.

This increase in the number of reported crimes on the network was broadly anticipated and has largely been driven by changes in the reporting and recording of certain types of offences. This reflects proactive efforts to improve confidence to report sexual offences and so the related rise in reporting of such crimes is considered to be a positive result of Project Guardian (see also: http://www.btp.police.uk/advice_and_information/how_we_tackle_crime/project_guardian.aspx).

Bearing in mind the systematic change in reporting referred to above and in relation to figure 4.24:

- There were 7.5 reported crimes per million customer journeys on the bus network in 2015/16, up from 7.2 in the previous year (an increase of 4.2 per cent). There were also increases in the number of reported crimes on London Trams and London Overground over the previous year, these increasing by 21.0 per cent and 19.3 per cent respectively.
- On the Underground and DLR networks, there was a 7.4 per cent increase in the number of reported crimes per million customer journeys.

Figure 4.24 Reported crime on TfL's public transport networks. Rate per million passenger journeys.



Source: TfL Enforcement and On-street Operations.

5. Healthy Streets, walking and cycling

5.1 Introduction and contents

Healthy Streets is central to the Mayor's vision to create a better city for all Londoners. Healthy Streets is an over-arching framework for the design and management of London's streets, incorporating measures to encourage walking, cycling and use of public transport, to improve road safety, tackle poor air quality, reduce car dependency, improve the environment and deliver an accessible and inclusive transport system. Healthy Streets is not an idealised vision for a 'model' street. It is a long-term approach to improving Londoners' experiences of the Capital's streets, helping everyone to be more active and to enjoy the health benefits that this brings.

This chapter sets out some of the underpinnings of the Healthy Streets approach in London, and then looks at measurements and other evidence, in particular trends relating to walking and cycling, that will assist in framing these policies.

5.2 The Healthy Streets approach

The importance of London's streets for public health and wider social and economic interaction

London's streets provide the opportunity for people to stay active. Their design and management can facilitate walking and cycling, and reduce the impact of motorised traffic.

It is not the case that London has 'healthy streets' and 'unhealthy streets'. However, in many cases, aspects of the street environment can be directly harmful to health as well as being uninviting – discouraging their use and meaning that the health benefits of active travel are not fully realised. Reducing air pollution, noise and crime, improving safety (both actual and perceived), and providing pleasant environments and facilities for rest and social interaction can all improve health directly, through facilitating more active travel, and helping to break down barriers to using streets, which in turn delivers wider social and economic benefits.

TfL's Health Action Plan (see: http://content.tfl.gov.uk/improving-the-health-of-londoners-transport-action-plan.pdf) advocates a 'whole street' approach to improving streets. This approach recognises that, although many streets in London have one or more characteristics which makes them good for health and attractive places to walk and cycle, it may take multiple positive characteristics to enhance the experience of using the street.

Healthy Streets outcomes

There are 10 Healthy Streets outcomes (figure 5.1), which summarise the essential elements that make a street an inclusive and healthy environment. To deliver these 10 outcomes a wide range of measures can be needed. One of the best ways to assess the health of a street is to spend time on the street, observing how it looks and feels, and how it is being used by people. However the outcomes can be assessed through quantified metrics as well.

Figure 5.1 The 10 Healthy Streets outcomes.

Indicator	How it relates to health
Pedestrians from all walks of life	Everybody needs to be active every day. If the mix of people walking in the street does not include certain groups such as children, older people or those with disabilities then the street environment is excluding some people from staying active.
People choose to walk and cycle	Some people walk or cycle not out of choice but due to poor access by other modes of transport. This can have negative impacts on their health and wellbeing. Success should be measured by people choosing to walk and cycle, rather than levels of walking and cycling.
Clean air	The health impacts of air quality include cardiovascular disease and respiratory disease.
People feel safe	People need to feel that they will be safe from injury and crime when they are on the street.
Not too noisy	Noise has a range of health impacts including stress and high blood pressure. It also discourages people from walking and cycling.
Easy to cross	If streets are difficult to cross because of physical barriers or traffic, people will be discouraged from using the street, particularly on foot. This can be socially as well as physically restricting.
Shade and shelter	Some people have difficulty moderating their body temperature, and this can put their health at risk in hot weather. Shade is needed on streets to enable people to keep cool.
Places to stop	Many people can only walk short distances without taking a rest, particularly those who are older, young, pregnant, injured or who have a disability or health condition such as chronic obstructive pulmonary disease. Providing seating at regular intervals is necessary to enable these people to incorporate much needed physical activity into their daily routine.
Things to see and do	Street environments need to be stimulating and engaging to invite people to walk and cycle more. This highlights the importance of good urban design and maintenance of public spaces in delivering health benefits.
People feel relaxed	Walking or cycling in the street should not be a stressful experience. If people are not relaxed it indicates that issues such as noise, insufficient space or fear of danger have not been addressed.

Source: Improving the health of Londoners: Transport action plan, 2014. TfL Planning Strategy and Policy.

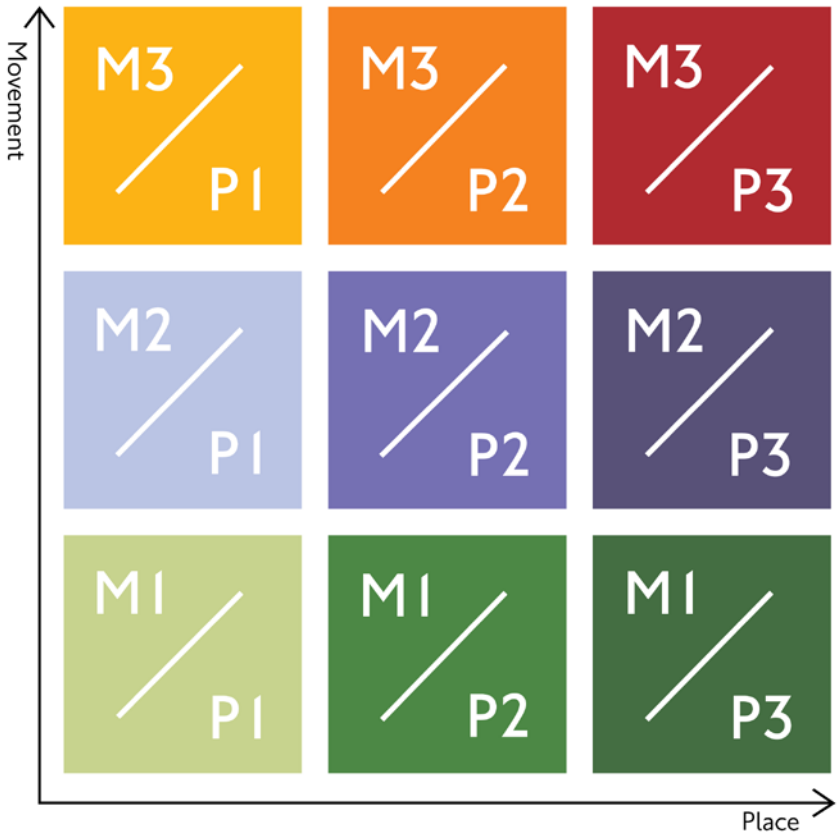
5.3 'Street Types' in London

TfL has been working with the London boroughs to classify streets into one of nine types on the basis of the degree to which they serve 'movement' (of people, vehicles and goods) or 'place' functions. 'Place' was assessed through factors such as pedestrian volumes, the occurrence of social activity, and the functional character of the street, for example, whether it has destinations like shops or tourist attractions, and other aspects of the street environment.

Figure 5.2 shows this conceptual framework, with nine Street Types identified. Interestingly, it will be observed that high-traffic roads do not necessarily have to be poor places, and can themselves have strategic significance as a 'place' (for example, the top right-hand square). They may not however currently perform particularly well as places, and there are clearly some key practical trade-offs implied between the two core functions of streets.

Classifying streets according to Street Types will allow an appropriate mix of interventions to be defined in each case to improve the 10 Healthy Streets outcomes within the functional context of the street. It will also provide, in certain cases, a framework and guidelines for interventions that might change the functional status of a street (ie move between cells in figure 5.2) where this is considered to be desirable.

Figure 5.2 Classification of streets by the degree to which 'movement' and 'place' functions are served.



Source: TfL Surface Transport Strategy & Outcome Planning.

Table 5.1 Street Types in London – extent of each Street Type.

Street Type	Length (km)	% of total
M3 / P1	1,237	8.5%
M3 / P2	110	0.8%
M3 / P3	36	0.2%
M2 / P1	1,288	8.8%
M2 / P2	84	0.6%
M2 / P3	24	0.2%
M1 / P1	11,676	80.1%
M1 / P2	70	0.5%
M1 / P3	47	0.3%
Total	**14,572**	

Source: TfL Surface Transport – Strategy & Outcome Planning

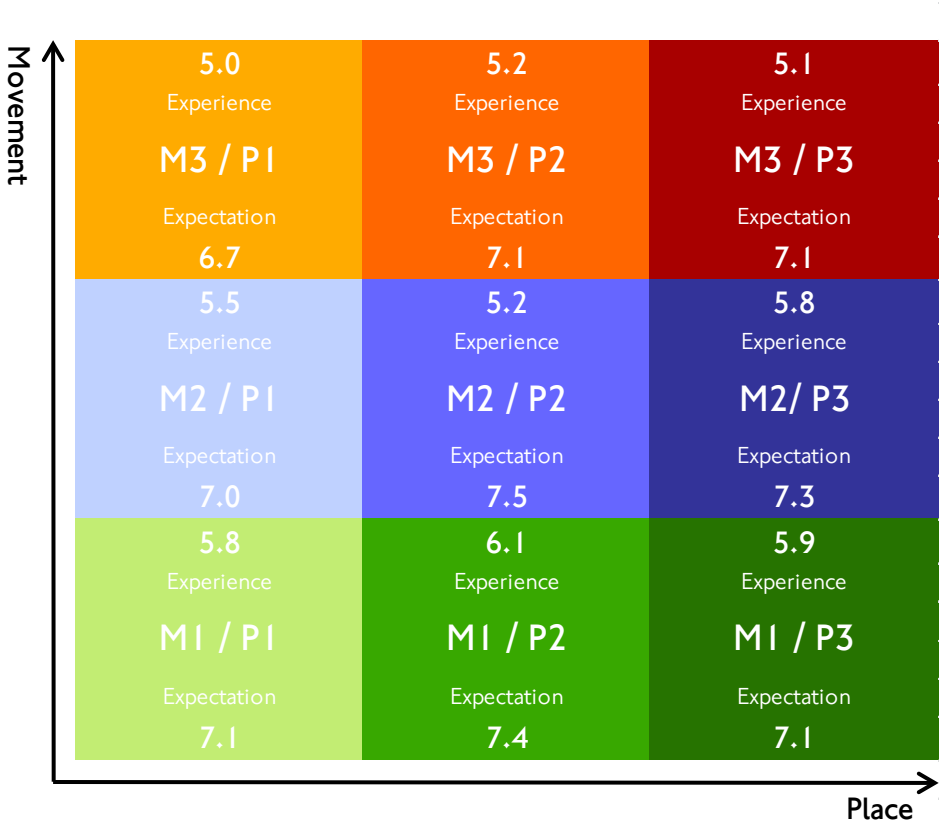
Table 5.1 gives some basic statistics relating to the extent of each of the Street Types in terms of the overall road network length in London. Although the proportion of the London street network assigned to categories other than M1/P1 (low movement/place – typically an ordinary residential road, for example) is small, some of the other categories include key

functional centres, such as town centres, or globally iconic places, such as London's tourist attractions.

5.4 Measuring the 'healthiness' of streets

Travel in London report 7 described exploratory surveys that TfL developed to measure and assess the achievement of the Healthy Street outcomes, set out in figure 5.1 above, in the context of specific street locations across London. The surveys are based on the perception of these aspects as reported by a representative sample of people walking or spending time on the street at that location. The Healthy Streets surveys aim to provide insight into how people perceive the street, including how attractive and enjoyable they find it to be there, how easy it is to cross the road and how safe it feels. A key aspect of these surveys is the distinction between people's experience and expectation of that street – allowing the difference between expectation and actual perceived performance to be quantified. The Healthy Streets survey has now been completed in 81 locations across London, with more than 8,000 respondents interviewed, and for the first time this allows an indicative quantification of performance against the Healthy Street outcomes.

Figure 5.3 Mean experience and expectation scores for Healthy Streets indicators by Street Type. TfL's Healthy Streets surveys.



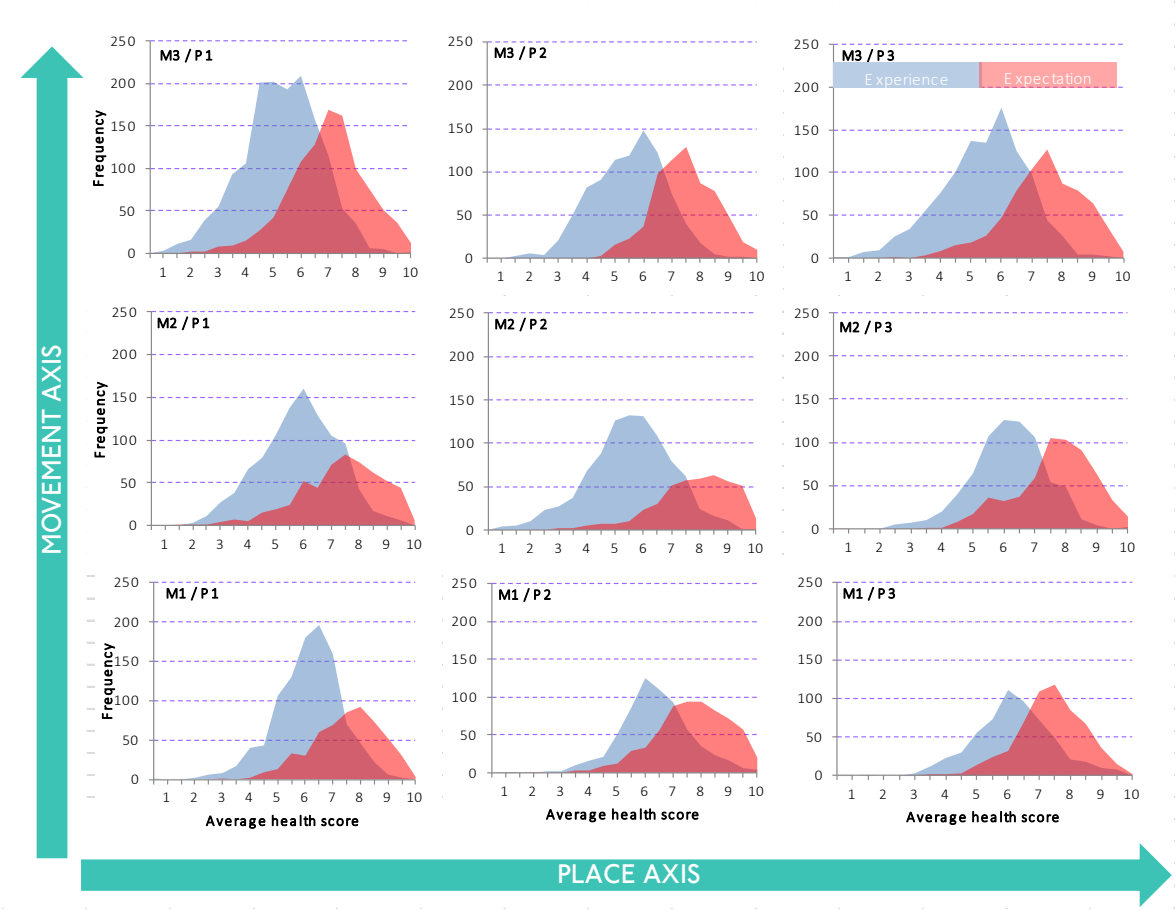
Source: TfL Planning Strategic Analysis.

Responses to the questions in the survey were averaged by indicator to give an overall health experience and expectation score out of 10 for each Street Type. Figure 5.3 shows results from a sample of the sites that have been surveyed. In general, people's experiences of the street environment decrease as the movement

function of streets increases. People's expectations of the street environment also broadly decrease as the movement function of streets increases, indicating that people do take into account the function of a street when setting their expectation. The trends in experience and expectation scores according to the place function of a street is less clear, as the 'form' of streets within Street Types can be diverse. Expectation scores are higher for streets with a medium place function rather than a high place function and experience scores do not show a clear pattern according to place function.

Figure 5.4 shows that the distribution of average experience and expectation scores by street type follow plausible and intuitive distributions. As expected, expectations are always higher than experiences. For each street type there is a distinction between experience and expectation, although some are less pronounced than others, for example streets with a low movement function tend to have smaller gaps between experience and expectation. Street Types with a larger gap between experience and expectation tend to have a higher movement function.

Figure 5.4 Distribution of average experience and expectation scores by Street Type. TfL's Healthy Streets surveys.



Source: TfL Planning Strategic Analysis.

5.5 The importance of increased physical activity for improving the health of Londoners

Physical activity, active travel and public health

Physical activity, for example through 'active travel' such as walking and cycling, is one of the most effective ways of maintaining and improving health. Encouraging and facilitating this through improving the street environment and enhancing facilities for walking and cycling can therefore deliver major health benefits, as well as other beneficial effects of mode shift – for example relieving capacity on congested parts of the transport networks or contributing to reduced air pollution.

Public health trends in London

The life expectancy of Londoners is increasing; however, on average more Londoners are living a greater proportion of their lives in a state of poor health. For example:

- Six in 10 Londoners are overweight or obese, and obesity is thought to account for 85 per cent of the risk of developing type 2 diabetes.
- Around one million Londoners suffer from some form of mental disorder, such as depression.
- An estimated 72,000 Londoners are thought to suffer from dementia – a figure expected to increase 2.5 fold by 2050, largely reflecting a relative ageing of London's population.

However:

- An estimated 28 per cent of Londoners do less than 30 minutes of physical activity per week.
- One quarter of men and a third of women aged over 65 years do not leave their house on a typical day.

Partly reflecting these trends, today's children are the first generation that is not expected to live as long as their parents. Four in 10 children aged 11 years in London are already considered to be overweight or obese. The number of teenagers with depression doubled between the 1980s and present day, and there is an increasing prevalence of type 2 diabetes among children – despite this usually being considered a 'disease of old age'. Today's children are relatively more restricted in terms of their independence and opportunities for outdoor play, while an estimated eight in 10 children in London do not achieve the minimum recommended physical activity levels of one hour per day.

Within this wider context, everyday active travel is one of the best – and easiest – ways to improve health. Walking, for example, is a near-universal mode of travel that creates no negative 'externalities'. Once people start walking a particular journey, the evidence suggests that it then becomes part of their everyday unconscious routine – thereby requiring little or no extra effort. Increasing walking as a mode of travel, either for whole trips or as part of public transport trips, therefore, is one of the best and easiest ways to get inactive people to become more active.

Role of the transport system

The transport system in London plays a very important part in people's health by enabling them to be physically active through everyday walking and cycling. This is the main way that many people stay physically active, and increasing active travel is

likely to be the easiest way for relatively inactive Londoners to incorporate more activity into their daily routine to meet their physical activity needs.

Recommended minimum levels of physical activity and levels of achievement

The recommendation in the Department of Health's 'Start active, stay active' report (see: https://www.gov.uk/government/publications/start-active-stay-active-a-report-on-physical-activity-from-the-four-home-countries-chief-medical-officers) is that adults need to achieve a minimum of 150 minutes (2.5 hours) of physical activity per week in periods of 10 minutes or more to stay healthy.

Evidence has shown that sessions of 10 minutes or more are sufficient to improve cardiovascular fitness and lessen the risk of heart disease, type 2 diabetes and other conditions. This can be achieved through work tasks, chores, leisure activity as well as active travel although the nature of jobs in London and labour saving domestic devices mean that active travel and leisure activities are the primary sources of activity for the majority of people in London

The Health Survey for England 2012 (see: http://www.hscic.gov.uk/catalogue/PUB13218) shows that in total, from all types of activity, only 67 per cent of men and 55 per cent of women living in London are estimated to achieve the recommended 150 minutes of physical activity per week. This can also be assessed using LTDS – in that if, on a given survey day (on the whole; representative of all days) a person achieves two sessions of active travel or 10 minutes or more, then it can be considered that they are meeting the weekly recommended target level through active travel alone.

Levels of physical activity through active travel are higher among younger people. Just more than 30 per cent of 18-29-year-olds and 30-39-year-olds meet the target through active travel in periods of 10 minutes or more, compared to 20 per cent or less for over 60s. The percentage of the population meeting the requirement through active travel alone generally decreases with age, although at a less steep gradient than other types of activity.

Reducing inactivity through active travel

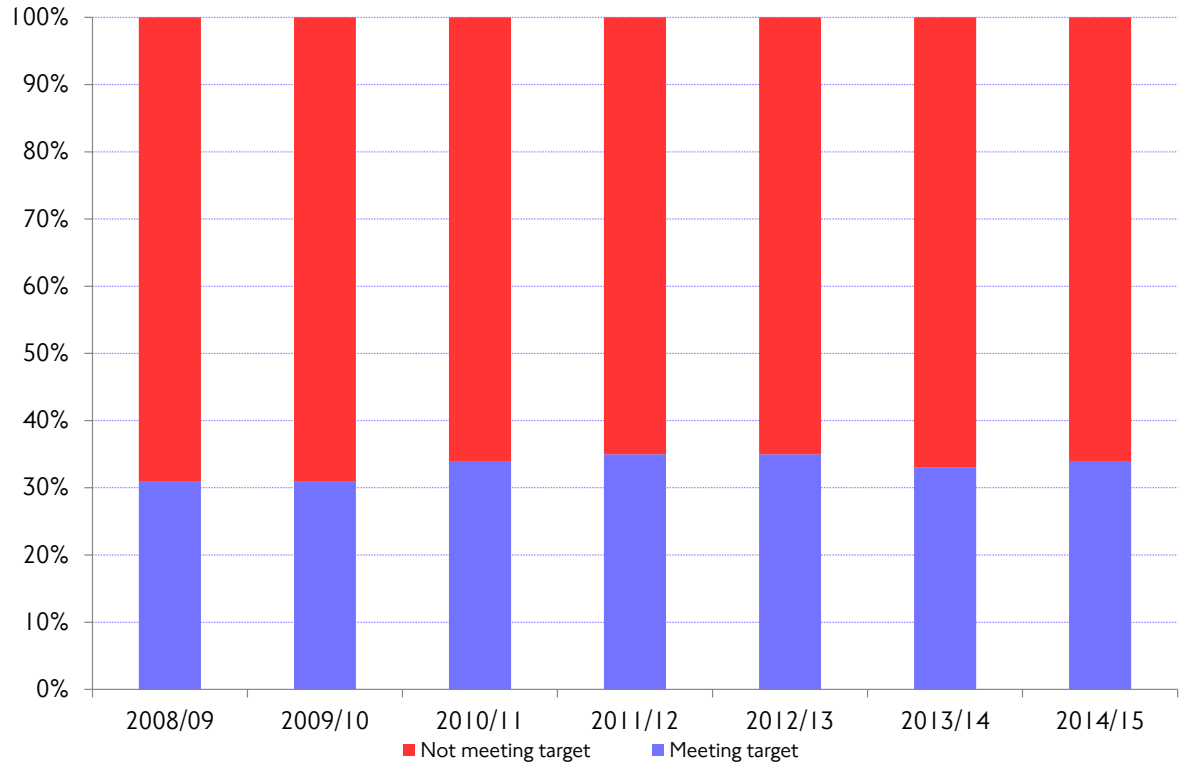
LTDS shows that if Londoners walked or cycled all of the trips that could potentially be walked or cycled (according to a set of reasonable constraints and very much reflecting an upper bound – see also section 5.8 below), then an estimated 60 per cent of Londoners would achieve the recommended two sessions of 10 minutes of physical activity per day from this source alone.

- Most of the people currently not achieving two sessions of 10 minutes of physical activity are under 50 years of age, reflecting the age profile of the general population, and are therefore relatively open to making changes to their lifestyle or travel behaviour to accommodate this.
- Some 72 per cent of Londoners say that they would walk more if there was improved safety and security, for example better street lighting or safer road crossings, and 66 per cent say that they would walk more if streets were cleaner and more attractive.
- One of the biggest determinants of how much walking and cycling Londoners do is car ownership. Car owners are 2-3 times less likely to achieve minimum recommended physical activity levels.

Measuring active travel in London

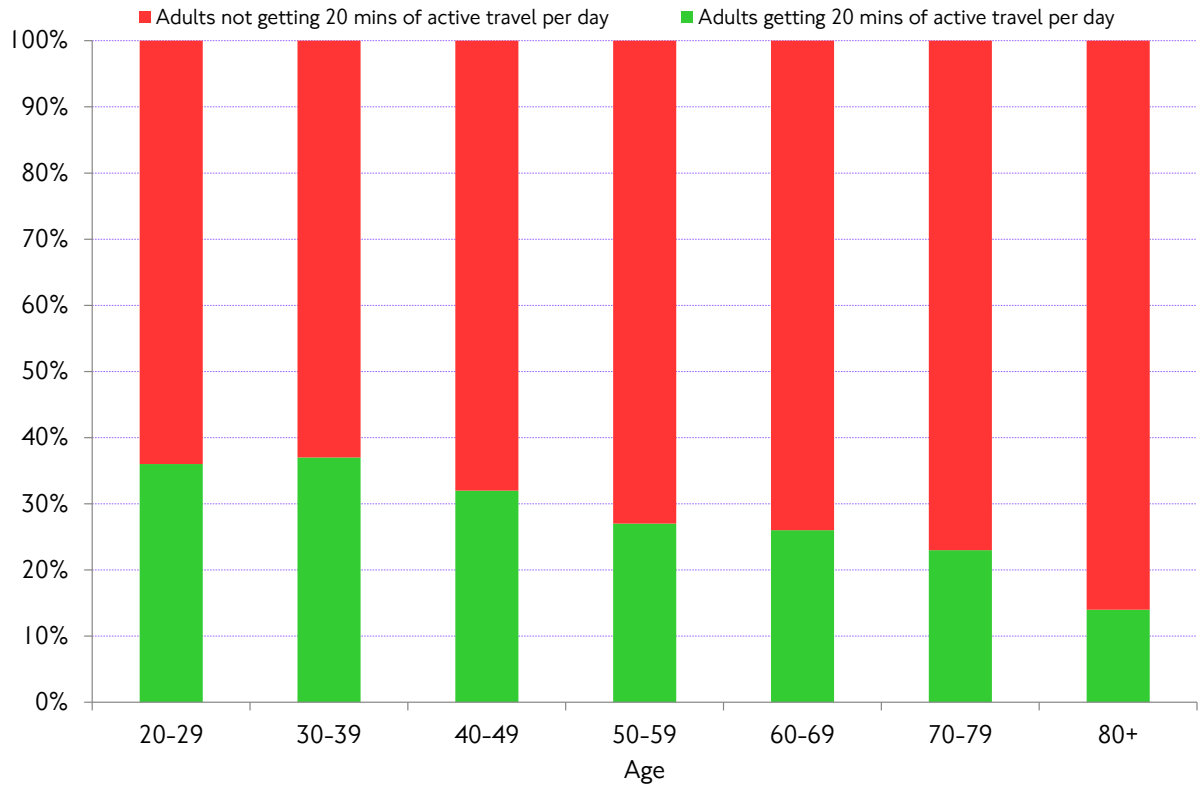
Fairly consistently over the period since 2008/09, the proportion of Londoners who report two sessions of 10 minutes of such activity on the survey day has been about one third (figure 5.5). Notable also from figure 5.6 is the progressive decline in the achievement of the minimum recommended level of active travel with increasing age.

Figure 5.5 Percentage of London resident adults achieving two sessions of 10 minutes or more of walking or cycling per day by year.



Source: TfL Planning Strategic Analysis.

Figure 5.6 Percentage of London resident adults achieving two sessions of 10 minute or more of walking or cycling per day by age band. 2012/13-2014/15.



Source: TfL Planning Strategic Analysis.

5.6 Characterising and measuring walking in London

Travel in London report 8 gave an overview of the basic characteristics of walking as a mode of transport in London. Here we take this analysis a little further, in particular by looking at some socio-demographic dimensions and distinctions in the use of walking as a mode of transport by different types of Londoner. It also reveals several shortcomings in our current knowledge of walking in London, and it is acknowledged that improvement is required in data relating to walking to enable TfL to better address the emerging policy agenda.

Some key statistics on walking in London

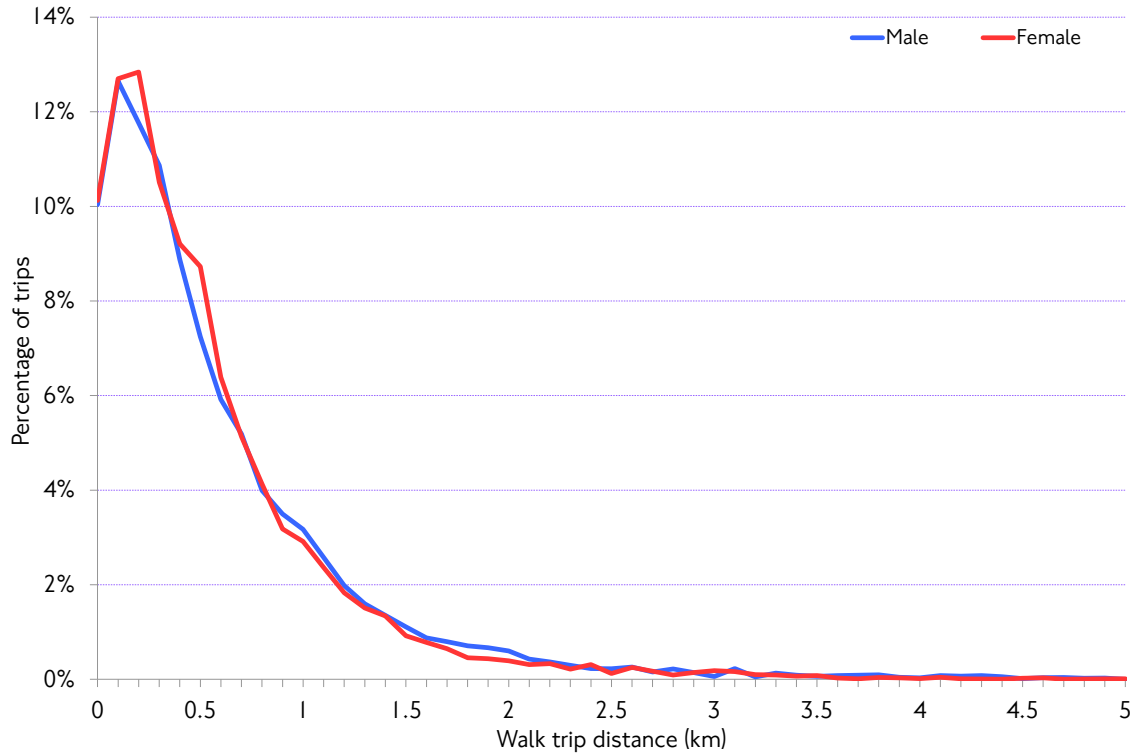
- Some 5.5 million walk all the way trips are made in London by residents on an average day.
- For journey stages, where one or more walk legs feature as part of a longer trip by, for example, rail or bus, there are a total of 26 million on a typical day made by London residents.
- On this basis, the trip-based mode share for walking by London residents is (in 2015/16) 29.4 per cent, while that for journey stages is 50.6 per cent.
- Considering only London residents, the average walk trip length is 0.5 kilometres and the average walk trip duration is just more than 9 minutes.
- The average walk trip rate by London residents (number of walk all the way trips made per person on an average day) is 0.7. This compares to an average trip rate for all modes of 2.3 trips per person per day, although many of these trips will include a walk stage.

Distance walked

Figure 5.7 shows the distribution of trip length for walk trips by London residents, categorised by gender (walk trip distances are assessed on a 'crow-fly' basis). The mean walk trip length is around 0.5km with, as might be expected, a pronounced bias towards shorter trips and a virtual absence of trips above 3km in length. Perhaps surprisingly, given that women are known to make more walk trips overall than men, there is no evidence from the figure of any substantial differences in the trip length distribution between men and women.

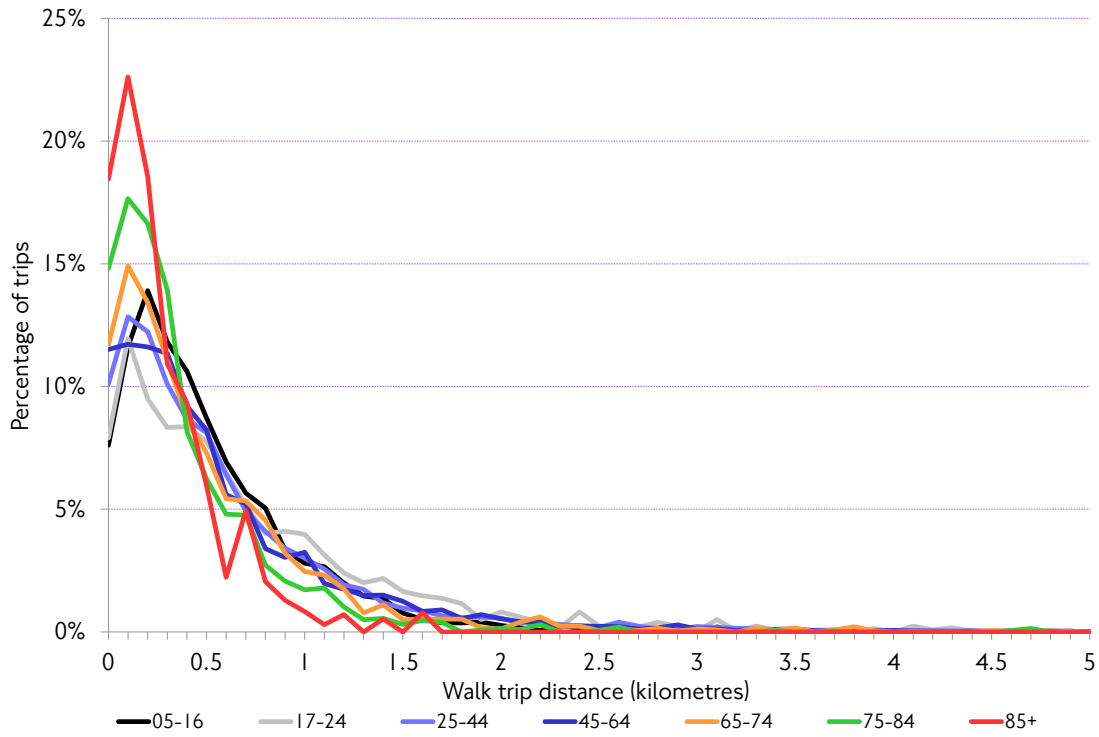
Walking trip length distributions by age show variation (figure 5.8), with a prevalence of short trips among older Londoners and younger Londoners making longer trips on average. Some 75 per cent of walking trips made by Londoners over the age of 85 are 500 metres or shorter in length, whereas the average walking trip length for Londoners aged between 17 and 24 is 800 metres.

Figure 5.7 Distance walked by gender – London residents (average day, seven-day week, 2013/14-2015/16).



Source: TfL Planning, Strategic Analysis.

Figure 5.8 Distance walked by age – London residents (average day, seven-day week, 2013/14 - 2015/16).



Source: TfL Planning, Strategic Analysis.

The propensity of people to walk of course depends on a wide range of factors – including things like their overall health, the availability of other modes of transport and land use densities.

Variation between boroughs

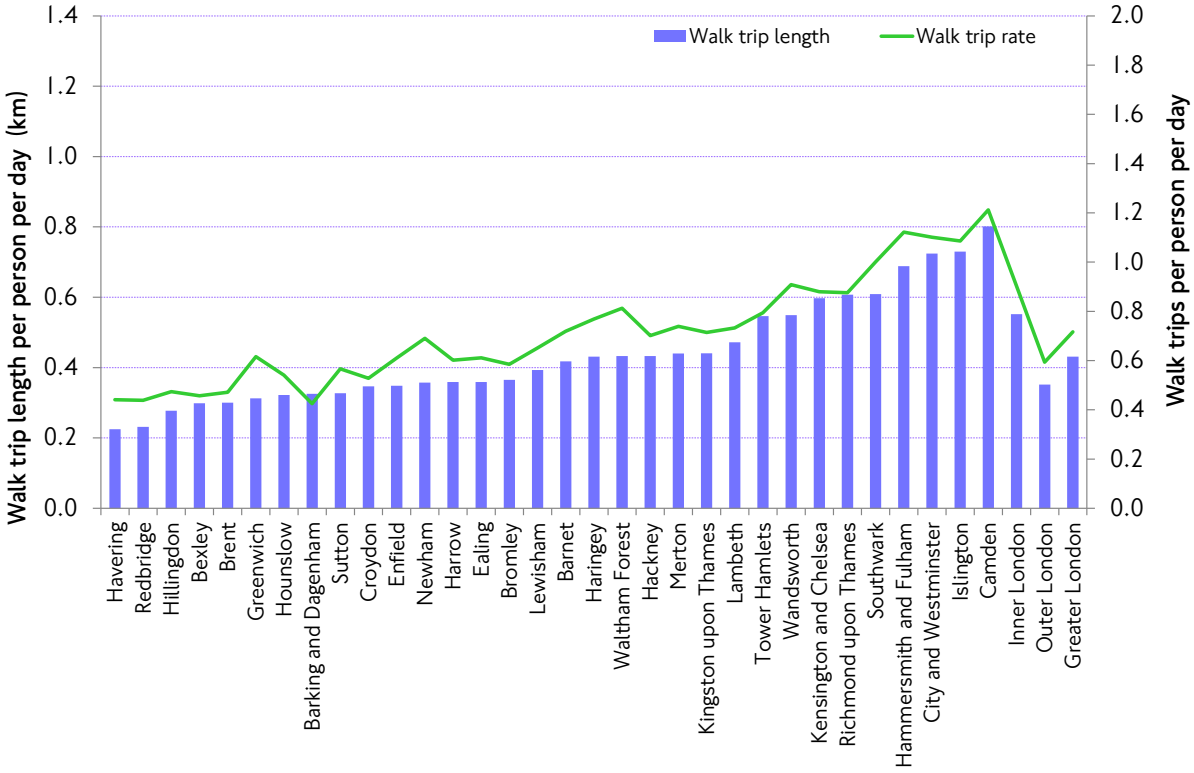
A borough-level presentation (figure 5.9) illustrates the scale of the variation between different parts of London in both the average walk trip rate and the average walk trip length (based on borough of residence). The data has been standardised to control for the variation in age structure among the boroughs since age is a factor that is known to affect how often and how far people walk. This means that the differences in average walk trip length and walk trip rate between boroughs are the result of factors other than age. Boroughs are ranked from left to right on the graph in terms of the average walk trip length of residents, which may occur in any part of London but are likely to be concentrated locally, as these are walk all the way trips.

It is seen that average walk trip lengths in inner London boroughs are typically longer than in outer London boroughs – reflecting the denser land use and therefore generally closer proximity of shops and services to 'home' in these boroughs. Walk distances to trip destinations tend to be longer in outer London, hence favouring the use of other modes of travel. The walk trip rate is also higher in inner London (0.9 trips per person per day) compared to 0.6 in outer London. The data indicates that, even after controlling for age, there remain real differences in the average walk trip length and walk trip rate among inner and outer London boroughs.

Interestingly, the figure shows a close correlation between the average walk trip rate and the average walk trip length by borough. For example, residents of Havering make the fewest walk trips per person per day (0.4) and also have the shortest average walk trip distance of 0.2km. In contrast, residents of Camden make 1.2 walk trips per person per day and the average walk trip length is 0.8km.

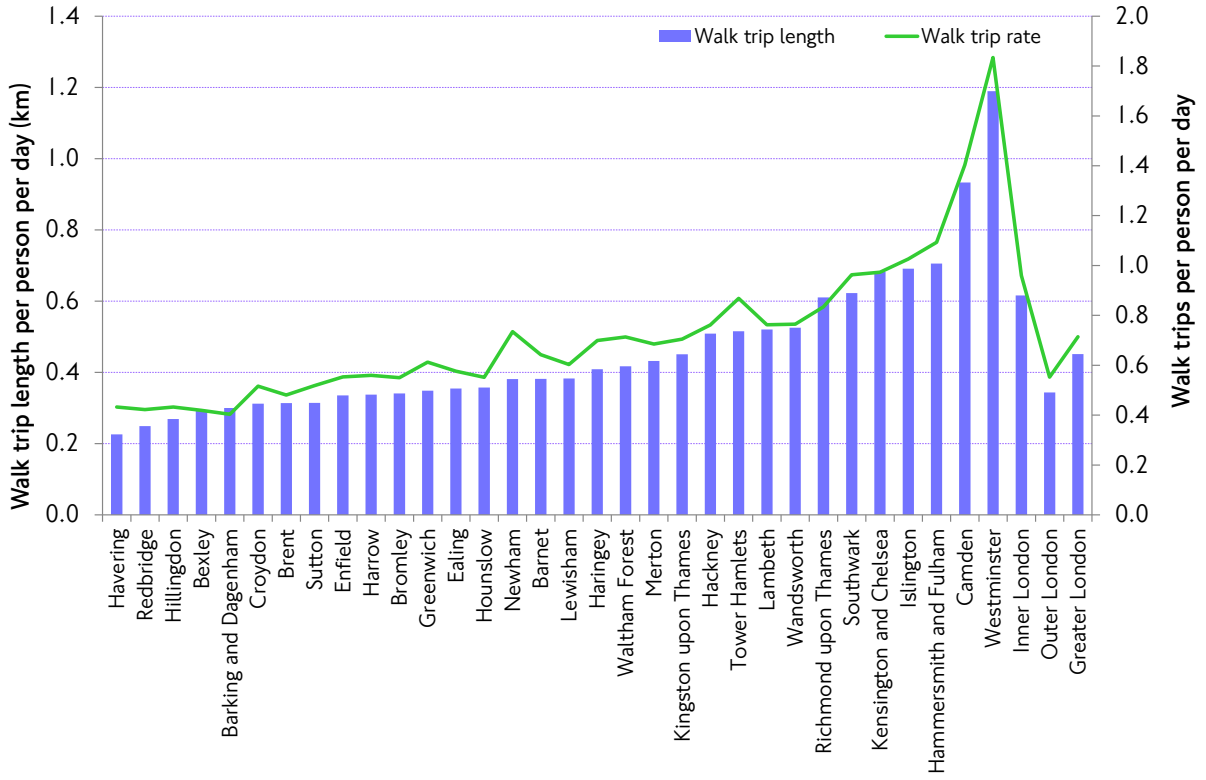
Figure 5.10 shows the average walk trip length and walk trip rate for London residents by borough of trip origin. The trend is not too dissimilar to figure 5.9 as walk trips that originate in outer London boroughs tend to be shorter than those originating in inner London. However, by looking at walk trips by borough of origin rather than by borough of residence, it is noticeable that in some central London boroughs, the number of walk trips per person is higher, although the average walk trip distances are shorter. This is the case in Southwark, Tower Hamlets and Hammersmith and Fulham and is likely to be due to London residents making short walk trips near their place of work or for leisure. In Westminster, the average trip length and the walk trip rate are higher when considering walk trips by borough of origin rather than walk trips by residents of the borough.

Figure 5.9 Average walk trip rate and average walk trip length by borough (age-standardised). Based on borough of residence. London residents only. (Average day, seven-day week, 2013/14-2015/16).



Source: TfL Planning, Strategic Analysis.
1. Walk trip distances are calculated as the crow flies.

Figure 5.10 Average walk trip rate and average walk trip length by borough. Based on borough of trip origin. London residents only. (Average day, seven-day week, 2013/14-2015/16).

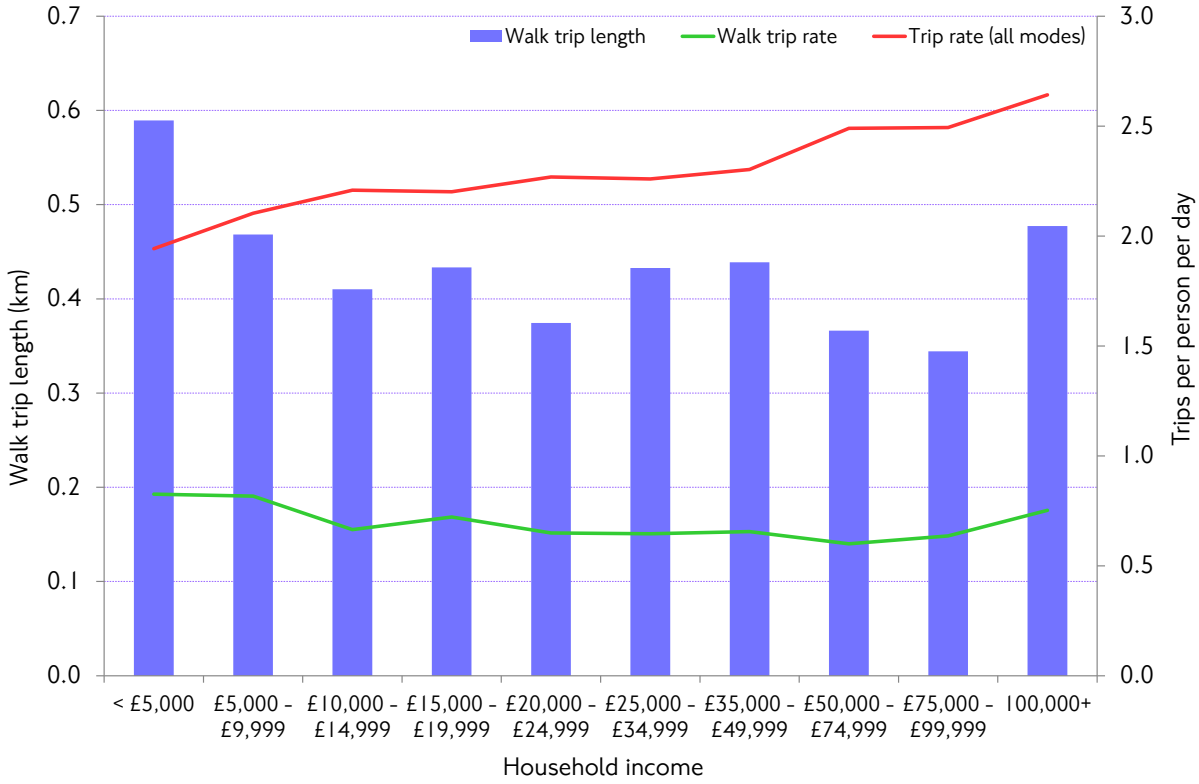


Source: TfL Planning, Strategic Analysis.
1. Walk trip distances are calculated as the crow flies.

Walking and socio-demographic characteristics

This section explores how basic measures of walking, such as trip rate and travel distance, vary between people with different characteristics. Figure 5.11 shows that London residents who live in households with the lowest annual income make the highest number of walk trips per person per day (0.83) and also have the highest average walk distance of 0.6km per person. Walk trip rates and average trip lengths per person however decrease slowly as household income increases. In fact, London residents living in households with an annual income of more than £100,000 have notably high walk trip rates and lengths – reflecting their greater overall mobility (as shown by the red line on the graph).

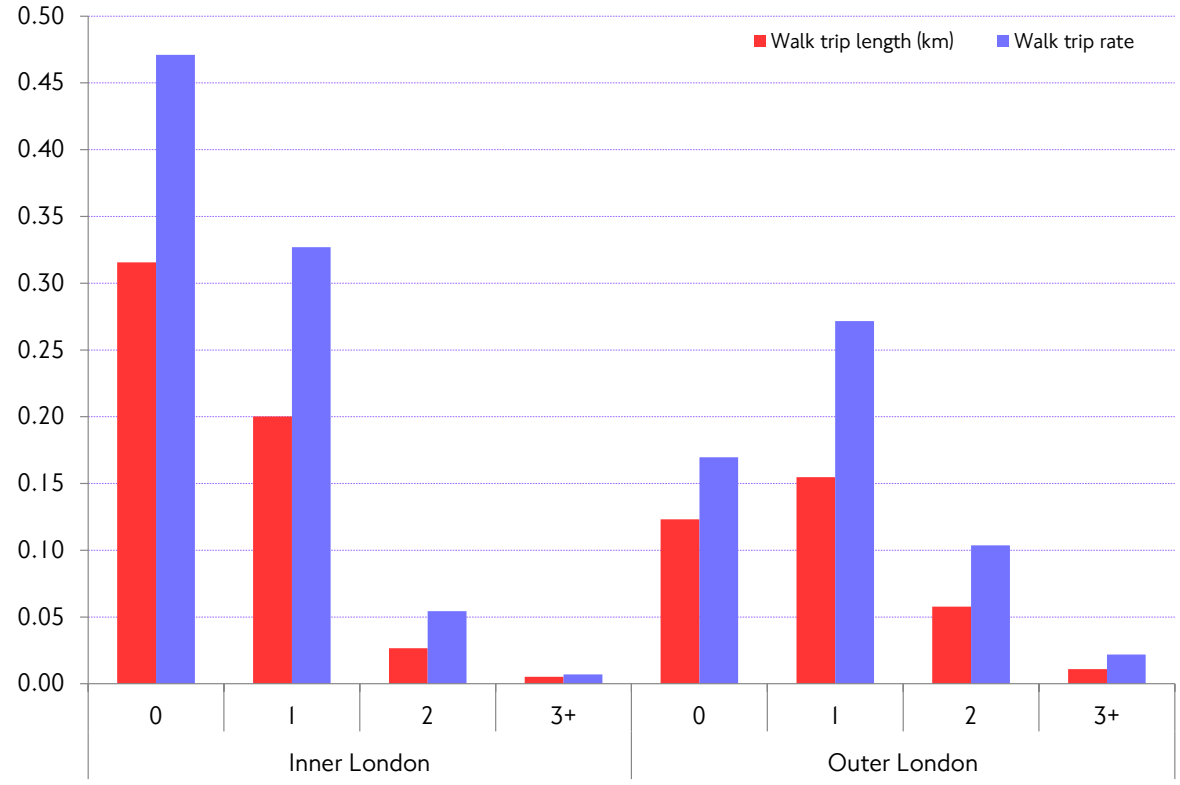
Figure 5.11 Average walk trip rate, overall trip rate and average walk trip length by household income band (average day, seven-day week), 2015/16.



Source: TfL Planning, Strategic Analysis.
1. Walk trip distances are calculated as the crow flies.

Looking next at car ownership and walking, figure 5.12 shows average walk trip length and number of walk trips per person per day by household car ownership in inner and outer London. The data shows that residents of inner London who do not own a car walk more often and further than residents of outer London who do not own a car. The same trend applies to inner and outer residents who live in households with one car. However, in households which have more than two cars, the walk trip rate and average walk trip length are higher for outer London residents than inner London residents.

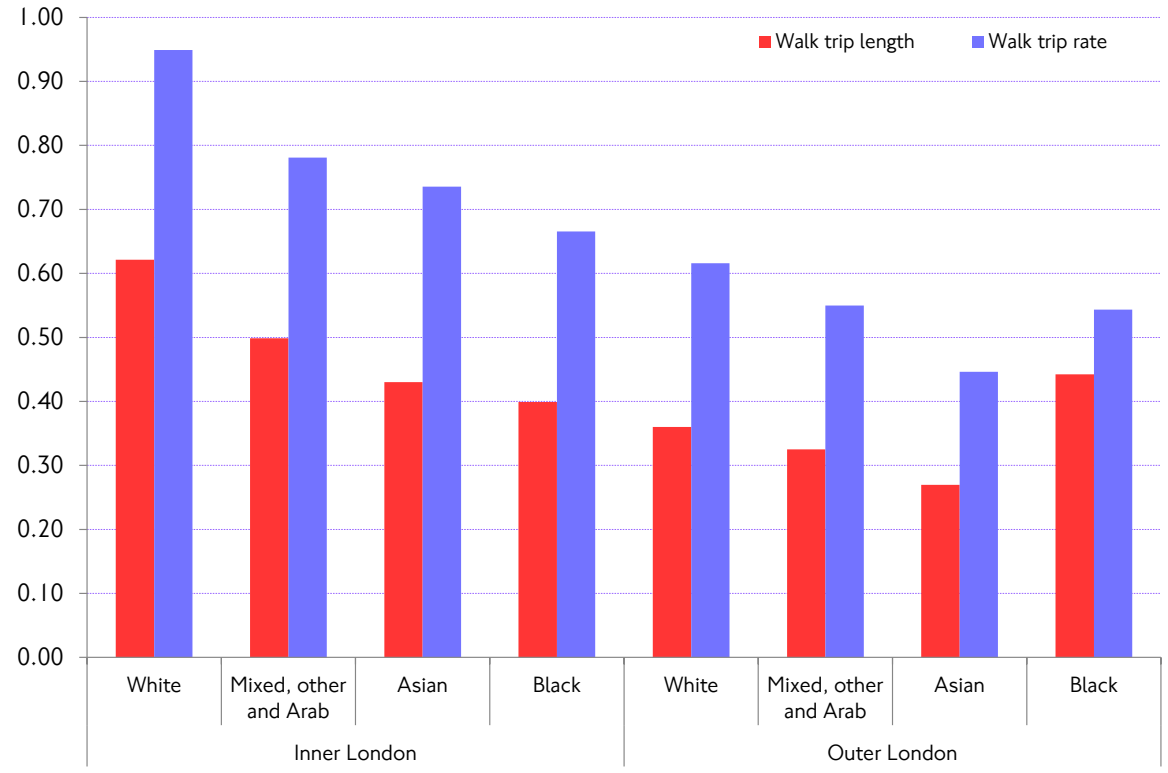
Figure 5.12 Average walk trip rate and average walk trip length by household car ownership.



Source: TfL Planning, Strategic Analysis.

1. Walk trip distances are calculated as the crow flies.

Figure 5.13 Average walk trip rate and average walk trip length by ethnic group.



Source: TfL Planning, Strategic Analysis.
1. Walk trip distances are calculated as the crow flies.

Variation in walking is also seen between different ethnic groups (figure 5.13). Here, walk trip rates are higher for all ethnic groups resident in inner London compared to outer London. Within this overall picture however it is notable that non-white groups have lower walk trip rates and walk trip lengths overall, although the relatively high walk trip rate and length for black people in outer London is notable.

International Walking Data Standard

The collection of data on walking varies considerably between cities and also over time due to the difficulty in capturing accurate and comprehensive data. This means that walking data is rarely directly comparable from one place to another. To address these problems of survey accuracy and comparability, a standard way of defining and measuring walking is now being promoted.

The International Walking Data Standard has been developed over several years by Walk21 and is supported by experts around the world (http://www.measuring-walking.org/international-walking-data-standard). The objective of the standard is to ensure that walking has a high profile in transport and urban planning throughout the world. International comparisons are important to establish best practice and to inspire and encourage better conditions for pedestrians. More specifically, the objective is to establish comprehensive data on trips, such that walking is recorded with the same degree of accuracy as other modes.

The following key indicators have been identified as being particularly relevant for walking. These are set out in table 5.2 below, with values for London given for all indicators, based on LTDS data.

Table 5.2 International Walking Data Standard. Recommended indicators of walking and values for London residents.

	2015/16
Share of people who have made at least one walk stage on an average day	54.6%
Average number of daily walk trips per person	0.67
Average number of daily walk stages per person	2.10
Average daily walk travel time per person (mins)	8.43
Average daily walk distance travelled per person (km)	0.44
Walk mode share based on:	
Stages	51%
Trips	29%
Time	13%
Distance	3%

Source: TfL Planning, Strategic Analysis.

More than half of London residents make at least one walk stage on an average day, and London residents make an average of 2.1 walk stages per person per day (compared to 0.7 walk trips per person per day). On average, London residents spend about 8.5 minutes walking per day and walk a distance of 0.4km.

The mode share for walking varies quite considerably based on the way that it is measured, for example the stage-based walk mode share in London is 51 per cent compared to the main mode-based walk mode share of 29 per cent. This highlights

the importance of consistency in the way walking is measured to ensure data is comparable between cities.

5.7 Attitudes to walking

Summary

TfL's annual Attitudes to Walking survey explores aspects of the walking behaviour of Londoners and looks at factors which facilitate or discourage walking. The survey is conducted once a year in the spring and comprises 1,000 telephone interviews, weighted to be representative of the London population in terms of age, gender, ethnicity, working status and inner/outer London borough.

The survey covers:

- Londoners' current walking patterns, frequency of walking and extent of walking for short journeys.
- Attitudes towards aspects of walking in London.
- Propensity to change walking behaviour.
- Motivations and barriers to walking.
- Use of and perceived usefulness of street signs and maps.

Some key findings

- Londoners have very positive attitudes to walking – for feeling good (getting fit), for the social and environmental benefits and for convenience and reliability.
- There is potential to increase walking further with 1 in 7 people thinking about walking more.
- Street signs and maps and the Walking Tube map (see: https://www.tfl.gov.uk/walking) are well received and encourage increased walking.
- However there has been a significant rise over recent years in the proportions of Londoners agreeing that traffic fumes and heavy traffic make people dislike walking in London.

Londoners' walking behaviour

The survey provides an alternative (but statistically non-comparable to LTDS) view of Londoner's walking behaviour. From the 2016 survey:

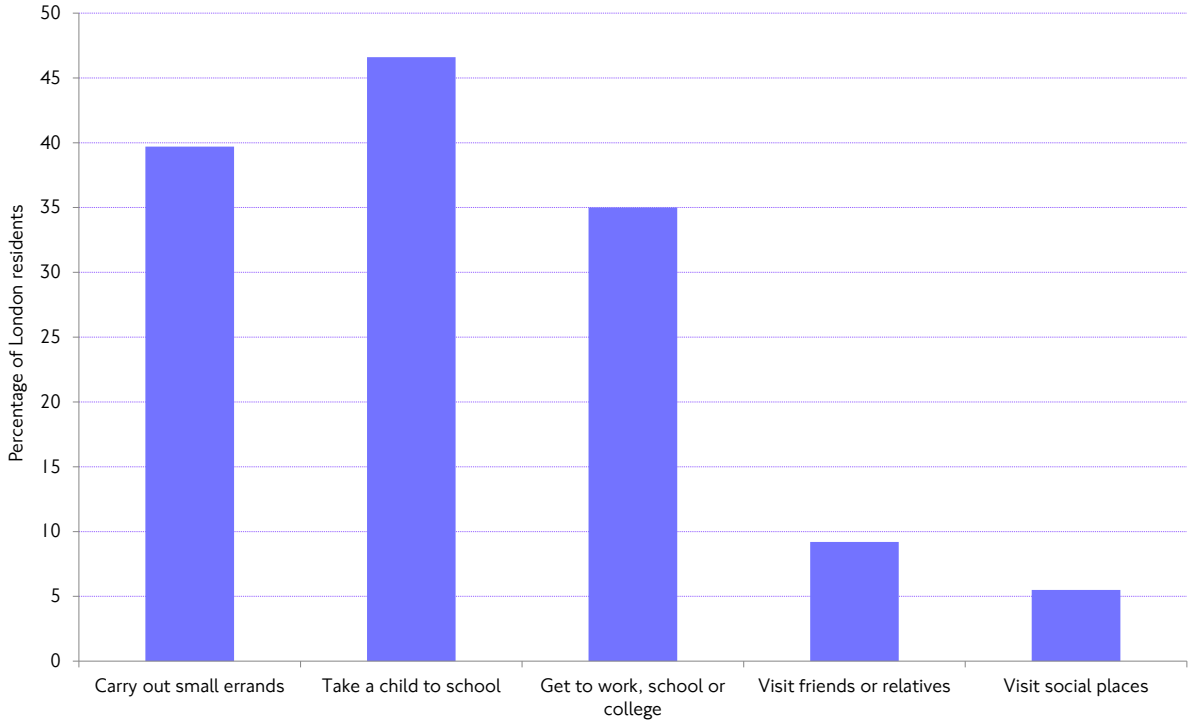
- 91 per cent of Londoners make a walk all the way trip at least once a week.
- More than half (54 per cent) make a walk all the way trip at least five days a week.
- The proportion of people walking as part of a longer journey by another mode at least five days a week was 46 per cent.

Looking at travel behaviour for four regular journeys: commuting, work-related trips, shopping trips and school runs, walking is the mode used regularly by the highest proportion of those making these trips, for example:

- 42 per cent usually walk to work, school, college or university ahead of rail (36 per cent).
- 30 per cent usually walk work-related trips (equal to Tube, 30 per cent).
- 60 per cent usually walk when shopping for groceries.
- 69 per cent of those who ever take a child to school usually walk.

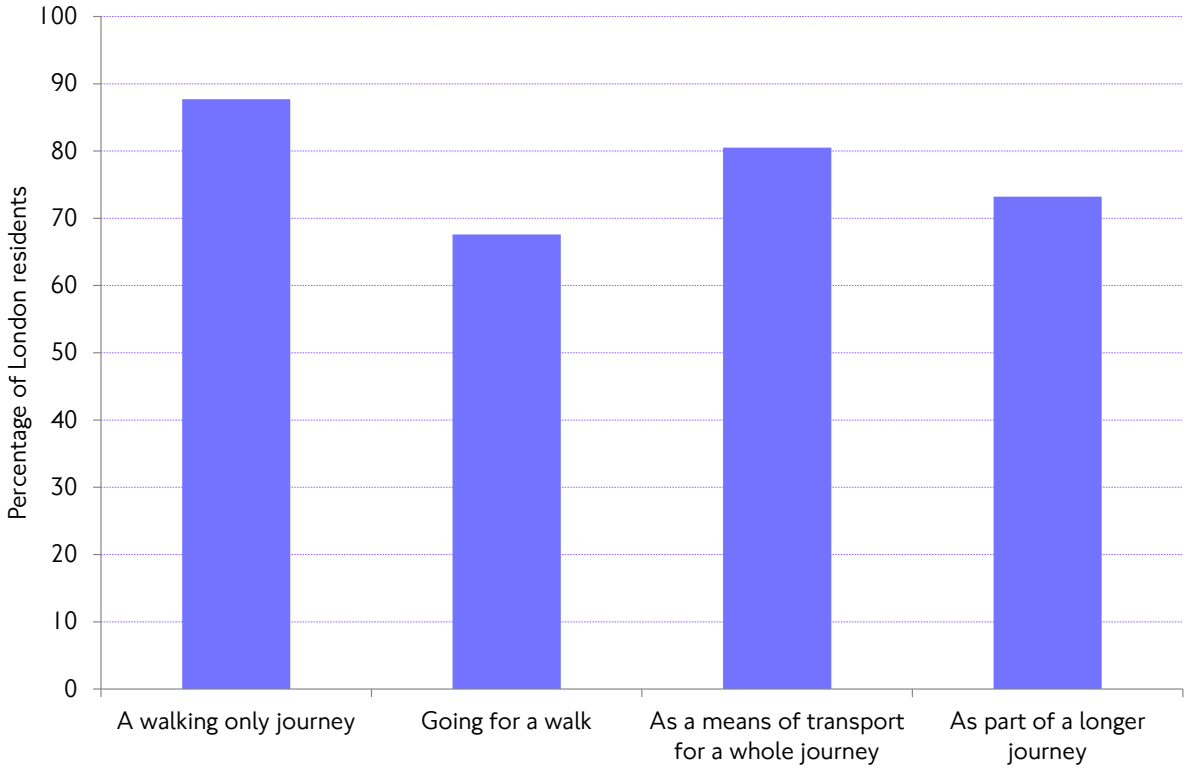
Figures 5.14 and 5.15 below show two features of particular interest. Figure 5.14 shows the percentage of London residents who undertake particular types of journey on foot at least five days per week. It is seen that almost half of all adult respondents make a walk-escort journey on five days a week to take a child to or from school. The proportion of respondents who walk to visit friends or relatives or on other social business on a daily basis is, unsurprisingly, much smaller. However, it is notable that around 40 per cent of respondents walk on a daily basis to carry out small errands – highlighting the importance of such trips to people's overall walking behaviour.

Figure 5.14 Frequency of walking – at least five days per week.



Source: TfL Customer Insight. Attitudes to Walking survey 2016.

Figure 5.15 Frequency of walking – at least once per week.



Source: TfL Customer Insight. Attitudes to Walking survey 2016.

Looking at walking journeys made 'at least once per week' (figure 5.15), almost all Londoners (91 per cent) make walk all the way trips at least once a week where they walk to their destination or walk for leisure. Some eight in ten Londoners walk as part of a longer journey, for example by public transport, at least once a week.

Attitudes to walking

In terms of assessing attitudes to walking, the following are some typical insights gained from the 2016 survey:

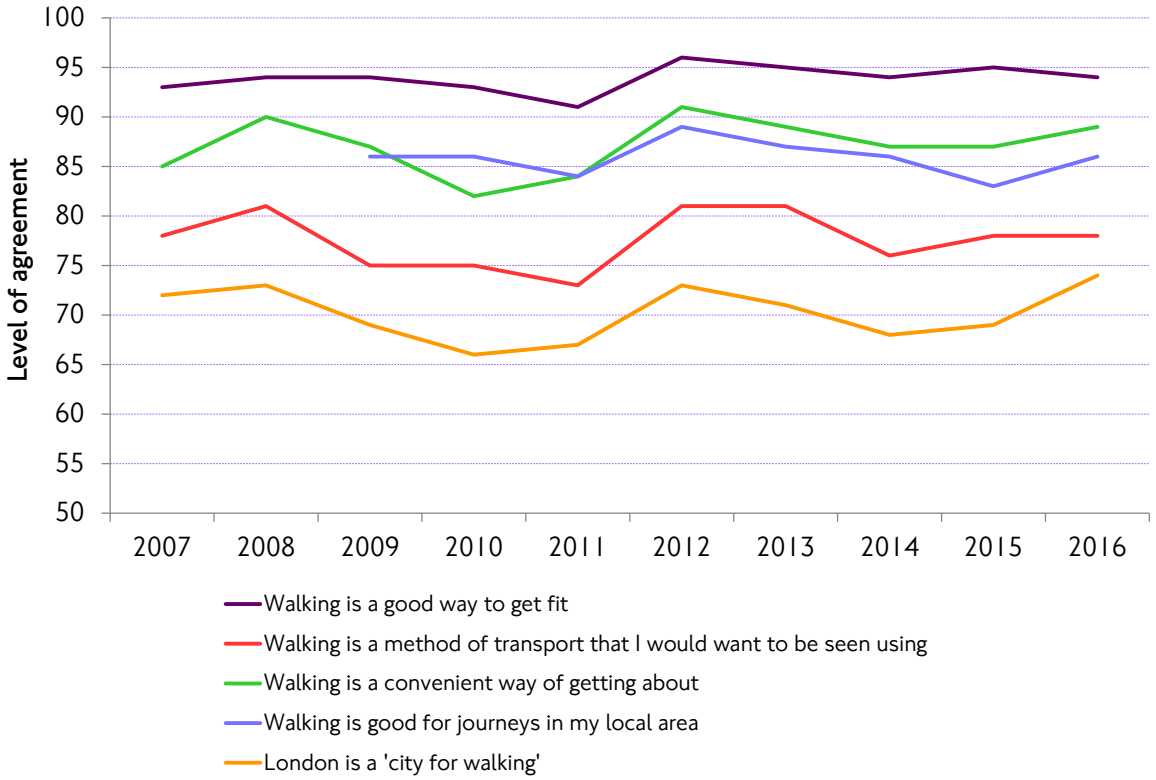
- Walking is a convenient and reliable mode of transport. Almost nine in ten believe that walking is good for journeys in their local area and that it is a convenient and reliable way of getting about. Eight in ten Londoners believe that walking is good for rush hour journeys and seven in ten agree that is it the fastest way to travel for short journeys.
- Londoners feel good about walking. The vast majority believe that it is a good way to get fit, is enjoyable, gives them time to think and is an interesting way to travel. Eight in ten believe that it is a pleasurable experience and three-quarters agree that they feel more relaxed when walking.
- There is a high level of agreement that walking is enjoyable and more pleasurable when pavements are well maintained and streets are well designed. Over recent years, there has been a significant rise in the proportion agreeing that good street design makes walking more enjoyable.

Positive attributes of walking – levels of agreement

Figure 5.16 shows 'level of agreement' scores (out of 100) for some positive attributes of walking. While typically 70 per cent or more of respondents agree with the propositions,

there is little evidence from the figure of change or improvement over the period covered by the survey.

Figure 5.16 Attitudes to walking – some positive attributes. Levels of agreement (out of 100).



Source: TfL Customer Insight. Attitudes to Walking survey 2016.

Negative attributes of walking – levels of agreement

In terms of barriers to walking, it is seen from figure 5.17 that dirty and vandalised streets are a major disincentive – typically four in five people agree with this statement. Some three in five respondents also agree that traffic fumes are a significant deterrent, with typically one in five citing safety concerns. Notable is that typically more than 30 per cent of respondents 'can't be bothered' to walk short trips – this gives some indication of the latent potential to increase levels of walking. Again, there is little evidence of a clear trend with any of these indicators across the years covered by the survey.

Figure 5.17 Attitudes to walking – some perceived barriers. Levels of agreement (out of 100).

Source: TfL Customer Insight. Attitudes to Walking survey 2016.

Likelihood to consider walking and incentives to walk

Those who do not usually walk on short routine journeys were asked how likely they would be to consider walking. In the case of school runs, just more than a third are likely to consider walking. In the case of commutes and grocery shops, three in ten are likely to consider it. There is a greater likelihood for considering getting off public transport one or two stops earlier and walking the remainder of the journey. Six in ten are likely to consider walking some of the way in the case of grocery shops and five in ten in the case of commutes. The only real barriers to walking more are perceived lack of time and the weather, mentioned by 26 per cent and 21 per cent of Londoners respectively.

The most influential factors cited by Londoners that encourage increased walking have remained stable over the time period covered by the survey. Figure 5.18 summarises these factors, based on the 2016 survey, in terms of the proportion of respondents agreeing, in each case, that this factor would encourage them to walk more.

Figure 5.18 Factors that would encourage Londoners to walk more.

Source: TfL Customer Insight. Attitudes to Walking survey 2016.

5.8 Identifying potentially walkable trips in London

Introduction

Policies that seek to increase the level of active travel in London can be informed by the analysis of current travel patterns and consideration of the extent to which trips currently made by non-active modes could potentially be made by walking and cycling, considering limiting factors such as distance and socio-demographic characteristics. Such analysis provides planners and policymakers with broad indications of the scope of the potential 'markets' for these modes, as well as new tools to help them target infrastructure and other interventions where they can be most effective. This section summarises recently updated TfL analysis that seeks to quantify potentially walkable trips in London.

Summary of methodology

TfL recently developed a tool that sought to identify trips currently made by London residents that *could reasonably be walked all the way* but are not walked at present. A trip is defined as a one-way movement from one place to another to achieve a single main purpose. More than one mode of transport may be used during a single trip. The analysis looked at trips currently made by a mechanised mode (car or public transport) that could potentially be walked all the way. The tool is based on TfL's LTDS survey. It seeks to quantify the nature and extent of the potential for walking in London, by identifying trips currently made by other modes, and assessing whether they could potentially be walked, based on a set of criteria about the person and trip.

The starting point for the analysis is all trips that are made by London residents by a mechanised mode (ie not walked or cycled). These trips are then filtered through a set of criteria designed to exclude trips that could not reasonably be walked, according to those criteria. Table 5.3 summarises the criteria – and it is seen that they reflect a sensible set of limitations where, in most cases, it would not be appropriate to consider the trip to be 'reasonably walkable'.

Table 5.3 Basic criteria used to establish walking potential. Trips are not potentially walkable if criterion is met.

Criterion	Description
Encumbrance	The person making the trip is carrying tools or heavy work equipment.
Age of person	Trips of more than 1.5km made by those aged under 12 or over 69; trips of more than 2km made by those aged between 12 and 69.
Current mode of travel	The trip is currently made by van, Dial-a-Ride, plane or boat.
Trip chaining limitations	The trip is part of a wider chain of trips that cannot be walked in its entirety.

Source: TfL Planning, Strategic Analysis.

These criteria are, of course, a broad rule of thumb only. The LTDS survey only provides a certain level of information about the nature of each individual trip and the characteristics of the person making them. There are therefore features that may cause the over- or under-estimation of walking potential, such as the willingness of some people to consider walking distances greater than the 2km cut-off used, or the fact that some trips assessed on the basis of these criteria as being potentially-walkable may have other features that would mean that they might not be walked (for example, occurring late at night). They therefore define a theoretical upper bound for walking potential.

The analysis considers trips by London residents that could be walked all of the way only. This means that any potential for increased walking as part of longer multi-stage trips (for example, to access public transport) is not included. One particular limitation arising from this is that the analysis would be expected to significantly under-estimate the total potential for increased walking in central London, which has a high proportion of non-London resident visitors and a high public transport mode share.

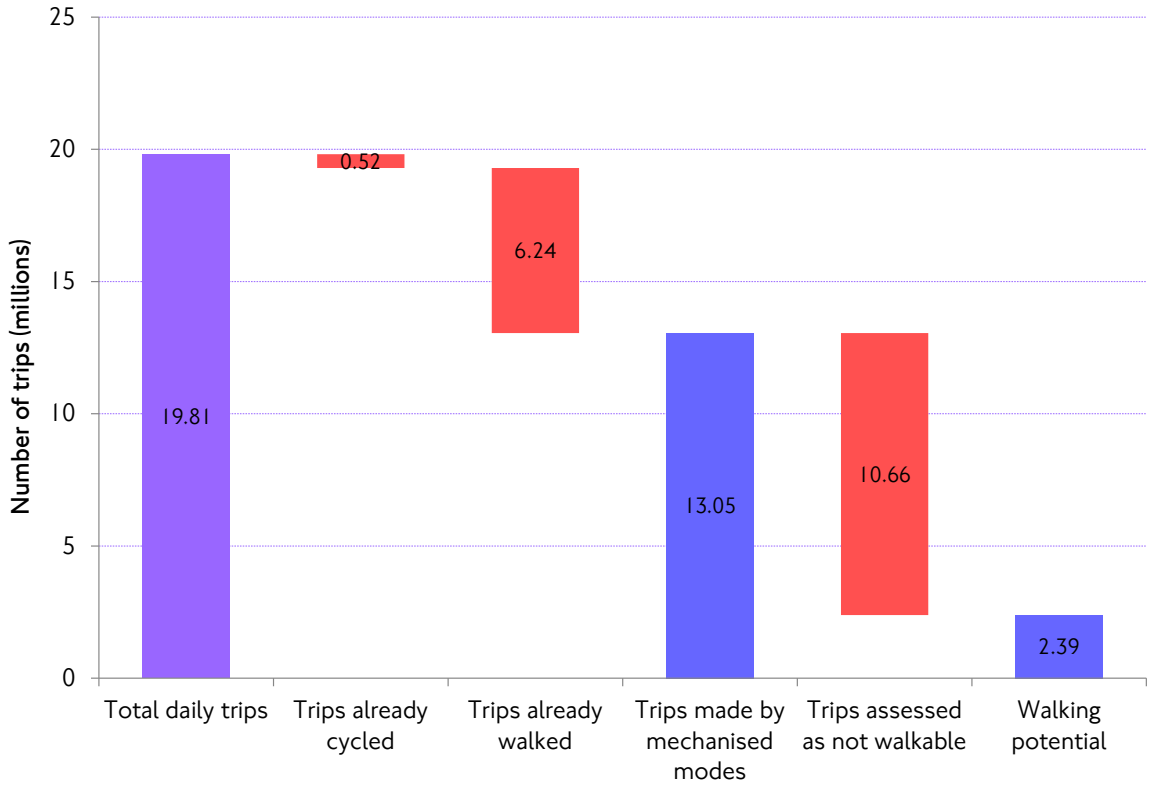
Finally, it is necessary to draw on a wider range of data sources in order to draw conclusions about whether or not these trips could or would transfer to walking, and under what circumstances such a change might happen.

Total number of potentially walkable trips

The analysis identified 2.39 million trips per day that are currently made by London residents by mechanised modes as being potentially walkable. On the basis that the 'total potential' is the sum of the currently walked and potentially walkable trips, it can be estimated that around 70 per cent of the total number of potentially walkable trips are already being walked.

Figure 5.19 shows the basic steps involved in the derivation of this estimate. Of the 19.81 million trips made by London residents on an average day, some 6.76 million are already walked or cycled. These trips are 'out of scope' for the analysis – with cycling trips included here because they already represent 'active travel' (although, in reality, there is scope for mode-switching in both directions between cycling and walking). This leaves 13.05 million trips made by mechanised modes, some 10.66 million of which are assessed, on the basis of the criteria described in table 5.3, as being not potentially walkable.

Figure 5.19 Process to identify potentially walkable trips. LTDS 2012/13-2014/15.

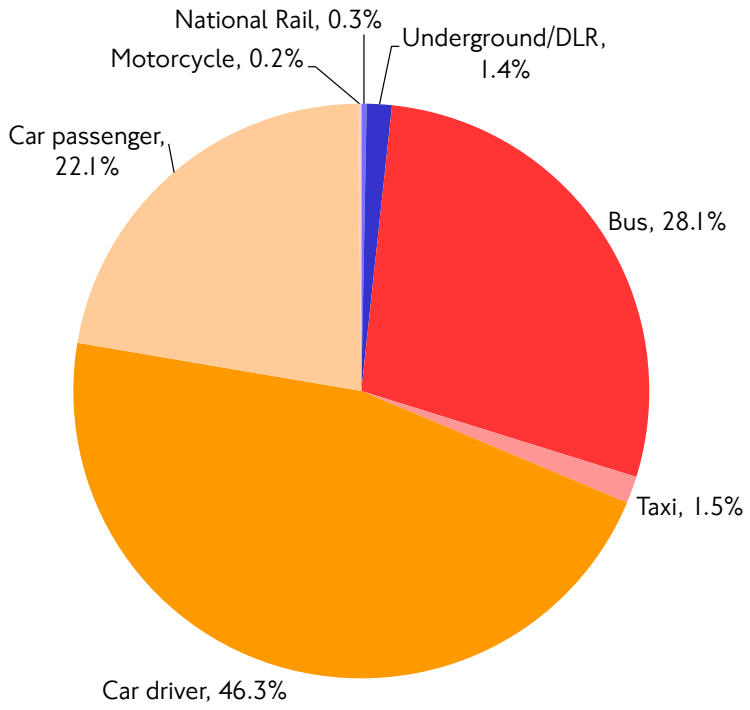


Source: TfL Planning, Strategic Analysis.

Some characteristics of potentially walkable trips – mode currently used

Figure 5.20 shows the current mode share for trips that are assessed as being potentially walkable. A little more than two-thirds of potentially walkable trips are currently made by car – this equates to 24 per cent of all car trips currently made by London residents. This is reflective of the high numbers of short car trips made by London residents, particularly in outer London. On a modal basis, trips currently made by Underground and rail were by far the least likely to be potentially walkable, as would be expected reflecting the longer average distance travelled by these modes. It should however be noted that public transport trips typically already include one or more short walk stages as part of the longer trip.

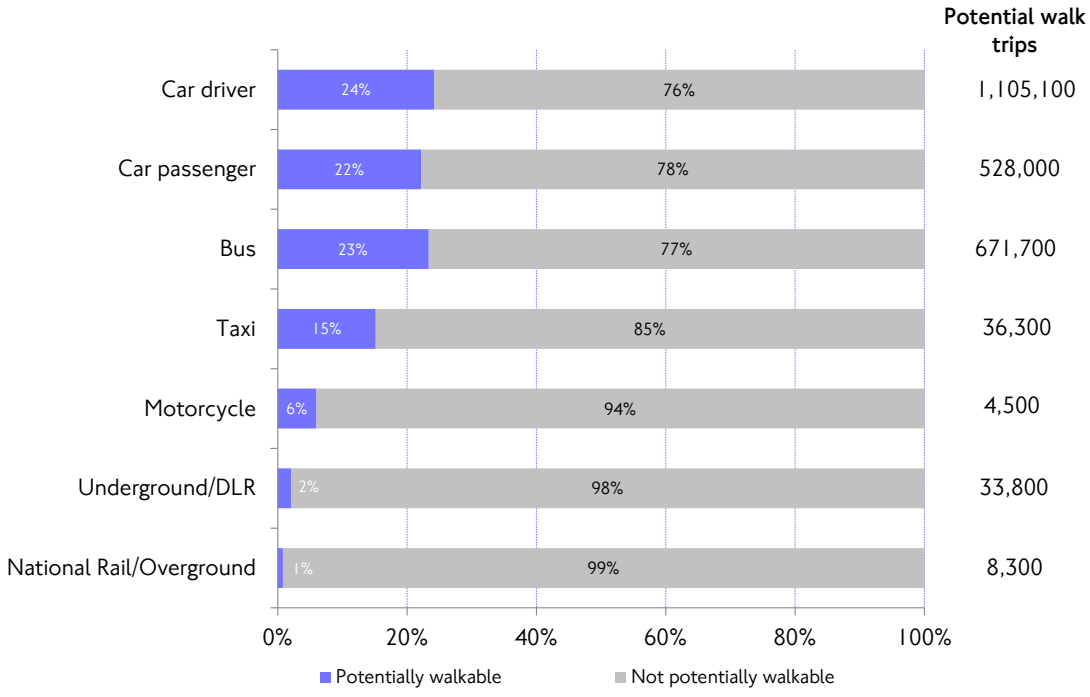
Figure 5.20 Current mode share for potentially walkable trips. LTDS 2012/13-2014/15.



Source: TfL Planning, Strategic Analysis.

Figure 5.21 quantifies these trips according to the main mode currently used. Especially noteworthy is that roughly one-quarter of all car trips currently made by Londoners are potentially walkable – a total of 1.63 million trips on an average day.

Figure 5.21 Trips by each mode identified as potentially walkable or otherwise. LTDS, 2012/13-2014/15.



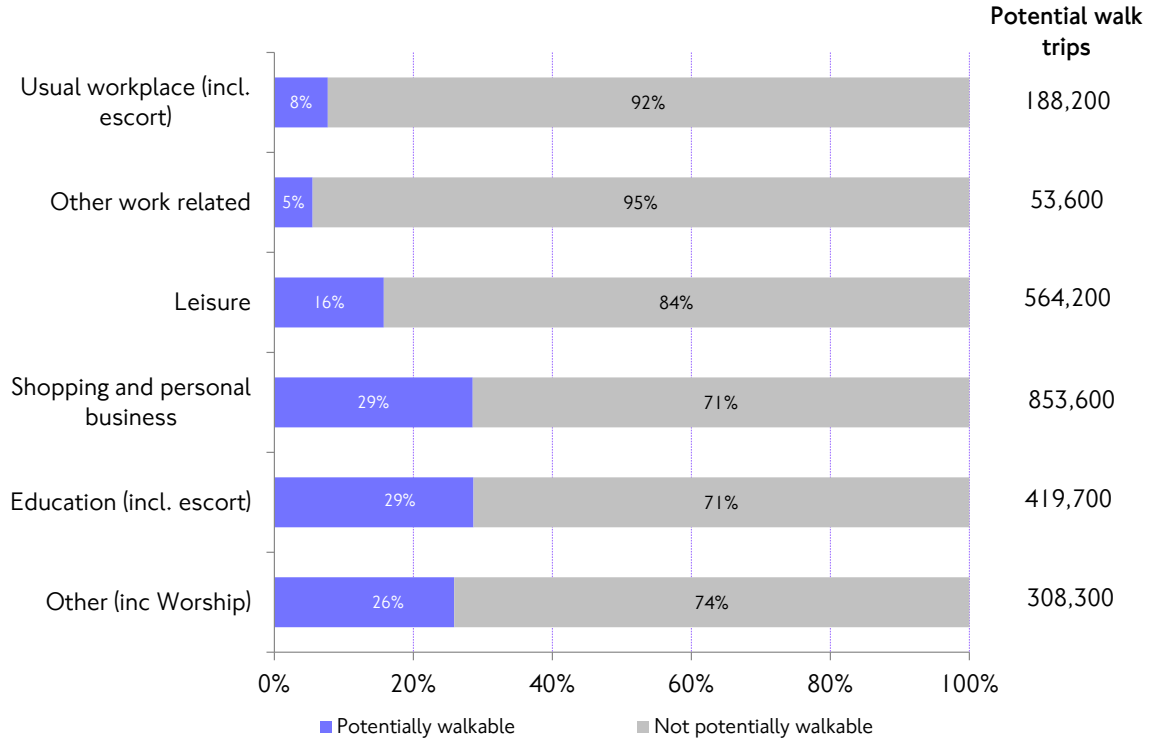
Source: TfL Planning, Strategic Analysis.

Journey purpose

In terms of journey purpose, figure 5.22 shows that trips for shopping and personal business account for the highest share of potentially walkable trips, at 37 per cent of all potentially walkable trips. This is similar to the profile of existing walk trips, where just fewer than 4 in 10 trips are made for shopping or personal business purposes. Just less than 30 per cent of all shopping and personal business trips that are not currently walked were identified as being potentially walkable.

In contrast, the lowest numbers of potentially walkable trips were for travel to a usual workplace, or travel for other work-related reasons. Combined, these two categories account for only eight per cent of potentially walkable trips, with more than 90 per cent of all trips of this nature assessed for this purpose as 'not potentially walkable'.

Figure 5.22 Trips by each purpose identified as potentially walkable or otherwise. LTDS 2012/13-2014/15.



Source: TfL Planning, Strategic Analysis.

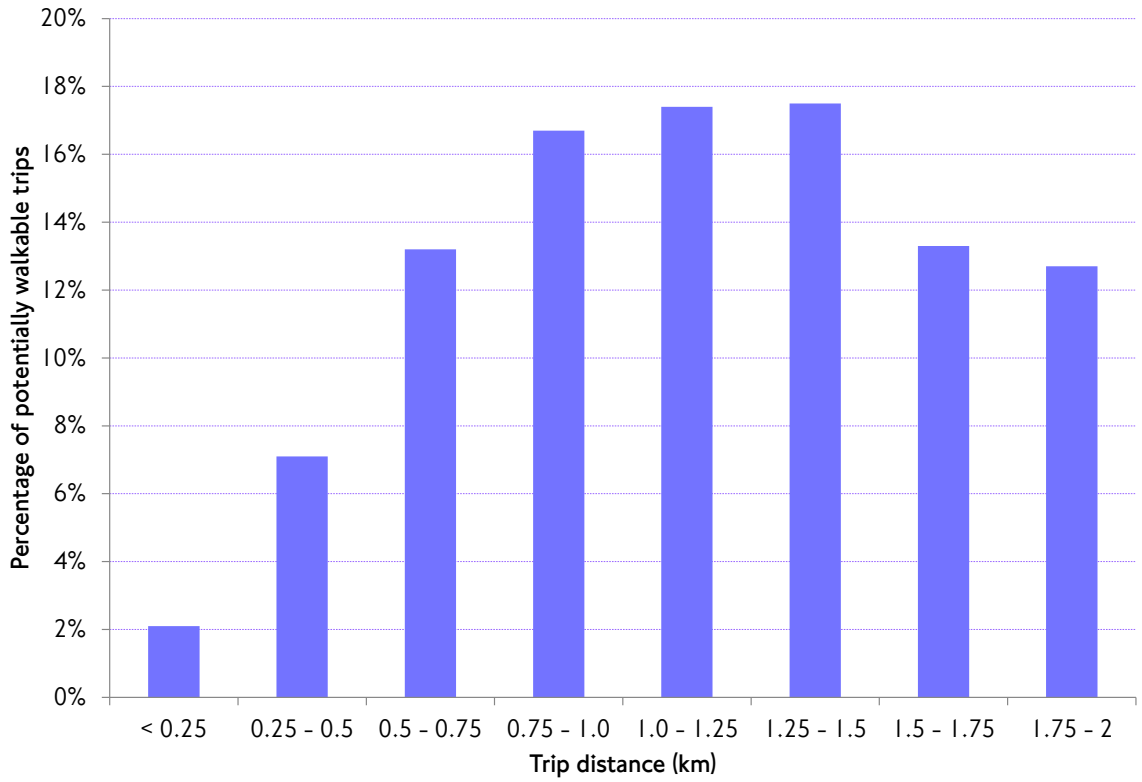
Looking at the journey purpose of walkable trips by mode, a notable proportion (34 per cent) of car driver trips that could be walked were being made to drop off or collect someone, be it for work, education or other reasons. Bus trips that could be walked were more likely to be for shopping (39 per cent, compared to overall average of 28 per cent) or for education purposes (12 per cent compared to 7 per cent).

Current and potential walk trips by distance

As shown in figure 5.23, 39 per cent of the assessed total of potentially walkable trips are less than 1km in length (based on crow-fly distances) and would usually take between 10 and 15 minutes to walk.

Almost 90 per cent of potentially walkable trips that are less than 1km (0.95 out of the 1.06 million) are made by car, either as a driver or passenger. The potentially walkable trips currently made by public transport or by taxi tend to be longer, and are much more likely to be between 1km and 2km in length.

Figure 5.23 Potentially walkable trips by distance (crow-fly). LTDS 2012/13-2014/15.



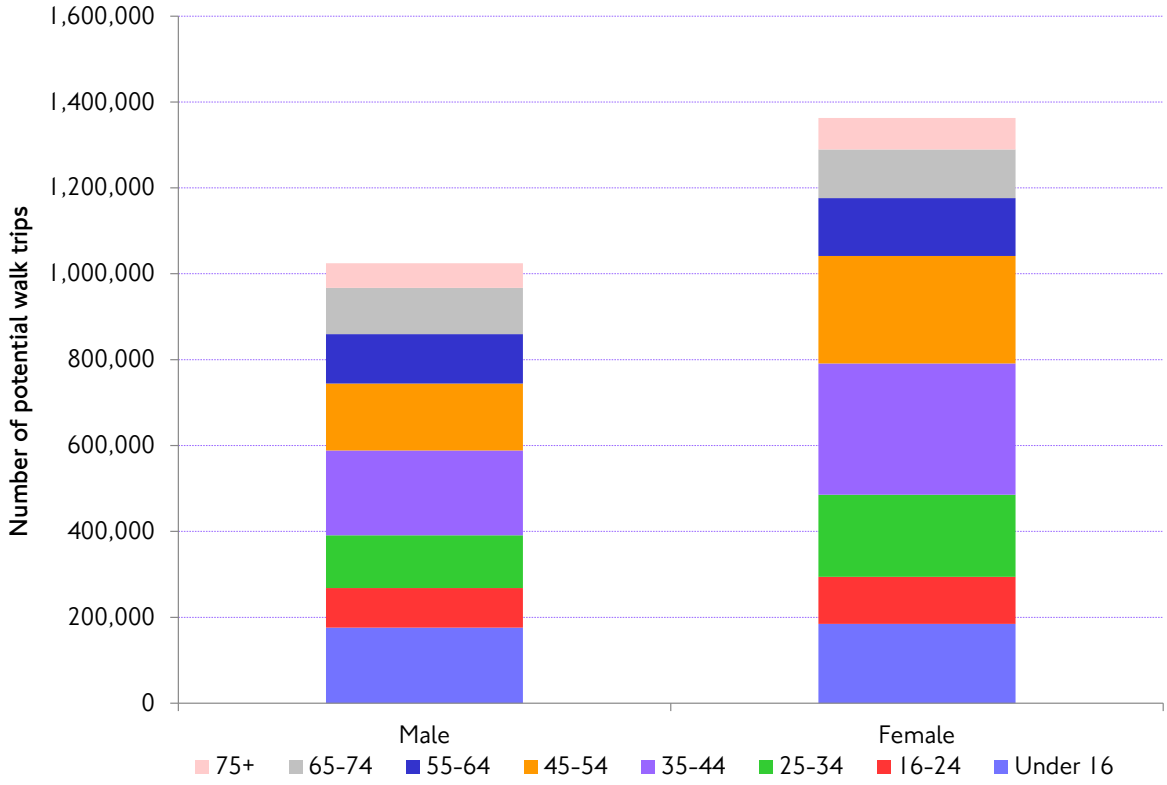
Source: TfL Planning, Strategic Analysis.

Age and gender

Reflecting current travel patterns, the potential for more walking is greater among females than males. In total, 58 per cent (1.4 million) of the total number of potentially walkable trips are made by women, compared to 42 per cent (1 million) for men.

Across both genders, the level of potential across the different age groups is relatively even, with the greatest potential concentrated on those aged between 35 and 54. It should be noted that, in this analysis, age is not considered to be a barrier to walking (figure 5.24).

Figure 5.24 Potential walk trips by age and gender. LTDS, 2012/13-2014/15.



Source: TfL Planning, Strategic Analysis.

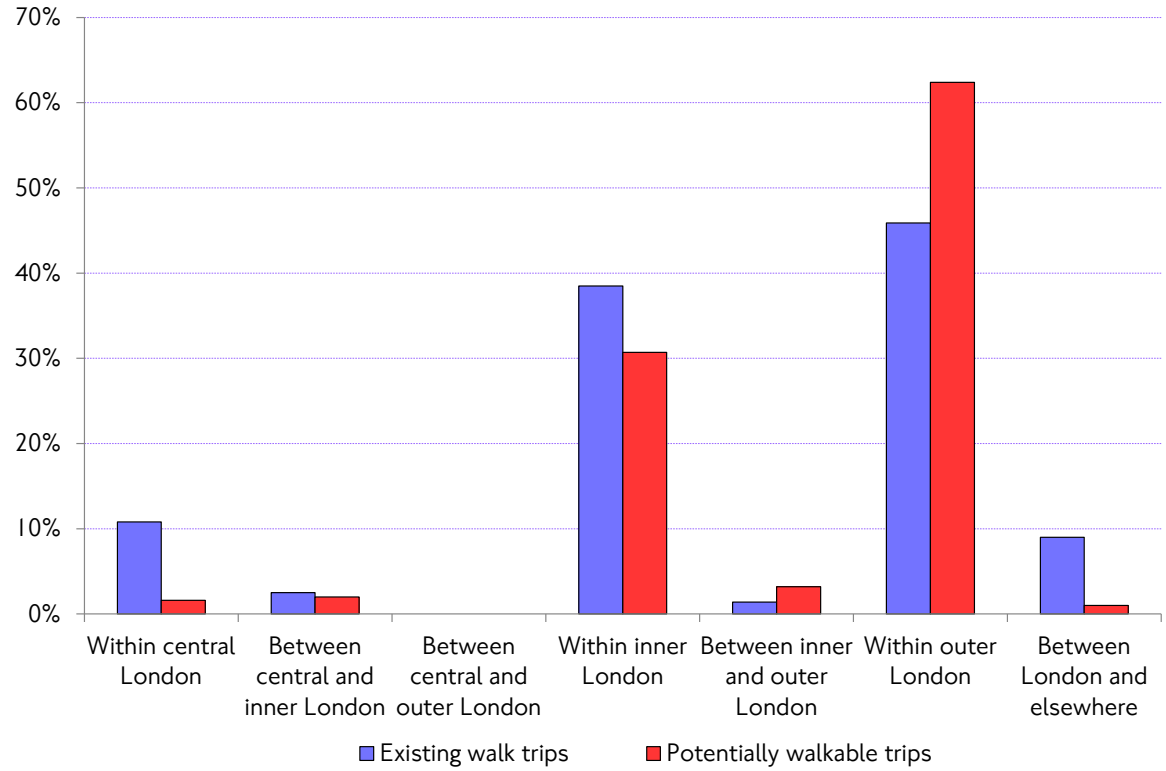
Considering this aspect by mode, potentially walkable trips made by men are more likely to be car driver trips, with women more likely to be travelling either by bus or as a car passenger. The split by journey purpose is fairly even, with women slightly more likely to be making education escort and shopping trips, and men slightly more likely to be making work or entertainment trips.

Spatial aspects of potentially walkable trips

Much of the potential for walking is concentrated within outer London. Nearly two-thirds (62 per cent) of all potentially walkable trips are made entirely within outer London, with a further three per cent made between inner and outer London. There is also a notable proportion (30 per cent) of trips made entirely within inner London. In contrast, there is very little walking potential identified in central London. This reflects the profile of current walk trips and the very high levels of walking in central London. Trips in central London (specifically the Central Activities Zone) account for more than 10 per cent of all walk trips (with trips in outer London accounting for a far higher share, at 46 per cent). The following figure compares the location profile of current walk trips and potentially walkable trips.

A key point to note is that this analysis is limited to travel by London residents only and trips that can be walked all the way. Central London attracts a large number of non-Londoners every day (eg daily commuters from outside London) and also has a high public transport mode share; it is likely that there are many more trips made by bus, rail and Tube where part, but not all, of the trip could be walked, but is not at present. Therefore, the real potential for walking in central London may be considerably higher than is represented here.

Figure 5.25 Origin and destination of current and potential walk trips, London residents. LTDS, 2012/13-2014/15.

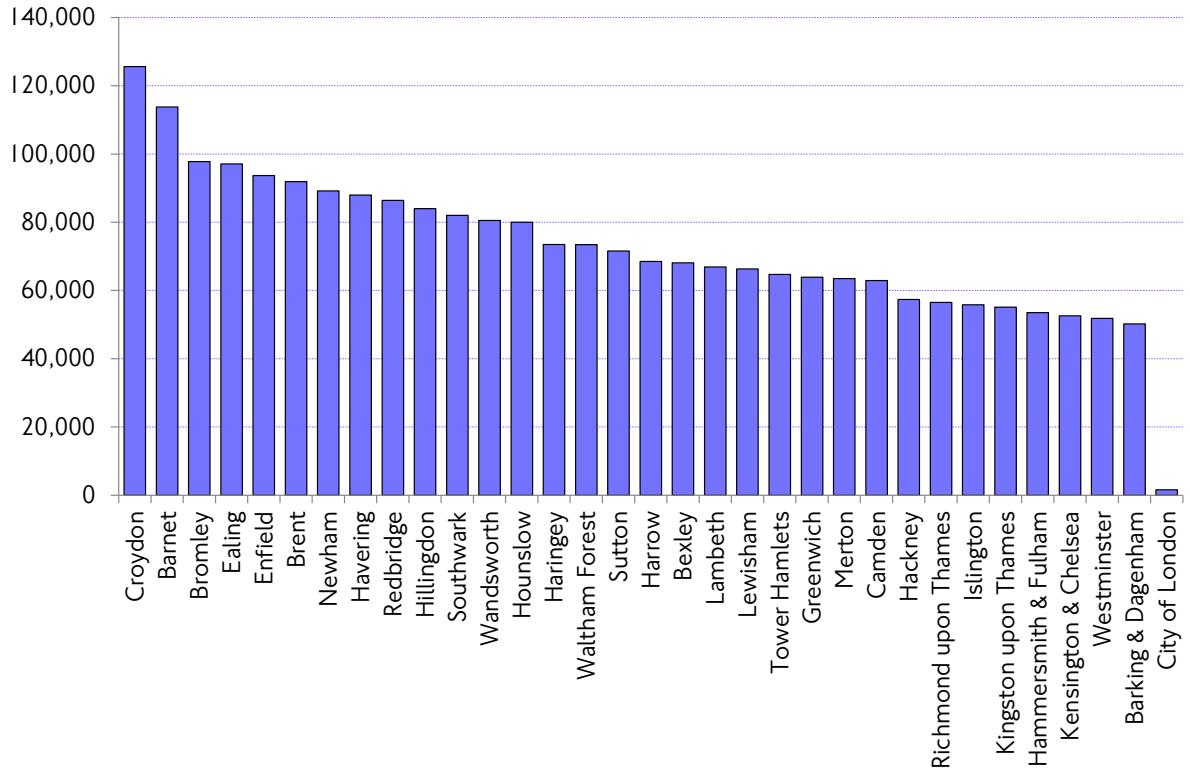


Source: TfL Planning, Strategic Analysis.

Walking potential by borough of residence

Figure 5.26 shows that the mode share for walking is significantly higher in inner London than outer London. This reflects shorter trip distances and lower levels of car ownership. The number of potentially walkable trips is highest in Barnet and Croydon, where the number of daily trips is more than 120,000. While the lower numbers of trips generally occur in inner London boroughs, such as Islington, Hammersmith and Fulham, and Westminster, there are a number of boroughs in outer London (eg Kingston upon Thames and Barking and Dagenham) which also have a much lower level of walking potential, where trip lengths are on average higher, thereby excluding a higher number of mechanised mode trips from the potential to be walkable.

Figure 5.26 Borough of residence of current and potential walk trips, London residents. LTDS, 2012/13-2014/15.

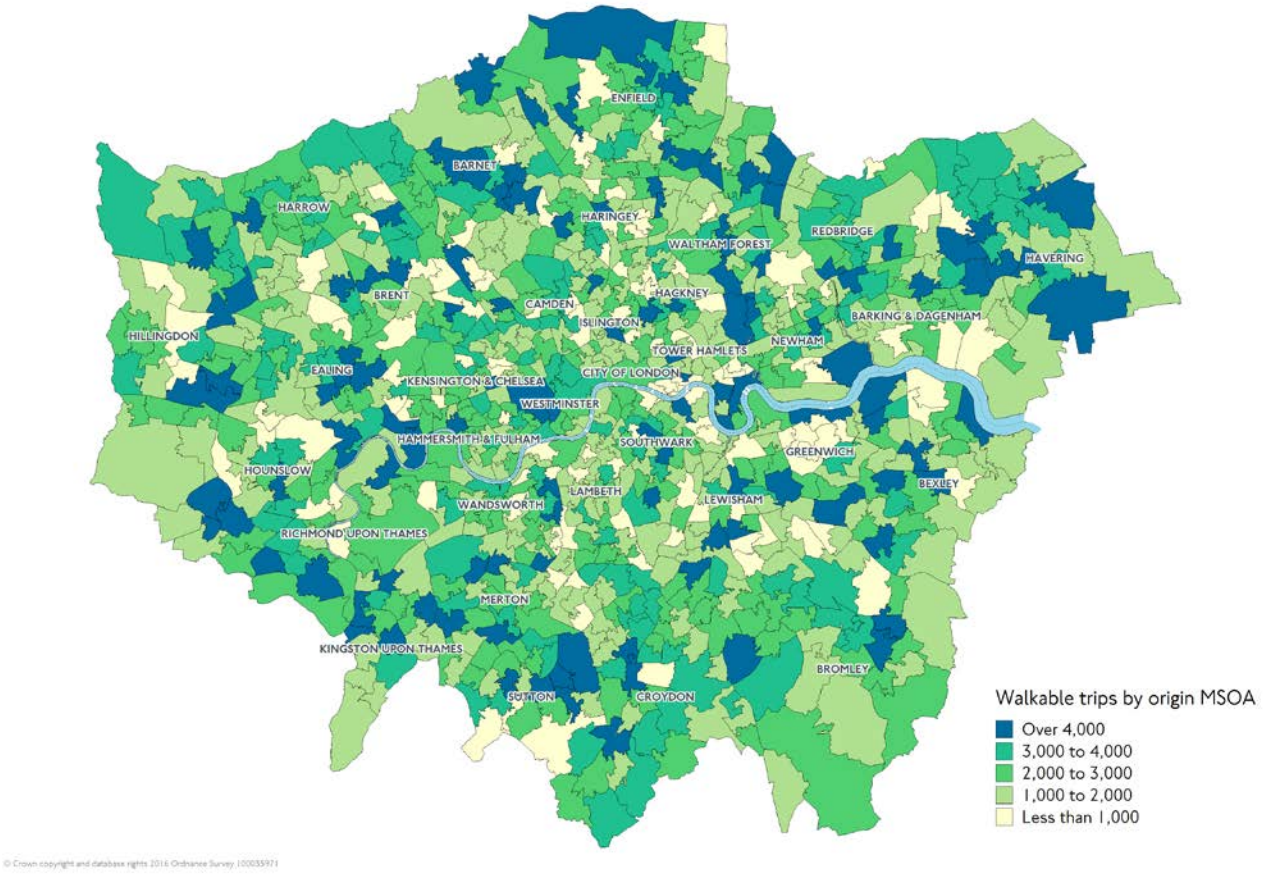


Source: TfL Planning, Strategic Analysis.

Areas with high density walking potential

Figure 5.27 shows that there are very few areas identified across London with a particularly high density of walking potential, other than in small pockets of outer London. This reflects the highly dispersed nature of potentially walkable trips across London as a whole. The relatively low – on the basis of this figure – potential for walking in central London is in part a function of the restriction of this analysis to London residents only.

Figure 5.27 Geographical distribution of potentially walkable trips – by trip origin. LTDS, 2012/13-2014/15.



Source: TfL Planning, Strategic Analysis.

5.9 Cycling in London

Scope

This section looks at recent strategic trends in levels of cycling in London, including average daily cycle stages and trips, the number of cyclists crossing a set of three strategic traffic counting cordons and the contribution of the Santander Cycles hire scheme.

Overall levels of cycling in London

In 2015, there were 670 thousand cycle journey stages in London on an average day, which is a 3.5 per cent increase on 2014. This follows a 10.3 per cent increase in the previous year, with an overall 61 per cent increase in cycle stages since 2005 (table 5.4) and a 133 per cent increase since 2000. Cycle stages are the preferred measure of cycling activity, and this measure has grown strongly and relatively consistently over the last decade or so. The (broadly similar) trend for cycle-all-the-way trips only is also shown on the table.

It is notable that the latter half of 2015 coincided with network disruption relating to construction of new cycling infrastructure, which may have had an impact on trips at this time.

Table 5.4 Daily average cycle stages and trips in London.

	Cycle stages		Cycle trips
	Millions	Year-on-year change %	Millions
2005	0.41	9	0.39
2006	0.47	12	0.42
2007	0.47	0	0.42
2008	0.49	5	0.44
2009	0.51	5	0.47
2010	0.54	6	0.49
2011	0.57	5	0.49
2012	0.58	2	0.50
2013	0.58	1	0.50
2014	0.65	10	0.56
2015	0.67	4	0.60

Source: TfL Planning, Strategic Analysis.

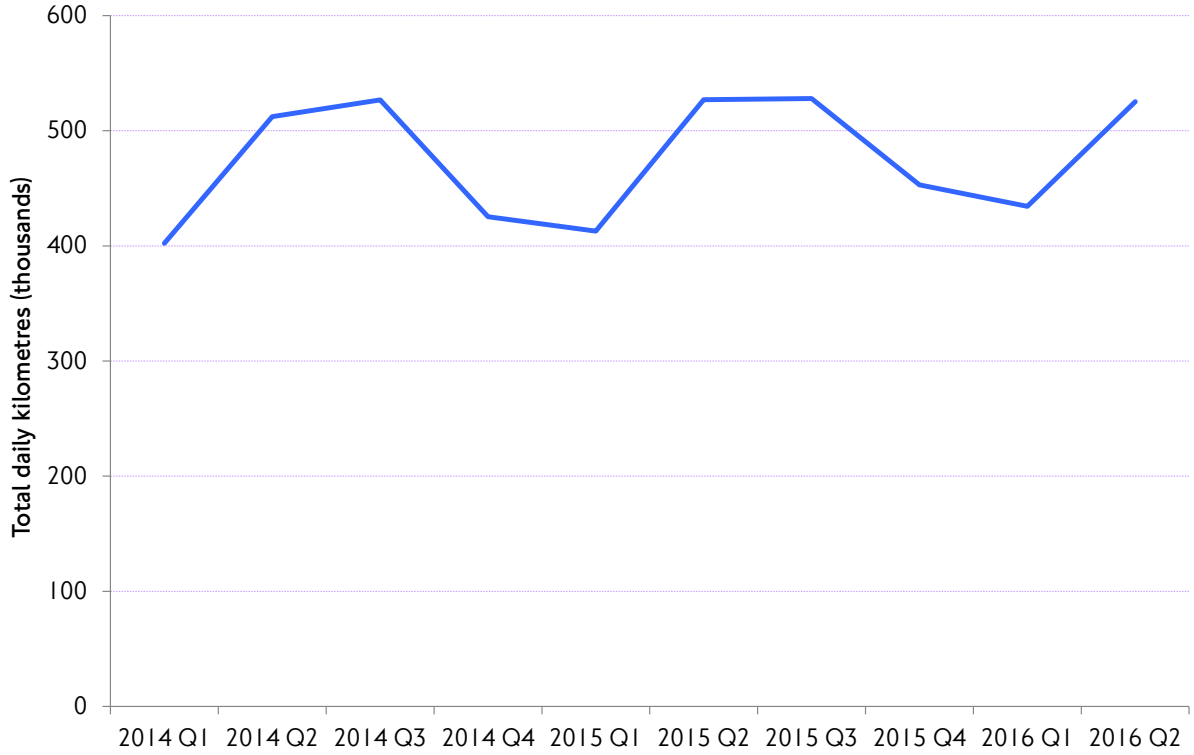
Note: A cycle trip is defined as a one-way movement to achieve a specific purpose that is conducted entirely by bike. A cycle journey stage includes these trips, but also includes shorter cycle legs undertaken as part of a longer trip using another mode – for example, cycling to a station to catch a train. Cycle journey stages therefore gives the best indication of total cycling activity.

This total applies to the whole of Greater London. It is the case that levels of cycling vary considerably across London, and there has in particular been strong and consistent growth in cycling in and around central London. This variability is explored in the next section below.

Cycling in central London

Representative measurement of the total number of kilometres cycled each day in central London, as defined by the congestion charging zone (CCZ), has been in place since quarter 1 of 2014 and is presented as a percentage change from the 2014 annual baseline. The most recent figures show that a daily average of 485,159 kilometres was cycled in the congestion charging zone in the year to the end of quarter 2 of 2016 (figure 5.28). This is a 4.0 percent increase in cycling within central London when compared to 2014 baseline.

Figure 5.28 Total daily cycle kilometres in central London.



Source: TfL Surface Transport, Outcomes, Insight and Analysis.

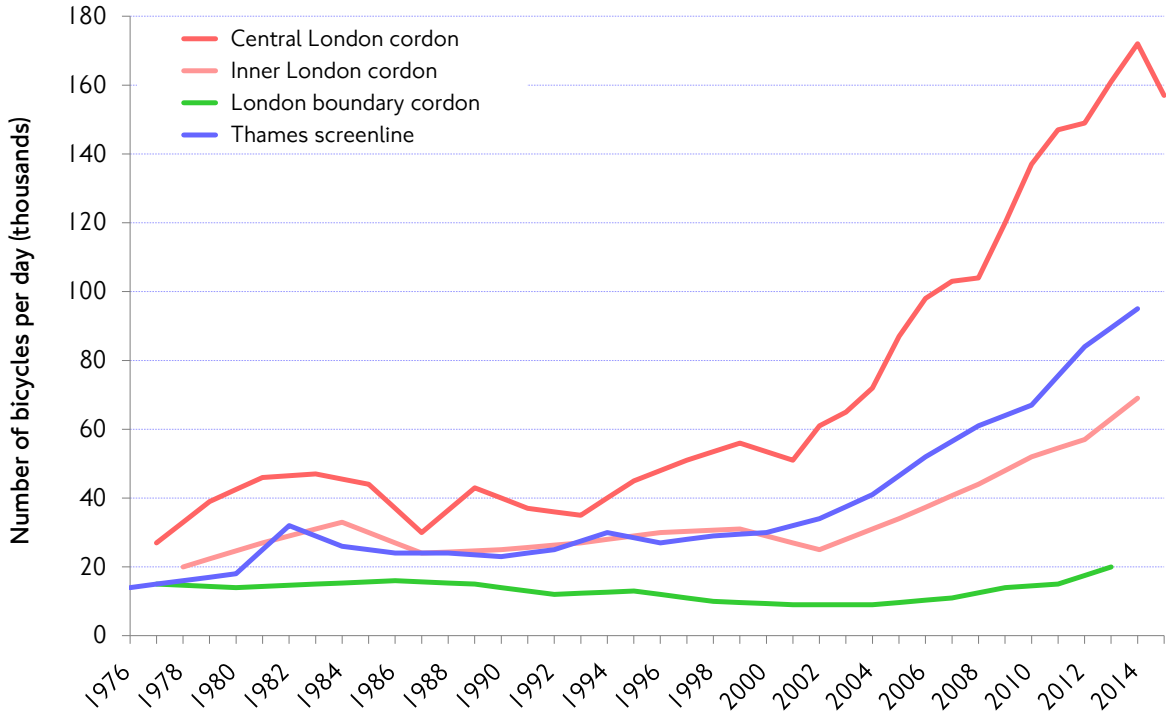
Cycling flows across strategic counting cordons and screenlines

Figure 5.29 shows the number of cycles crossing the three strategic counting cordons in London (central, inner and London boundary) and the Thames screenline between 1976 and 2015. These data are the total number of cycles crossing the cordon in a full weekday (24-hours). Surveys are taken at the same time of year, to ensure there is no seasonal bias.

The long-term trends are clear, with cycling levels at all cordons remaining broadly constant until the year 2000, after which they started to increase. Rates of growth are highest at the central cordon and on the Thames screenline, with cycle flows at the Thames screenline growing by 217 per cent between 2000 and 2014. Flows across the central cordon, surrounding central London (not the same as the Congestion Charging zone), grew by 221 per cent between 2000 and 2014, although there was a fall of 8.7 per cent in 2015. This may reflect high levels of construction work on the road network in central London in the latter part of 2015.

Growth has also occurred at the inner and boundary cordons, although the growth started later and has been at a lower rate than in central London. Cycle flows at the inner cordon increased by 138 per cent between 2000 and 2014. Flows at the boundary cordon also increased by 114 per cent between 2000 and 2013. However, reflecting these spatial differences, cycle flows across the central cordon are almost twice as high as the inner and boundary cordon flows combined.

Figure 5.29 Long-term trends in cycling across strategic cordons and screenlines in London, 24-hour weekdays, both directions.



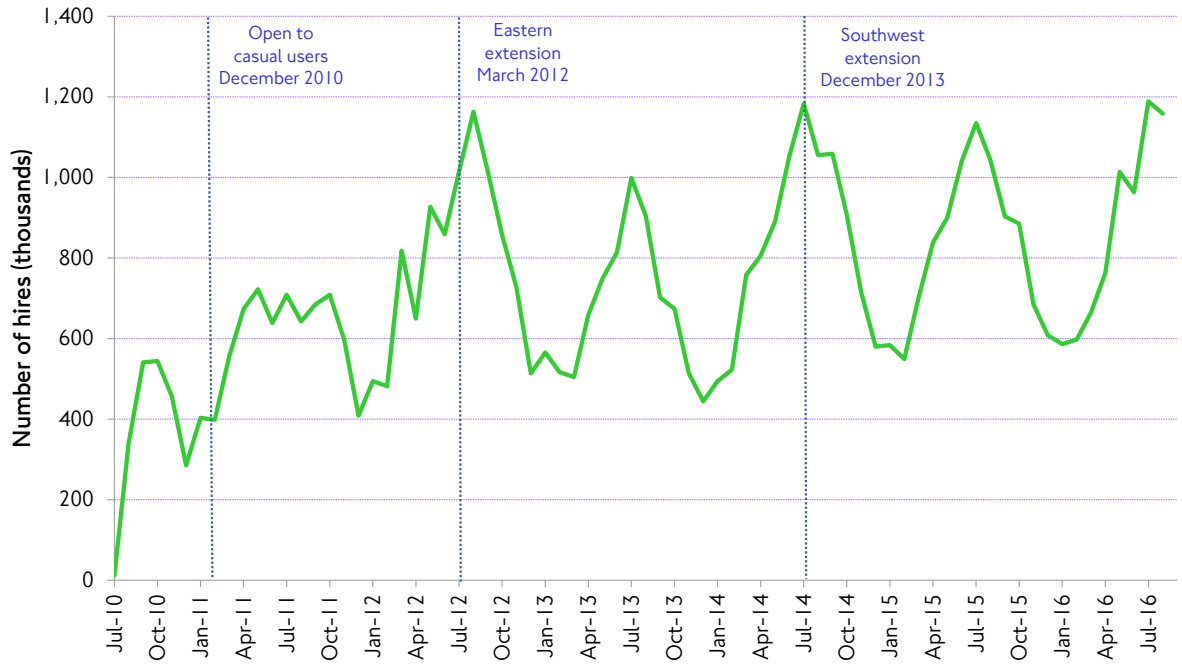
Source: TfL Surface Transport, Outcomes, Insight and Analysis.

Santander Cycles hire scheme

The Barclays Cycle Hire scheme began in July 2010 in central London. Since then there have been progressive enhancements, including the opening up of the scheme to casual members in December 2010, an expansion to the east in 2012 and an expansion to the south west in late 2013. From April 2015, the name of the scheme changed to Santander Cycles, to reflect a change of sponsor, although the operational aspects of the scheme remained substantially the same.

In the financial year to March 2016, there were a total of 9.9 million cycle hires, down from 10.1 million to March 2015, a decrease of two per cent. It likely, as is suggested by other indicators, that levels of cycling during the latter part of 2015 were temporarily affected by high levels of construction activity on the road network, and that the full impact of the new cycling infrastructure will not have been reflected. Despite this small decrease, there are signs of a return to growth in 2016, with July seeing the highest number of monthly hires since the scheme began (Figure 5.30).

Figure 5.30 Santander Cycles hire. Trend in monthly cycle hires by type of hire.



Source: TfL Surface Transport, Outcomes, Insight and Analysis.

Developing strategic cycling monitoring in London

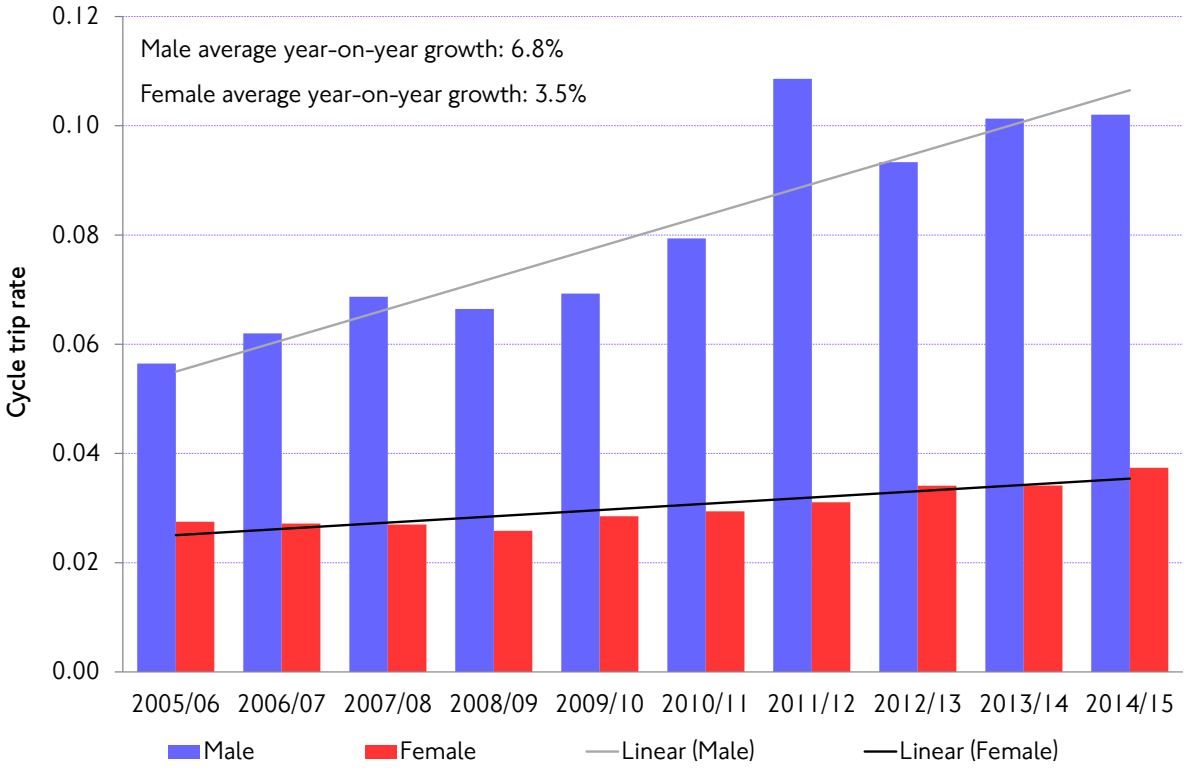
As described in Travel in London report 7, section 3.16 (see: http://content.tfl.gov.uk/travel-in-london-report-7.pdf), TfL has put in place new strategic cycle monitoring, designed to improve our understanding of cycling even further, and better track progress against aspirations to both improve the environment for cycling in London and to increase cycling levels. Many of the 'baseline surveys' have now been completed along key routes, prior to delivery of the infrastructure. As the infrastructure and behaviour change programmes are delivered, usage of the various interventions, both infrastructural and otherwise, will be published separately as the data become available over the coming years.

5.10 Insight: Cycling in London – who cycles?

Cycling is growing strongly and relatively consistently year on year. However, there are clear socio-demographic differences in the uptake of cycling and the growth rate. This demonstrates areas of success but also highlights areas where additional focus is needed in future to maintain momentum and tap harder-to-reach parts of the target market.

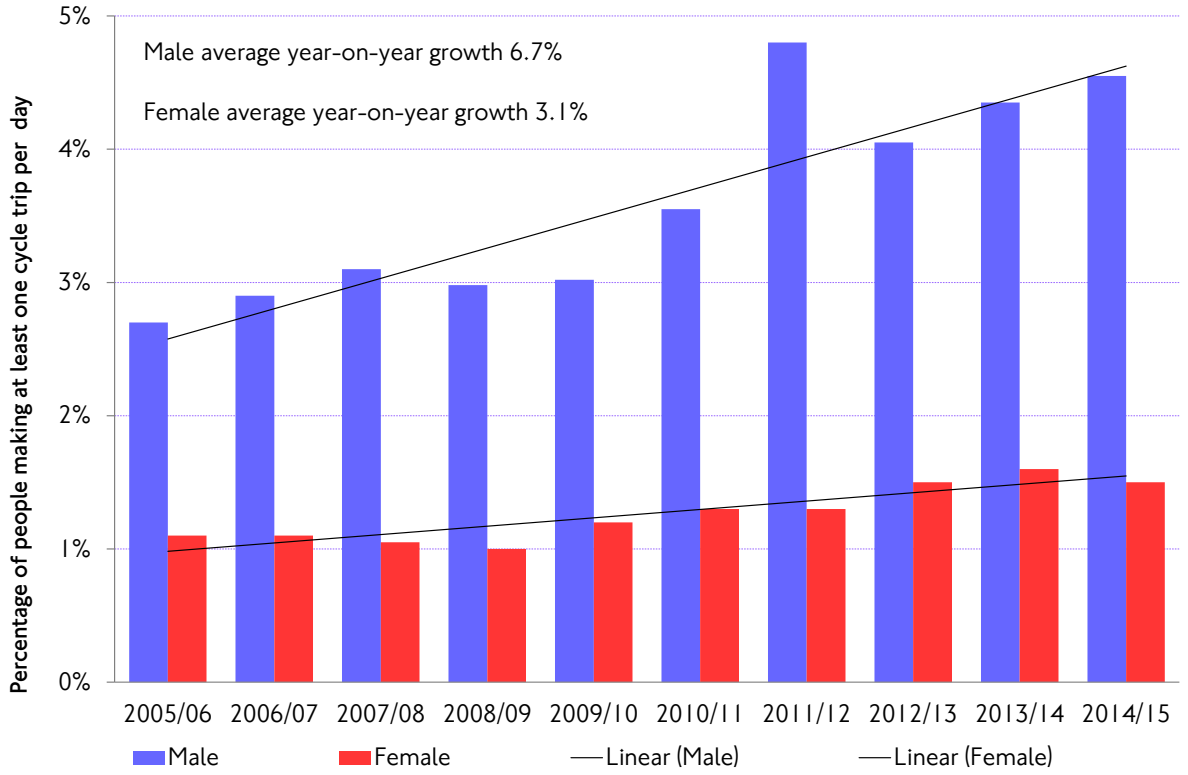
The data shows that men cycle more frequently than women, and cycling among men is growing at a faster rate than among women (figures 5.31 and 5.32). This suggests that additional effort to encourage women to cycle would be particularly effective. A further insight here is that the increase in the number of people who cycle at least once per day is similar to the increase in cycle trip rates.

Figure 5.31 Cycle trip rates by gender. London residents.



Source: TfL Planning Strategic Analysis. LTDS Survey.

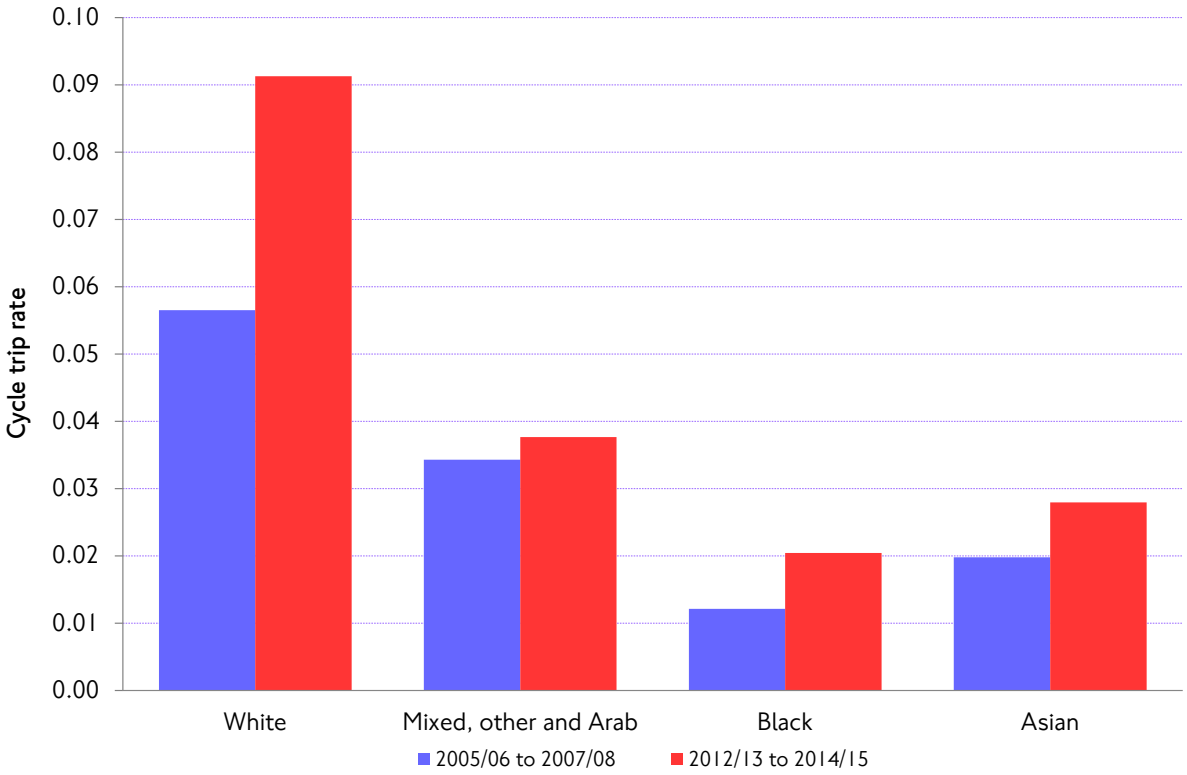
Figure 5.32 Percentage of people making at least one cycle trip per day by gender. London residents.



Source: TfL Planning Strategic Analysis. LTDS Survey.

In terms of cycling participation among ethnic groups, figure 5.33 shows that cycling is most popular among white Londoners and least popular among black Londoners – with almost a five-fold difference in frequency of cycling between the two groups. Interestingly however, the highest rate of growth over the period was shown by black people – their average cycle trip rate increasing by 68 per cent over 2005/06 to 2014/15 compared to 62 per cent for white Londoners. Asian and mixed ethnic groups, although showing higher average trip rates than black Londoners, grew at a notably slower rate – by 41 and 10 per cent respectively. This suggests that there is great scope to encourage non-white ethnic groups to cycle more, if their specific barriers to cycling could be addressed.

Figure 5.33 Change in average cycle trip rate by main ethnic group. London residents.



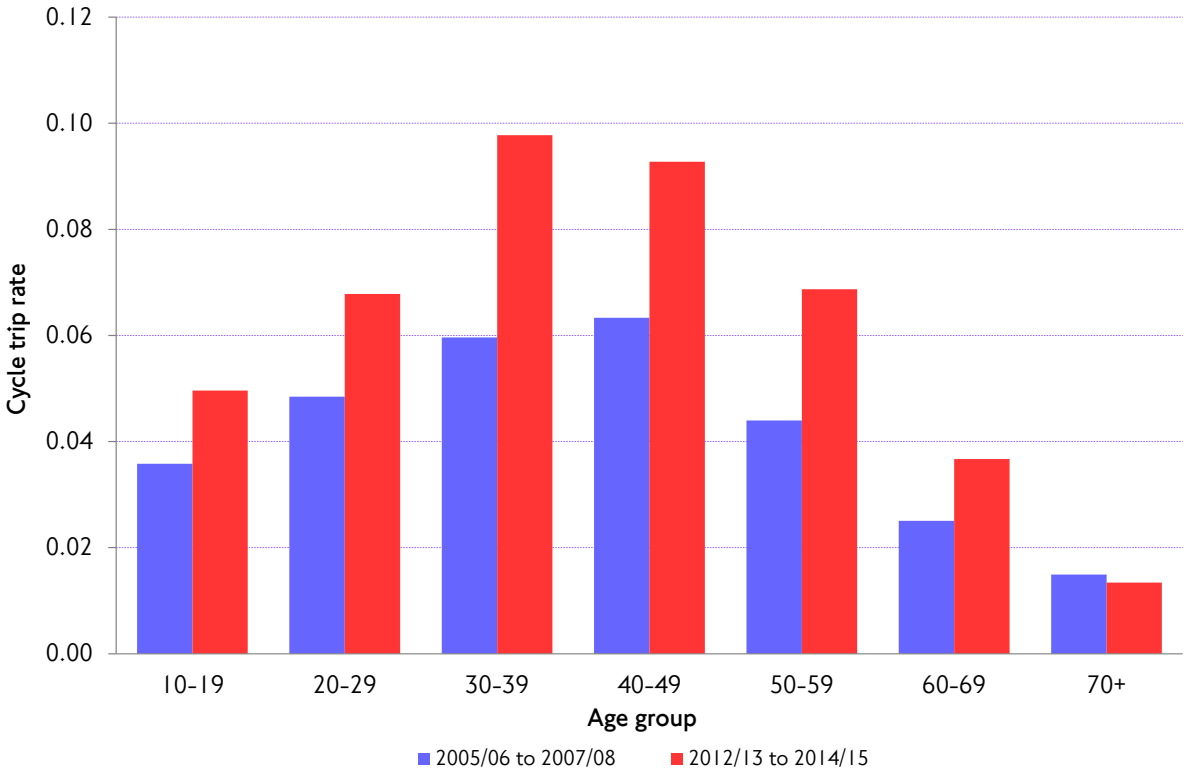
Source: TfL Planning Strategic Analysis. LTDS Survey.

In terms of household income (figure 5.34), the trend is generally one of increasing average cycle trip rate with increasing household income. Growth rates have varied considerably between income groups – however the generally higher growth rates for the higher-income groups is notable.

Figure 5.34 Change in average cycle trip rate by household income. London residents.

Source: TfL Planning Strategic Analysis. LTDS Survey.

Figure 5.35 Change in average cycle trip rate by age. London residents.



Source: TfL Planning Strategic Analysis. LTDS Survey.

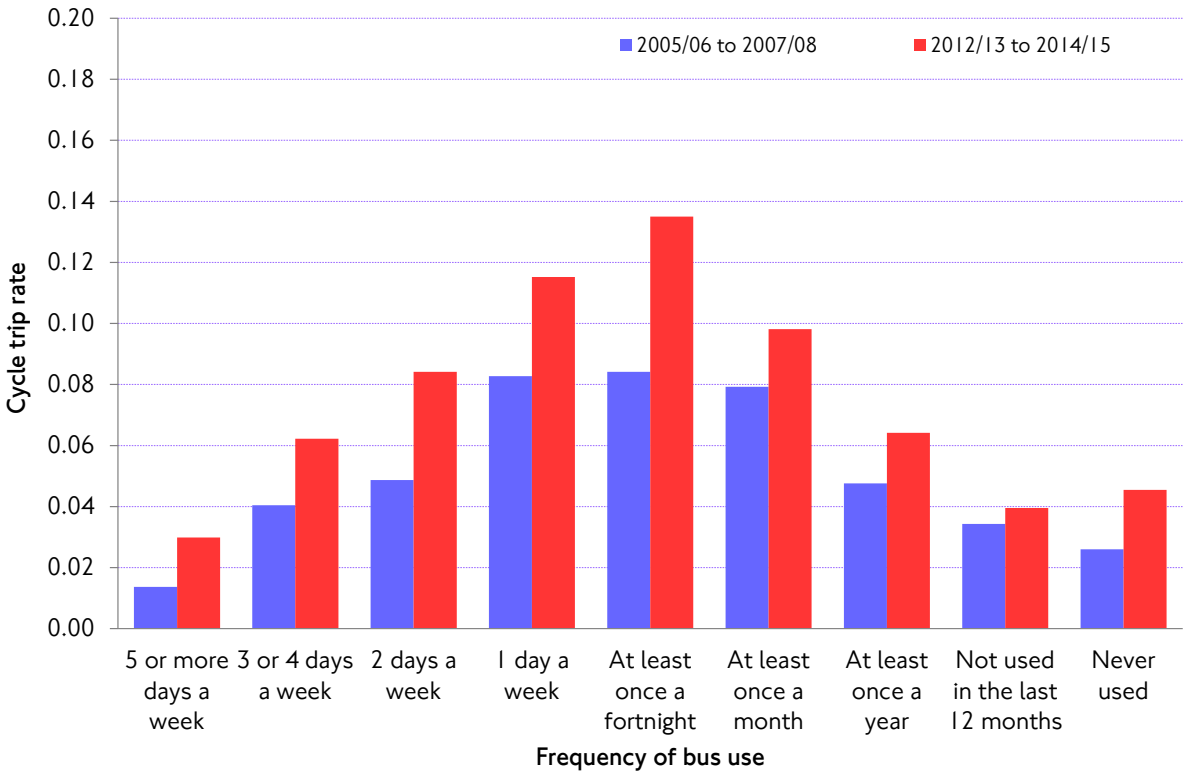
Finally, a comparison by age (figure 5.35) reveals the highest trip rates, and rates of growth, to be among those aged between 30 and 50 years.

How cycling growth relates to the use of other modes

Because LTDS includes full travel details of individuals, it is possible to look at how levels of cycling (in terms of average cycle trip rates) have changed in relation to the individuals' use of other modes. This provides useful information in terms of understanding the relative attractiveness of cycling and also allows potentially more targeted initiatives to be designed. For example, to encourage the use of cycling to relieve issues such as limited capacity or disruption on other modes. Looking at change in these indicators over time can help TfL understand how cycling initiatives have addressed the different travel 'markets' in London.

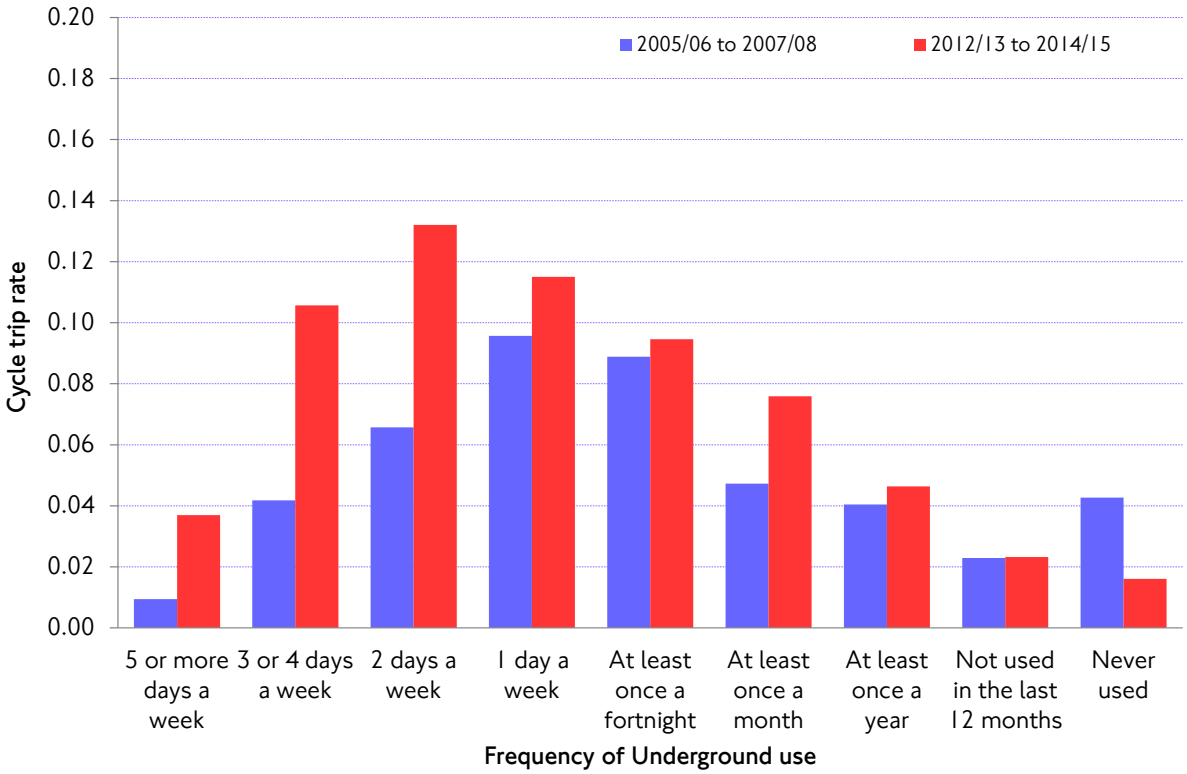
Figures 5.36 and 5.37 and 5.38, for bus, underground and car users respectively have the same scale, and therefore the height of the bars is comparable in absolute terms. But it is necessary to bear in mind that individuals can be reflected in more than one of these groups (ie they can be both car and bus users), and the absolute size of each group also varies.

Figure 5.36 Change in individuals' cycle trip rate by frequency of bus use. London residents.



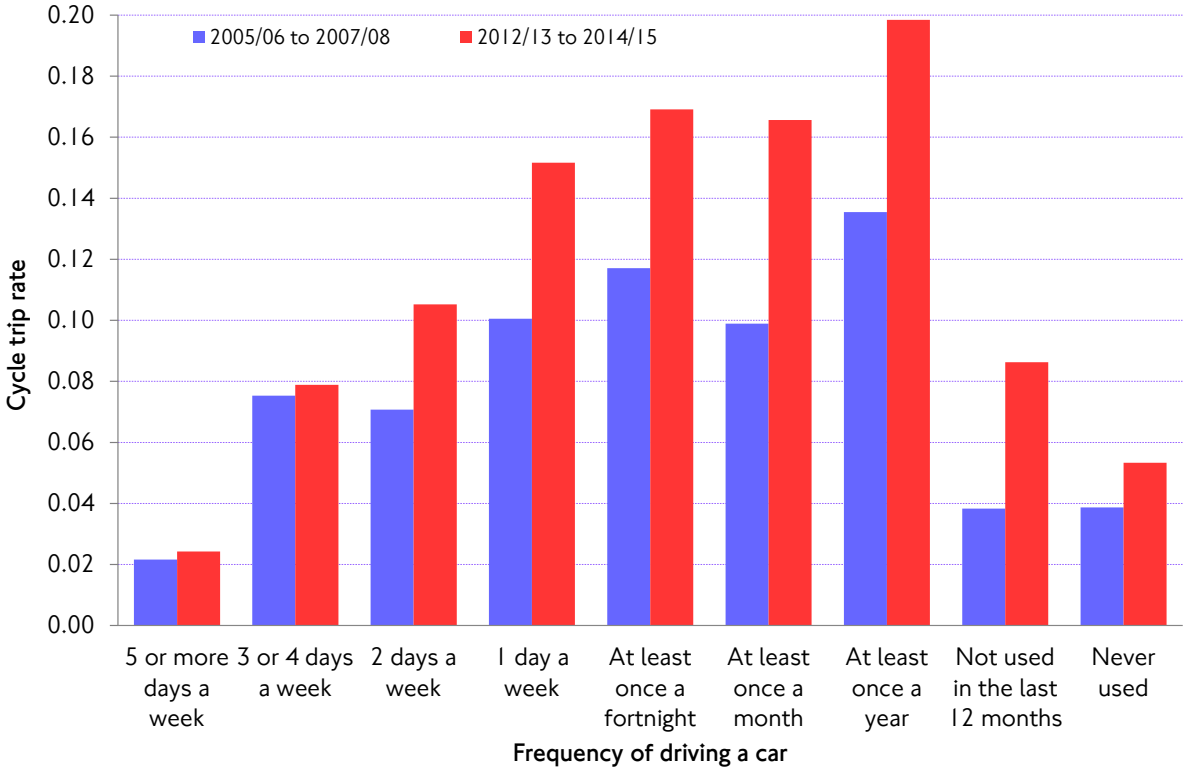
Source: TfL Planning Strategic Analysis. LTDS Survey.

Figure 5.37 Change in individuals' cycle trip rate by frequency of Underground use. London residents 2005/06 to 2014/15.



Source: TfL Planning Strategic Analysis. LTDS Survey.

Figure 5.38 Change in Individuals' cycle trip rate by frequency of car use. London residents.



Source: TfL Planning Strategic Analysis. LTDS Survey.

Looking across figures 5.36 to 5.38:

- Bus and Underground users share similar overall cycle trip rates; cycle trip rates for car users tend to be higher overall – suggesting a higher potential among car users.
- Cycle trip rates among Underground users have grown especially among frequent users of the Underground, suggesting that this group are particularly susceptible to change.
- However, cycle trip rates among car users have hardly grown at all among frequent car users, but there has been very strong growth among less-frequent car users.
- Growth in cycle trip rate has been fairly uniform across all categories of bus user. This tells us that there are no strong features of 'being a bus user' that affect propensity to take up cycling – although the overall rate of growth is comparatively low across the board for people in this category.

6. London's roads – travel demand patterns, network performance and road safety

6.1 Introduction and contents

This chapter looks at London's road network from the point of view of motorised vehicular traffic. Following a brief review of the main strategic trends and developments that have affected London's roads over the period since 2000, the chapter reviews trends in road traffic volumes, based on several long-standing key strategic indicators. The overall picture has been one of progressively declining levels of motorised road traffic across all parts of London, although within that overall picture there have been several developments that are of particular policy significance. The focus then turns to traffic congestion and journey time reliability, reviewing recent trends and focusing on new research that attempts to better quantify the causes of congestion in London. A review of recent road safety trends in London precedes consideration of road-based freight, goods and servicing transport in London.

6.2 Summary of key developments since 2000

The period since 2000 has been marked by several significant trends and developments in the evolution of demand for mechanised travel by road in London, and in the policy and management responses to these. These effectively frame most of the current policy issues relating to the road network. The following factors are identified as the most significant in this regard.

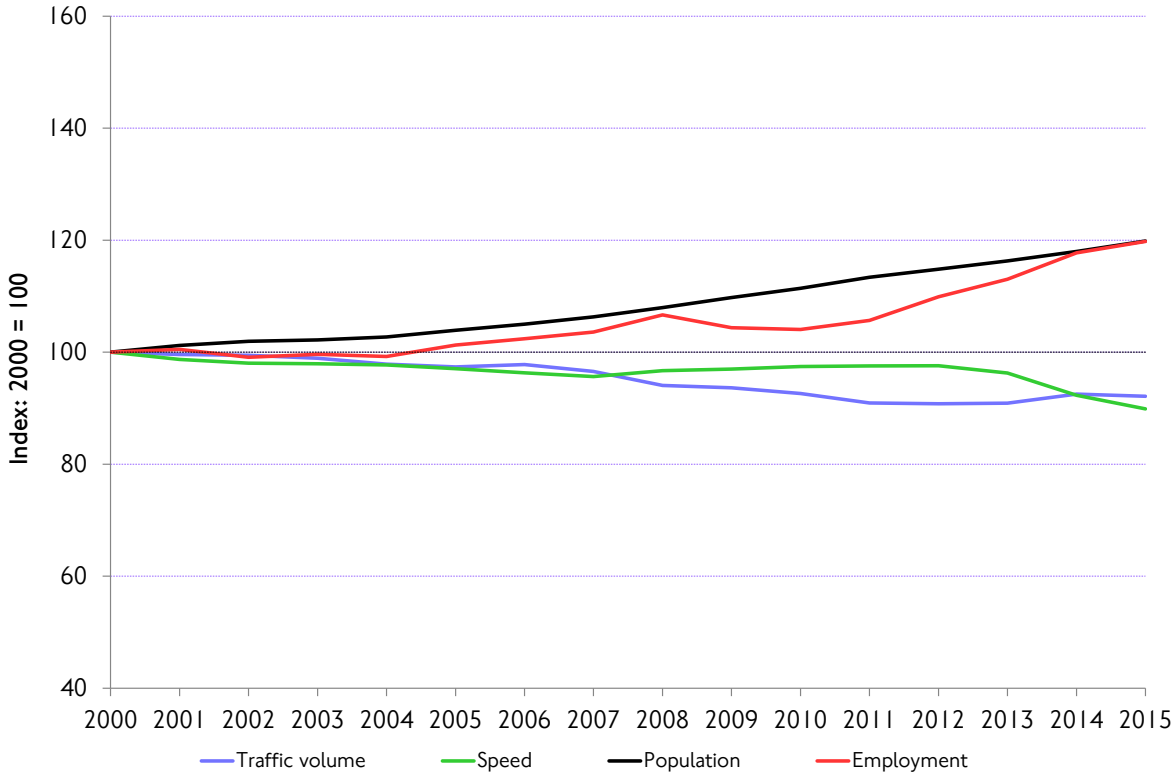
- For most of this 15-year period, **traffic volumes have fallen** overall, and this has affected all parts of Greater London. Road traffic volumes (expressed demand) were some 9.9 per cent lower in 2015 compared to 2000 at the Greater London level. In outer London, where approximately 70 per cent of London's traffic occurs, the reduction was 6.4 per cent, in inner London it was 16.8 per cent, and in central London (not directly equivalent to the Congestion Charging zone) the overall reduction has been 20.5 per cent.
- Most notably, **London has grown substantially** over this period, both in terms of population (up by 19.9 per cent) and economic activity (up by more than 30 per cent in terms of gross value added (GVA)). Car ownership levels among London residents have also fallen – albeit at a much slower rate than traffic volumes.
- This pattern – of declining absolute and/or relative car use – has been recognised in the wider literature as **'peak car'**, and has also been observed in several other advanced western cities. It is not clear, however, whether this will prove to be a temporary phenomenon as London continues to grow at a rapid rate into the future, and some modest further growth in traffic levels is expected by TfL over the long term (see chapter 7 of this report).
- At the same time, **congestion has increased** overall. While comparable statistics are not available for the whole of the period, the available data suggests a sharp upward trend in the early part of the period since 2000, followed by a period of stability around the end of the last decade, with resumption in the trend of increasing congestion in the most recent years. Again, this trend has been visible in all parts of London, and much of TfL's network management activity in

recent years has been focused on getting the most out of the limited road capacity available, and ensuring the resilience of the network to disruption.

- The introduction of **Congestion Charging** in central London in 2003 was a significant milestone in the sense that, for the first time, motorists were required to pay to use roads at the point of use. While the original objectives – framed in terms of traffic and congestion reduction – were achieved in the short term, these impacts have since diverged. There has been continued incremental reduction to the volume of traffic circulating in the zone – not immediately related to the imposition of, or changes to, the charge itself, while congestion has returned – to levels comparable to those that applied before the introduction of the charge. The introduction, in 2008, of **London's Low Emission Zone** did not have significant impacts on either traffic volumes or congestion, nor was it intended to, but it did introduce the important principle of incentivising the use of cleaner vehicles in the Capital to achieve environmental goals.
- It is thought that these diverging trends – of congestion increasing and volumes of traffic falling – reflect the overall impact of the **removal of effective capacity for general traffic** from the road network. This takes many forms, but will typically be recognised to result from policies relating to, for example, road safety improvement, pedestrian, bus and cycle priority, general traffic calming, such as closing 'rat runs' through residential areas, as well as the more general dynamism of London, with large-scale programmes of utility renewal and construction.
- While these policies typically imply relative dis-benefit for motorised road users, they do of course deliver substantial benefits in other areas. **The policy judgment has therefore increasingly favoured these policies**.
- Recognising the implications for traffic congestion, and the role of London's roads in facilitating the economic and social prosperity of the city, there continues to be a great emphasis on **ensuring the efficient and reliable operation of the road network.** Innovation continues to be aimed at squeezing the maximum out of the limited available road space and ensuring resilience in the event of disruption, for example by tackling particular bottlenecks. This requires a much deeper understanding of the causes of congestion, and the exploitation of technology and other measures to help mitigate its impacts.

Figure 6.1 illustrates these strategic trends over the period since 2000. Based on indicators at the Greater London level, there has been a progressive reduction in traffic volumes – down by 9.9 per cent over the period, and average traffic speeds, down by 10.1 per cent. Although a consistent measure of congestion is not available over the period, the trend for congestion has generally been the inverse of that for average traffic speed. Importantly however, in key areas like central London, the absolute level of congestion is broadly comparable to that of 2000, reduced traffic volumes here being the primary response to increased congestion pressure. In contrast, both population and employment have grown strongly, up by 19.9 and 19.8 per cent respectively.

Figure 6.1 Relative trends in average traffic speed, traffic volumes, population and employment in Greater London since 2000.



Source: TfL Planning Strategic Analysis.

From a policy perspective, these trends serve to throw the spotlight ever more clearly on policies that seek to optimise the use of scarce road space, alongside policies that ensure that this limited resource is also made to serve, so far as is possible, a wide range of policy priorities in addition to and alongside those immediately related to motorised travel.

6.3 General road traffic demand – key strategic trends

Scope

This section considers road traffic volumetric trends in London. It first looks at vehicle-kilometre based estimates from the DfT, and then looks at complementary traffic flow data from TfL's own traffic counts. The latest available DfT data is for the 2015 calendar year, and shows a slight decline in vehicle kilometres compared to 2014.

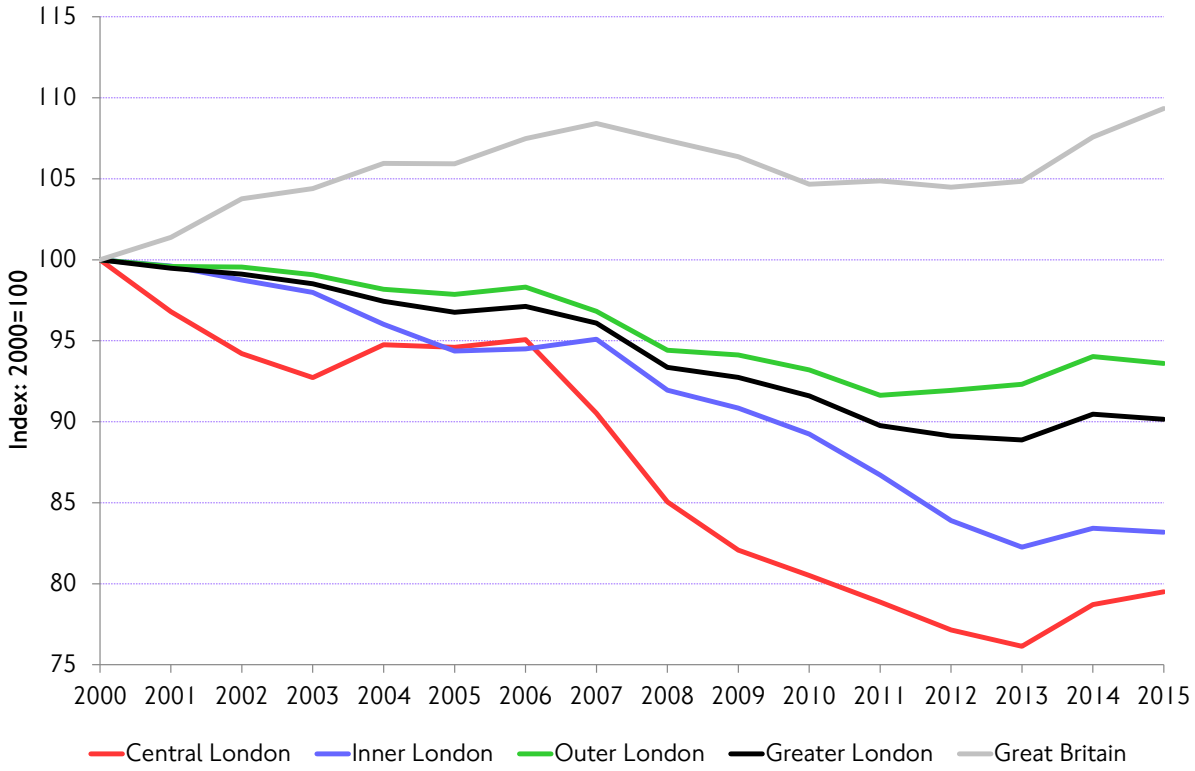
Traffic trends since 2000 (DfT data)

The Department for Transport produces an annual volumetric estimate of traffic in London, in terms of annual vehicle kilometres. This is part of a wider national traffic survey, but does provide a good long-term indicator of traffic trends in the Capital.

In 2015, vehicle kilometres in London were down by 0.3 per cent overall against 2014. While traffic in central London increased by 1.0 per cent, traffic in inner London decreased by 0.3 per cent and traffic in outer London, which accounts for about 70 per cent of traffic in London, decreased by 0.4 per cent (figure 6.2).

DfT data shows that vehicle kilometres in London in 2015 were 9.9 per cent lower than in 2000. This fall in road demand has been a consistent feature of the last decade, and has been particularly prominent in central London (although this indicator applies to an area larger than the central London Congestion Charging zone), where vehicle kilometres in 2015 were 20.5 per cent below the 2000 level, even taking into account the increases in the latest two years. In inner London, the equivalent fall was 16.8 per cent, while vehicle kilometres in outer London fell by 6.4 per cent. Traffic in outer London only started to fall steadily in the second half of the decade, from 2007 onwards, after a slight increase in 2006, and in 2012 it started to increase again, although it has decreased in the latest year.

Figure 6.2 Trends in road traffic (vehicle kilometres), all motor vehicles in central, inner and outer London. Index: Year 2000=100.



Source: Department for Transport.
In interpreting the trend for central London shown by figure 6.2, it is important to recognise that this reflects a different area and set of conditions to that previously reported by TfL through the Congestion Charging impacts monitoring reports.

At the national level, road traffic volumes increased by 1.6 per cent in 2015. Vehicle kilometres driven nationally in 2015 surpassed the pre-recession peak of 2007 for the first time. The opposing trends of continued growth at the national level, coupled with falls in London, were a consistent feature of the last decade.

Table 6.1 London road traffic (billion vehicle kilometres) by central, inner and outer London. All motor vehicles, with Great Britain comparison.

Year	Central London	Inner London	Outer London	Greater London	Great Britain
2000	1.3	9.0	22.1	32.4	466.2
2001	1.2	9.0	22.0	32.3	472.6
2002	1.2	8.9	22.0	32.1	483.7
2003	1.2	8.8	21.9	31.9	486.7
2004	1.2	8.7	21.7	31.6	493.9
2005	1.2	8.5	21.7	31.4	493.9
2006	1.2	8.5	21.8	31.5	501.1
2007	1.2	8.6	21.4	31.2	505.4
2008	1.1	8.3	20.9	30.3	500.6
2009	1.0	8.2	20.8	30.1	495.8
2010	1.0	8.0	20.6	29.7	487.9
2011	1.0	7.8	20.3	29.1	488.9
2012	1.0	7.6	20.3	28.9	487.1
2013	1.0	7.4	20.4	28.8	488.8
2014	1.0	7.5	20.8	29.3	501.5
2015	1.0	7.5	20.7	29.2	509.7

Source: Department for Transport.

Table 6.2 Index of London road traffic (all motor vehicles, based on vehicle kilometres). Index: Year 2000=100. With Great Britain comparison.

Year	Central London	Inner London	Outer London	Greater London	Great Britain
2000	100.0	100.0	100.0	100.0	100.0
2001	96.7	99.6	99.6	99.5	101.4
2002	94.2	98.8	99.6	99.1	103.8
2003	92.6	98.0	99.1	98.5	104.4
2004	94.7	96.0	98.2	97.4	106.0
2005	94.5	94.4	97.9	96.8	105.9
2006	95.0	94.5	98.3	97.1	107.5
2007	90.6	95.1	96.8	96.1	108.4
2008	85.1	92.0	94.4	93.4	107.4
2009	82.0	90.9	94.1	92.7	106.4
2010	80.5	89.2	93.2	91.6	104.7
2011	78.9	86.7	91.6	89.8	104.9
2012	77.2	83.9	91.9	89.1	104.5
2013	76.1	82.3	92.3	88.9	104.8
2014	78.7	83.4	94.0	90.5	107.6
2015	79.5	83.2	93.6	90.1	109.3

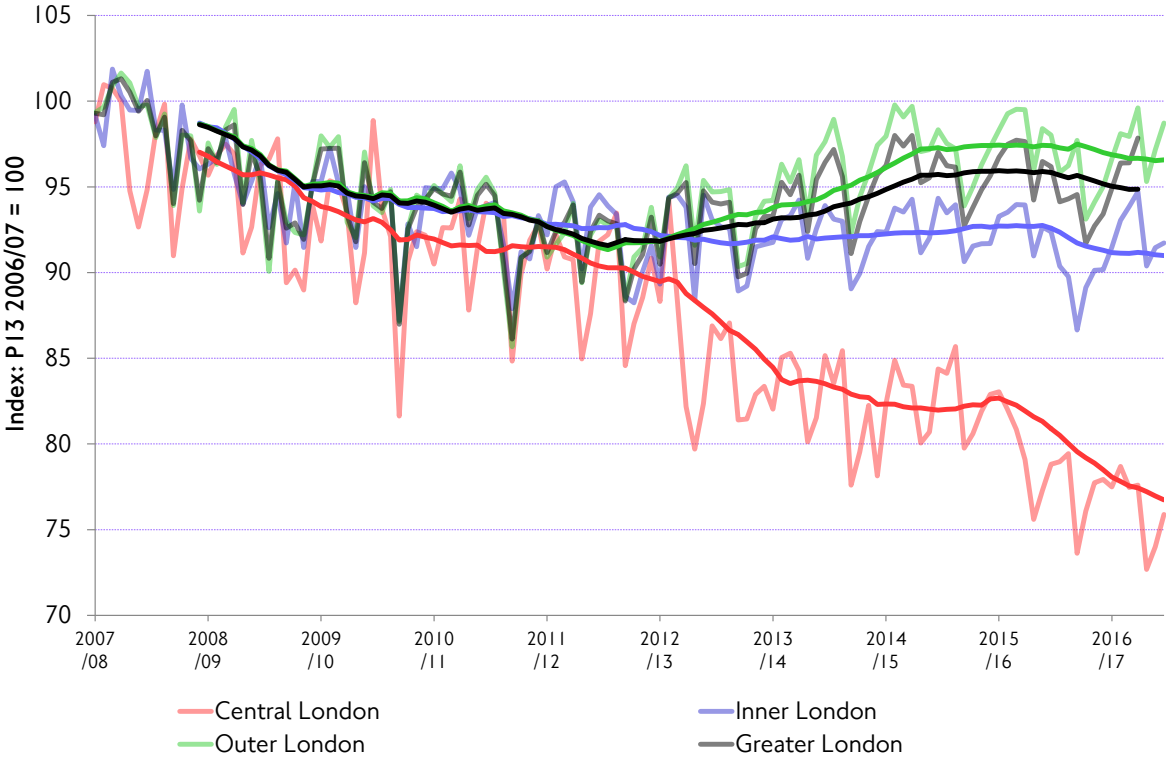
Source: Department for Transport.

Trend shown by TfL's volumetric data

Data from TfL's traffic counts highlight the seasonal nature of traffic flows, and also show broadly similar long-term trends to the traffic data above. The traffic flow

data shows a large drop in flows in central London (in this case using a definition aligned with the Congestion Charging zone) from 2012/13 onwards, with traffic flows almost 25 per cent lower than in early 2007. In inner London, flows declined to 2011/12, and have been relatively stable since then, and are around 8 per cent lower than in 2006/07. Traffic flows in outer London also declined up to 2011/12, and after a return to growth up to 2014/15, flows have started to decline in the latest year, and are around 3 per cent below 2006/07.

Figure 6.3 Trends in road traffic (traffic flows), all motor vehicles in central, inner and outer London. Index: P13 2006/07=100.



Source: TfL Surface Transport, Outcomes, Insight and Analysis.

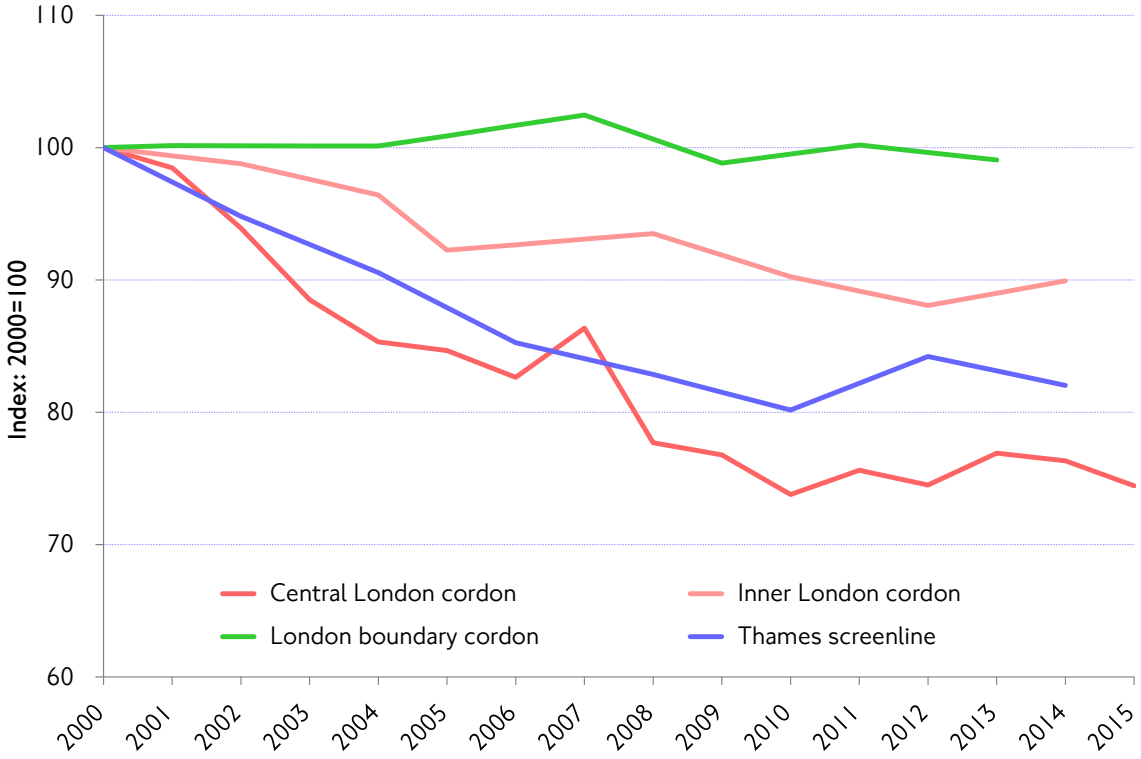
Trend shown by TfL's cordon count data

Trends in the numbers of motor vehicles crossing the three London cordons and the Thames screenline show a similar pattern to data on vehicle kilometres. Since 2000, and bearing in mind that not all cordons are surveyed every year, the number of motor vehicles crossing the central cordon has fallen by 25.6 per cent. Across the inner cordon, the decline has been 10.1 per cent (to 2014), while the boundary cordon has been relatively stable, with a 0.9 per cent decrease comparing 2013 against 2000. The number of vehicles crossing the Thames has also declined over the same period, with 18.0 per cent fewer vehicles in 2014 compared with 2000. In considering these cordon and screenline counts, it should be noted that there may be considerable variation locally from the trends quoted here, as they include a wide range of locations with differing road network and traffic growth characteristics.

Comparing the cordon data with the DfT traffic data in table 6.1, the overall trends since 2000 are relatively similar. Both data sources show a drop of more than 20

per cent in central London, although the DfT traffic data suggests larger falls in both inner and outer London.

Figure 6.4 Daily number of motor vehicles crossing at the three cordons and Thames screenline. Index: 2000=100.



Source: TfL Surface Transport, Outcomes, Insight and Analysis.

6.4 Performance of the road network for movement by motorised vehicles

Introduction and content

This section updates established indicators of road network performance in London, looking at average traffic speeds and delay (congestion) levels, based on Trafficmaster GPS data, as well as TfL's indicator of journey time reliability on major roads. These indicators focus on motor vehicle traffic only.

Established measures of road network performance in London

There are three established measures of road network performance for motor vehicle traffic:

- **Average traffic speed** is the simplest measure, but does not indicate how actual network performance compares to what might be 'expected' for the network. This would vary, for example, between major and minor or residential roads.
- **Excess delay** is the conventional measure used to describe traffic congestion. It compares the actual travel rate (in minutes per kilometre) for a given journey against the travel rate for the same journey under uncongested conditions (typically and for practical purposes taken as the overnight period).
- **Journey time reliability** is the MTS outcome indicator which quantifies the variability of actual journeys around a nominal average, typically the most

important aspect of road performance from a business and commuter customer perspective. The measure is independent of both absolute average speed and delay. This measure is described more fully in Travel in London report 3.

These are essentially 'pragmatic' measures that provide a good and consistent overview of the performance of the road network for general motorised traffic.

Summary of long-term trends for traffic speeds and delays in London

Previous Travel in London reports have described the trends over two decades towards slower average traffic speeds and increased congestion (delay) in London. They also described the relationship of these trends to levels of traffic demand, which had been falling for much of the last 15 years, and interventions, such as urban realm improvements, that have reduced the effective capacity of London's road network for general motorised traffic.

The consistency of this relationship, visible in the historic data from moving car observer surveys up to 2006/07, was more recently obscured as newer Trafficmaster GPS data (which replaced the traditional method of recording speeds and delays) had shown a notable lack of trend at the aggregate level since first becoming available in late 2006. This was, in part, due to the differing technical assumptions between the two indicators (see also Travel in London report 6, section 6.4).

Over the most recent two years, however, there are clear indications that the long-standing trends are changing, with clear evidence of a fall in average traffic speeds and an increase in delays. This also coincides with indications that the trend of slowly-falling traffic levels may be stabilising, and in the most recent year with a substantial increase in road and street works on the network, reflecting an increase in large-scale construction activity as London emerges from the recession, as well as TfL's continuing investment programme.

Average traffic speeds

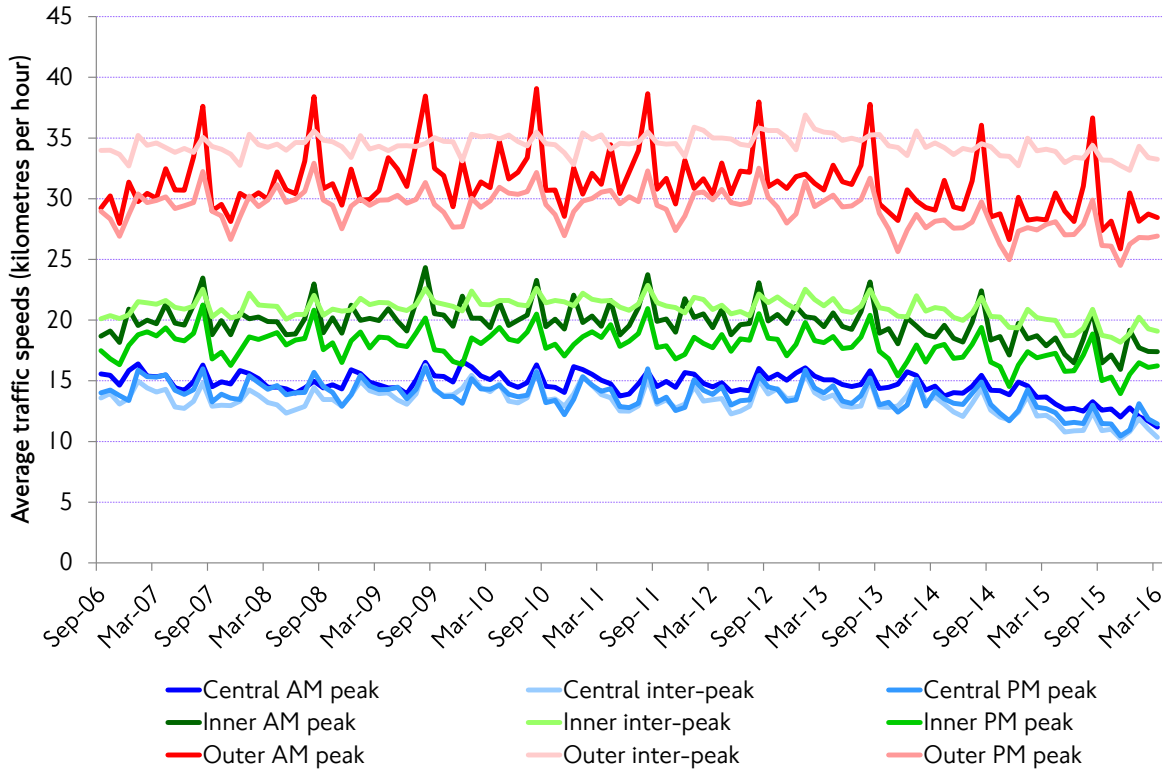
Figure 6.5 shows the trend in average traffic speeds by functional sector of London since late 2006, when Trafficmaster data first became available.

There are clear and expected patterns associated with seasonality and the fluctuations in traffic demand on the network over the course of each year. There are also clear and expected differences in the prevailing average speeds for each of central, inner and outer London, reflecting the density and characteristics of the different networks. The overall trend was remarkably stable between 2007 and 2012; however, since this time the trend for average vehicle speed has been downwards in all parts of London, but particularly in central London. This is likely to be attributable to greater temporary disruption to the road network.

Table 6.3 shows a comparison of data over equivalent periods between 2014/15 and 2015/16 (12 months in each case). Average traffic speeds have declined in all sectors and time periods between 2014/15 and 2015/16. The largest declines in average traffic speed were all in the central area, by 12.6 per cent in the AM peak, 12.5 per cent in the inter-peak and 11.0 per cent in the PM peak. The average decline in traffic speed in inner London was lower, at 5.7 per cent and just 1.7 per cent in outer London.

Average traffic speeds have declined the most in the AM peak in central and inner London, by 12.6 per cent and 6.5 per cent respectively, but in outer London the greatest decline in traffic speed was in the PM peak (2.2 per cent).

Figure 6.5 Average traffic speed (kilometres per hour) by functional sector of London. Working weekdays by time period. TfL's 'network of interest'.



Source: TfL Surface Transport, Outcomes, Insight & Analysis.

Table 6.3 Average traffic speed (kilometres per hour) and average vehicle delay (minutes per kilometre) by functional sector of London. Working weekdays, by time period. 2014/15 vs. 2015/16. TfL's 'network of interest'.

Area and time period	2014/15 average speed	2015/16 average speed	% change	Area and time period	2014/15 average delay	2015/16 average delay	% change
Central AM peak	14.2	12.4	-12.6	Central AM peak	1.7	2.1	25.9
Central inter-peak	12.7	11.1	-12.5	Central inter-peak	2.2	2.7	22.6
Central PM peak	13.2	11.7	-11.0	Central PM peak	2.0	2.4	19.0
Inner AM peak	19.0	17.7	-6.5	Inner AM peak	1.4	1.5	11.2
Inner inter-peak	20.3	19.2	-5.5	Inner inter-peak	1.2	1.3	9.0
Inner PM peak	17.0	16.1	-5.2	Inner PM peak	1.8	1.9	7.4
Outer AM peak	29.7	29.4	-1.1	Outer AM peak	0.8	0.8	2.3
Outer inter-peak	34.0	33.4	-1.8	Outer inter-peak	0.5	0.6	4.7
Outer PM peak	27.6	27.0	-2.2	Outer PM peak	1.0	1.0	4.5

Source: TfL Surface Transport, Outcomes, Insight and Analysis, based on data from Trafficmaster.

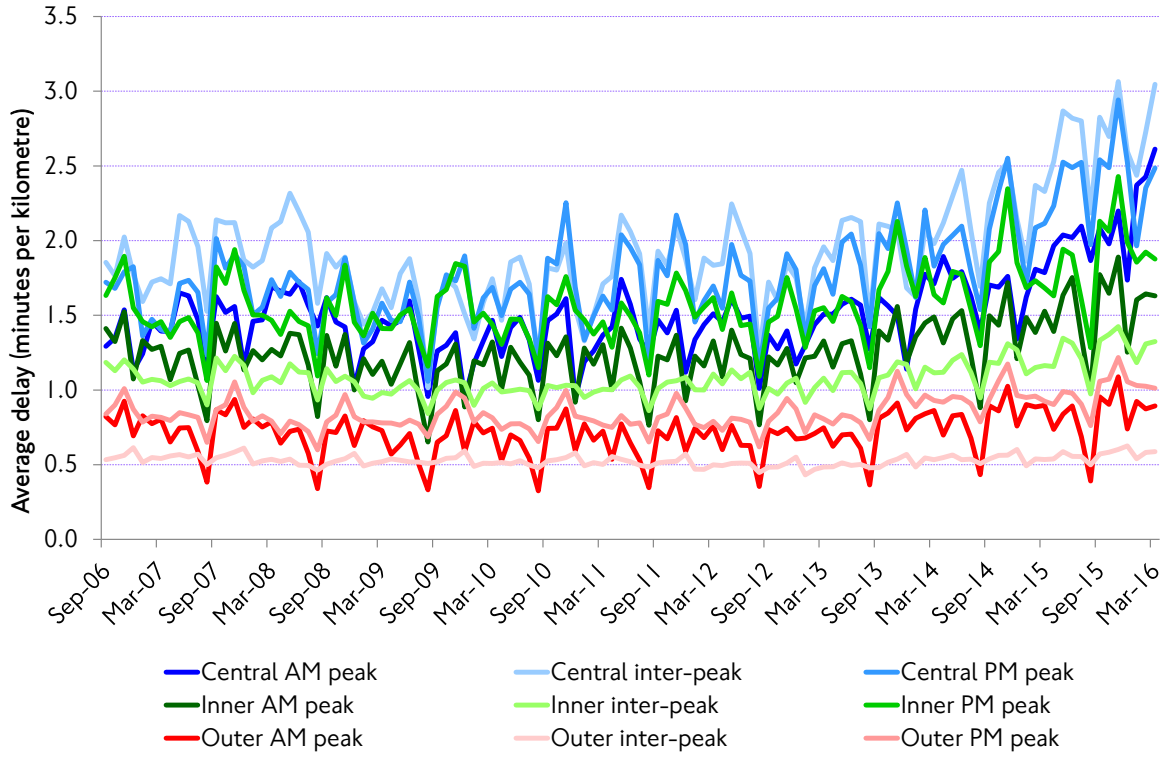
Vehicle delay (congestion)

Figure 6.6 shows the trend for congestion (delay), corresponding directly to the average speed data in figure 6.5. Trafficmaster delay values are calculated against a variable 'uncongested' night-time speed, which is that actually measured on a day-by-day basis, rather than a fixed nominal 'night-time' speed, as was the case with previous moving car observer data. Furthermore, Trafficmaster 'uncongested' speeds relate to the period from 22:00 to 06:00 – a period that, in many parts of London, sees substantial volumes of traffic. Previous indicators based on moving car observer data used a faster night-time speed, reflecting the period from 02:00 to 05:00.

As well as the expected seasonal and geographical patterns shared with the speed data, figure 6.6 shows large differences in the degree of variability of traffic congestion by both area and time period. So, inter-peak congestion in outer London has historically remained remarkably stable from month-to-month at about 0.5

minutes per kilometre, whereas morning peak congestion here may vary by up to 100 per cent from month-to-month. In inner London the degree of variation in peak-period congestion is also roughly twice that of inter-peak congestion. In central London the pattern is reversed – inter-peak congestion being the most variable and this coinciding with the period of highest traffic demand on the network. This pattern is characteristic of networks where traffic demand routinely approaches the carrying capacity of the network. Congestion, as a measure of network instability, increases at a greater rate, and journey times are therefore more variable, the closer that traffic demand is to the carrying capacity of the network.

Figure 6.6 Average vehicle delay (minutes per kilometre) by functional sector of London. Working weekdays, by time period. TfL's 'network of interest'.



Source: TfL Surface Transport, Outcomes, Insight & Analysis.

Average delay has shown a similar pattern to average speeds, with the time series remaining relatively stable to late 2013, after which there has been a sharp increase in all parts of London. Table 6.3 shows a comparison of 2014/15 and 2015/16 (based on 12 month periods in each case).

Figure 6.6 shows that, similar to trends in average speeds, the greatest increases in average vehicle delay between 2014/15 and 2015/16 are all in the central area. The greatest increase was in the AM peak (25.9 per cent), followed by the inter-peak (22.6 per cent) and the PM peak (19.0 per cent). Vehicle delay also increased in inner and outer London, by an average of 9.2 per cent and 3.8 per cent respectively.

Congestion – a different perspective

Congestion is a major challenge for the operation of London's roads. While some congestion is desirable – it is the sign of the effective use of a scarce and valuable resource (road space) – it is also undesirable in other ways such as frustration, missed opportunities; poor air quality and other negative environmental

consequences also follow. There are few 'good' points about congestion, but there are two aspects of the recent trends that deserve to be better understood.

The first relates to the question of how bad congestion really is. Congestion trends are usually considered in the sole context of the road network. It is however also reasonable to look at them in the context of the wider transport system and the growth of London. A simple way of doing this is to consider congestion trends in relation to population and employment growth – calculating indices of congestion per resident or per job and seeing how these have changed over time.

Taking this approach, figure 6.7 shows that between 2007 and 2013, the total quantum of time lost to congestion in London actually decreased. This is because while there were some increases in delay per kilometre travelled on the road network, the total volume of traffic in London decreased substantially as a positive effect of modal shift towards public transport, walking and cycling.

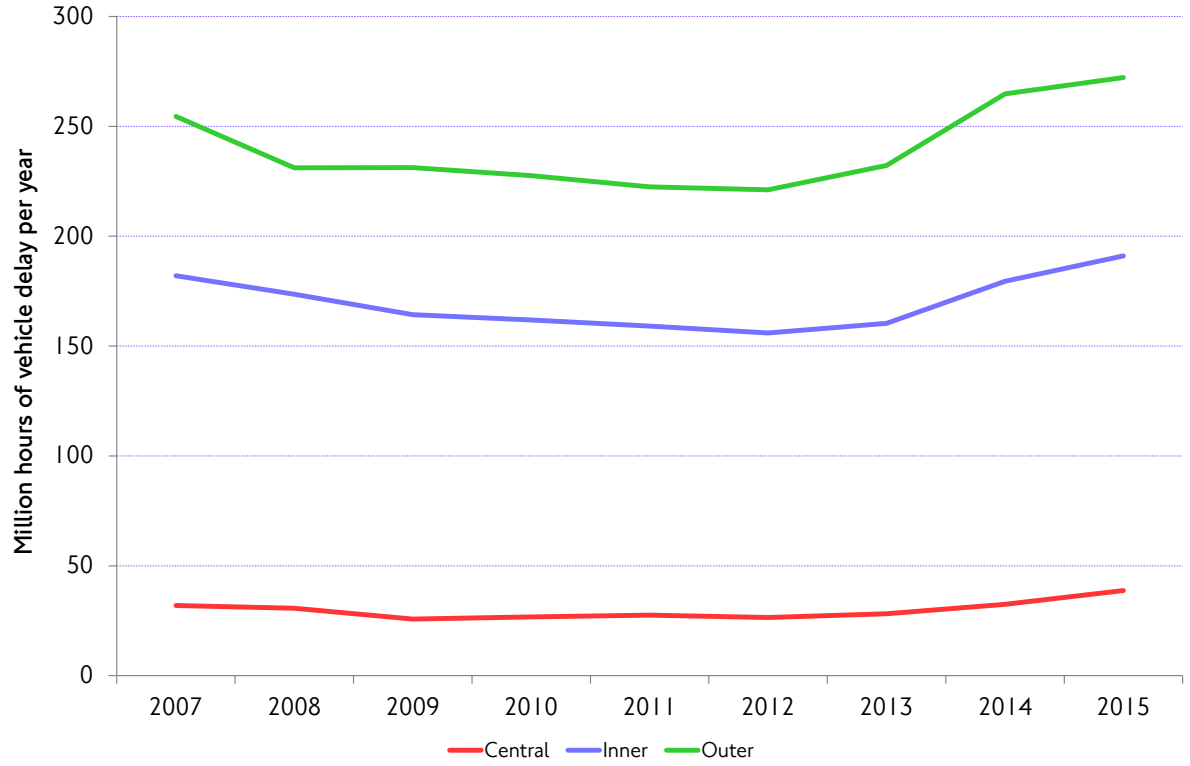
Following this, however, total time lost to congestion increased and by 2015, reflecting the recent trend also highlighted above, was at a level greater than the start of the series in 2007. This is because the increase in total time lost to congestion in the last two years was greater than the decrease over the previous six years. The increase in time lost to congestion between 2013 and 2015 was primarily due to large increases in delay per kilometre on the road network, although in some areas there were also small increases in the volume of traffic over the period in contrast to the declining trend in traffic to 2013.

Figure 6.8 shows the burden of congestion per London resident and per central London job. Given the rapid growth London is experiencing, this measure could be considered to better represent the effect of congestion on Londoners and London's economy, since it reflects the time lost to congestion per Londoner or per job as opposed to per unit distance travelled on the road network.

As was the case with total time lost to congestion, in the earlier period of this series the time lost to congestion per person or job decreased, reaching a low in 2012. This is due to the rapid growth in London's population and employment not being accompanied by equivalent growth in use of the road network – ie the achievement of more sustainable urban growth.

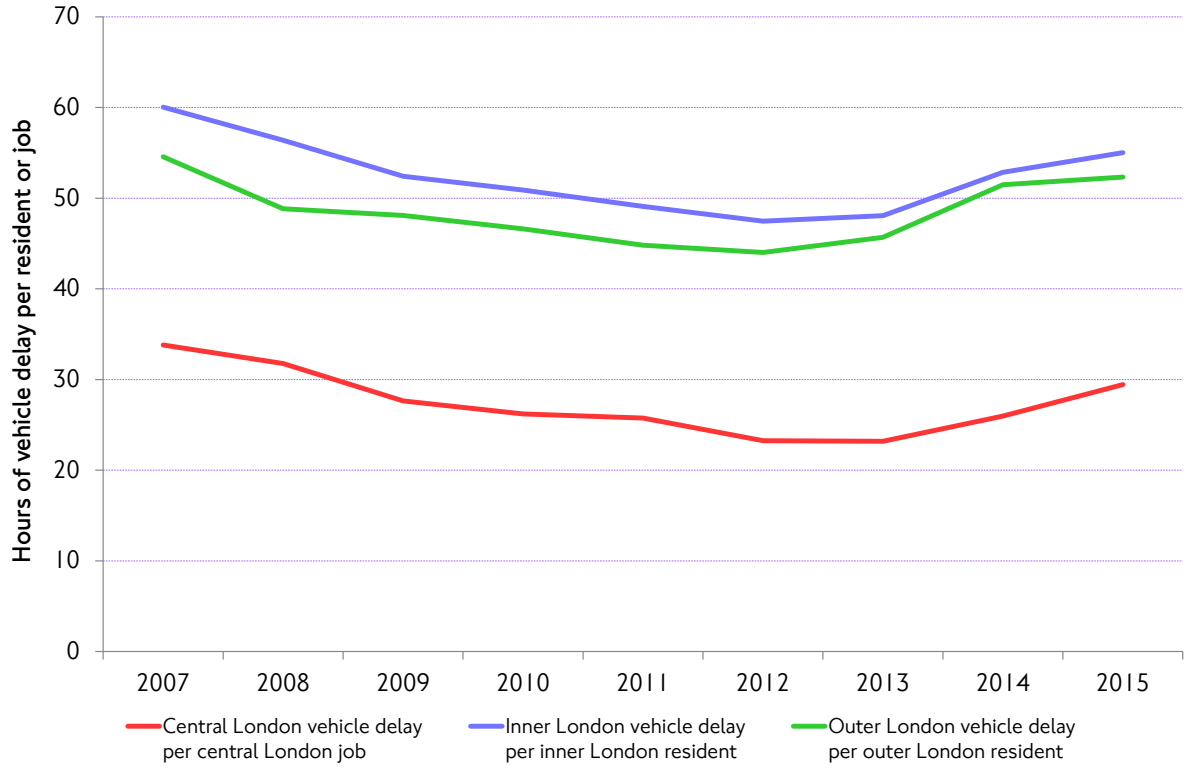
Again, though, in the final years of the series, time lost to congestion per person or job increased. This was due to the rate of increase in delay on the network having outstripped the rate of growth in population and jobs in the period 2012 to 2015.

Figure 6.7 Total delay experienced by motor vehicles by functional area of London



Source: TfL Planning, Strategic Analysis.

Figure 6.8 Ratio of vehicle delay to population or employment by functional area of London



Source: TfL Planning, Strategic Analysis.

The second aspect of recent trends in congestion that deserves further reflection is that congestion acts as a cap on increasing demand for travel by road. In a city such as London, where there are generally reasonable alternatives for many (but certainly not all) journeys currently made by road, particularly in the dense inner area, increasing congestion (resulting in an increase to the 'generalised cost' of the journey) will result in 'economically marginal' users choosing an alternative, more efficient mode. This general mechanism is thought to have been significant in explaining much of the trend for declining traffic volumes observed over the last two decades, albeit alongside a substantial programme of investment in public transport, walking and cycling.

Some level of congestion is regarded as a healthy sign of a prosperous and dynamic city; no congestion would represent an inefficient use of a key resource – road space. It is however clear, as was explored quantitatively in Travel in London report 4, section 4.13, that effective road network capacity for general traffic has been, and continues to be, removed from London's roads. This has been to support a very wide range of beneficial policies such as improved road safety, public transport, walking and cycling priority, improved urban realm and infrastructure development – all of which make demands on limited road space.

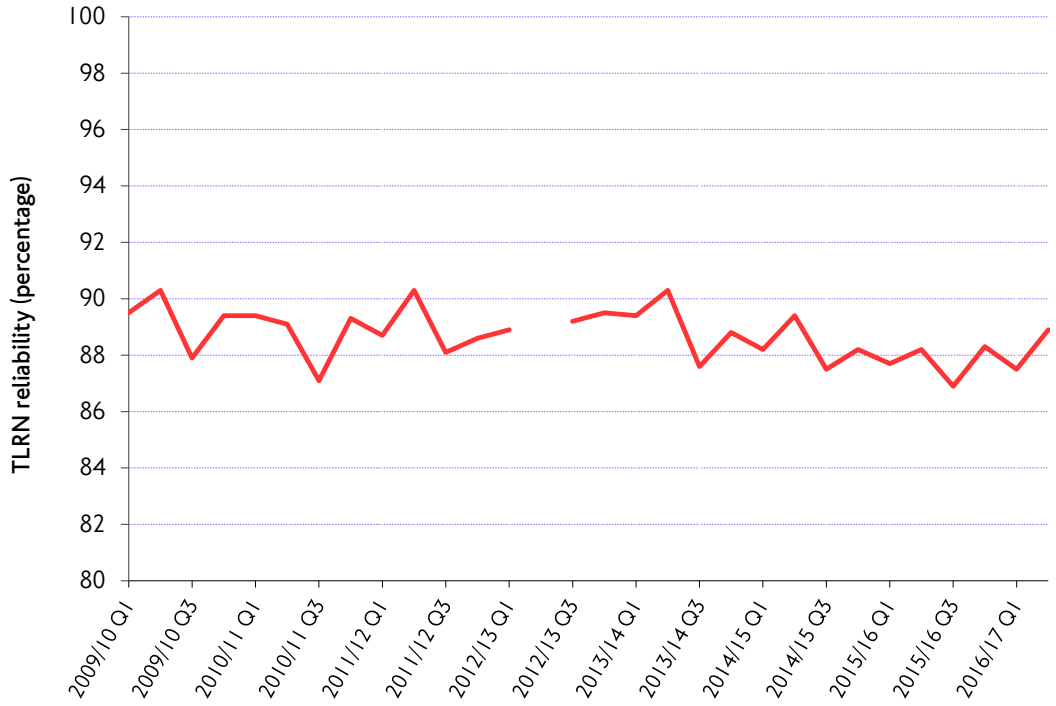
This process – of incremental capacity removal, leading to increased congestion pressure, leading in turn to reduced traffic demand (in the context of the availability of reasonable alternatives but not wholly without disbenefit to those affected) is increasingly recognised. With the policy debate increasingly favouring policies that will have this kind of effect, the spotlight is thrown more clearly on measures that minimise the disbenefit to those suffering congestion, particularly for the more 'essential' traffic. This can be achieved principally through continuing to encourage mode shift by providing attractive alternatives to the car, and by using advanced management techniques to better manage and optimise the day-to-day operation of the road network.

Journey time reliability for general road traffic

TfL's assessment of road network performance is primarily based on the concept of journey time reliability for general road traffic. TfL's journey time reliability metric considers the relationship of actual measured journeys (using Automatic Number Plate Recognition, ANPR, cameras) to a nominal average journey time that is representative of motor vehicle journeys by road in London. This is measured quarterly on a road corridor basis, covering most of the TLRN in London, and is aggregated to a London-wide index. This measure was explained in Travel in London report 2, section 4.4.

Figure 6.9 shows the available trend for AM peak journey time reliability from the start of 2009/10. Against a working target of 87 per cent of road journeys in London to be achieved within five minutes of the nominal 30-minute average journey time, recorded performance since the start of this measure has mostly been between 87 and 90 per cent.

Figure 6.9 AM peak journey time reliability on the TLRN. Percentage of journeys completed within an allowable 'excess' of a normalised average journey time.



Source: TfL Surface Transport, Outcomes, Insight & Analysis.
Note that, due to the widespread alterations made to the operation of the major road network in London during the 2012 Games, a comparable value for this period is not available.

The reliability trend in figure 6.9 shows a similar pattern to that of the speed trend in figure 6.5, with relatively stable performance between 2009/10 and 2012/13, before deteriorating in the following years. This is to be expected as both are effectively different representations of the same underlying journey time distribution.

Consistency of road journey times is important to road users. To that end there has been a significant focus within TfL to improve reliability through a range of initiatives aimed at actively managing traffic flow, as described in Travel in London report 4 section 4.14.

London's strong growth is changing the way TfL's roads operate and are used. In response to this, TfL is continuing to oversee the largest ever investment in London's roads and streets. The plan comprises numerous projects and programmes that will transform some of the busiest roads and junctions in London making them safer and more attractive for all road users including vulnerable road users. Some specific recent initiatives have included:

- Large scale redevelopment projects such as Lewisham Gateway, Victoria Station upgrade and Nine Elms.
- Completion and bedding in of the Cycle Superhighways: East-West, North-South and Cycle Superhighway 2.
- Borough road scheme improvements such as Aldgate, Shepherd's Bush town centre and Harlesden town centre.

- Transformation of major junctions such as Elephant & Castle northern roundabout and Stockwell Cross.

Major construction and roadworks often require significant traffic management and network interventions such as temporary traffic signals, re-phasing of traffic signals and lane reductions, and TfL works with contractors and other agencies to minimise the disruptive effect on the day-to-day operation of the road network.

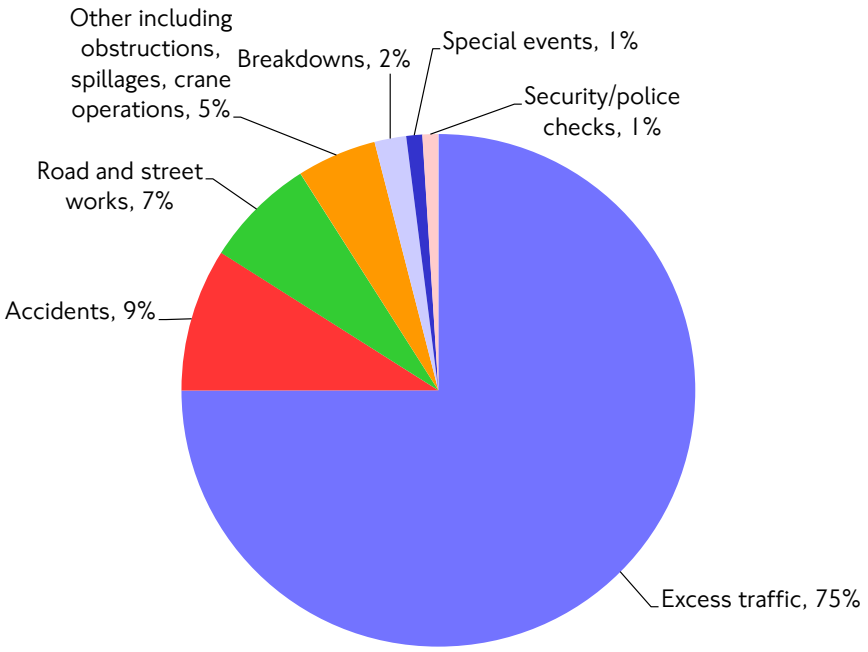
6.5 Maintaining the reliability and resilience of the road network – understanding the causes of congestion

Rationale

Developing techniques to better manage congestion requires a good understanding of the underlying causes of the problem. Identifying the circumstances or events that give rise to it allows these situations to be foreseen and managed.

Travel in London report 6, section 4.10, explored TfL's efforts to quantify these factors – from which it was clear that the biggest contributor to congestion is simply the balance of 'background' or recurrent traffic demand over the available supply or capacity of road space. Other factors, relating for example to temporary disruptions of various kinds, exacerbate the problem in certain areas and at certain times. This can be represented in terms of a 'congestion pie' (figure 6.10).

Figure 6.10 Estimated contribution of various factors to road traffic congestion.



So, while on a daily basis a motorist might typically 'expect' a certain level of delay on their journey, on some days the experienced delay is much greater, owing for example, to emergency roadworks or a collision. This kind of analysis threw the spotlight on how best to manage these disruptions – either planned (for example, roadworks) or unplanned (for example, road traffic collisions) to maintain journey times at a level approximating the delay caused by the 'background' level of demand.

Level shift identification

TFL have developed a new technique, 'level shift identification', for attributing causes to delay on the road network. This work addresses a weakness in previously used regression modelling techniques, which are unable to adequately account for the effect of long-term (usually planned) works on the network. It is confined to the TLRN – London's network of major roads that carries approximately 30 per cent of vehicle kilometres in the Capital.

The new technique relies solely upon patterns in journey time data to algorithmically identify the causes of delay over six calendar years, January 2010 to December 2015. The cause of delay is categorised into long-term events, short-term incidents, recurrent demand and excess demand (that above recurrent demand).

Total cost of congestion and proportionate causes

In 2015, the total cost of congestion on the TLRN (only), 07:00-19:00 working weekdays, is estimated at £1,300m, up 8 per cent from 2014. Across the six years analysed, the year with the least delay was 2012, when delay on the TLRN was valued at £1,037m. The year 2015 saw 25 per cent more delay than the 2012 low.

Table 6.4 Cost of vehicle delay (on TLRN only) by cause. Working weekdays 07:00 to 19:00 (£m).

Year	Long-term events	Short-term incidents	Excess demand	Recurrent demand	Total
2010	95	156	163	673	1,087
2011	110	148	158	678	1,094
2012	56	157	156	667	1,037
2013	55	156	199	691	1,100
2014	78	174	241	706	1,199
2015	190	171	228	710	1,300

Source: TfL Surface Transport, Outcomes Delivery.

Table 6.4 sets out the estimated contribution to congestion from each of the main causal factors, in terms of millions of pounds. Using the level shift identification technique it is estimated that, on working weekdays between 07:00-19:00, long-term events (lasting a minimum of three days) such as roadworks, caused £190m in delays on the TLRN in 2015. This is a notable increase of 142 per cent over the 2014 figure of £78m and coincides with a step change in the intensity of works taking place on the network.

Correspondingly, short-term incidents such as collisions and vehicle break downs accounted for £171m in delays, a decrease of less than 2 per cent from 2014.

The cost of recurrent demand on the TLRN due to typical daily demand levels – by far the biggest contributor to congestion – has increased by an average of 1 per cent per year from 2010 to 2015, rising from £673m to £710m.

Once recurrent demand, long-term events and short-term incidents have been accounted for, the residual delay has been attributed to local fluctuations in

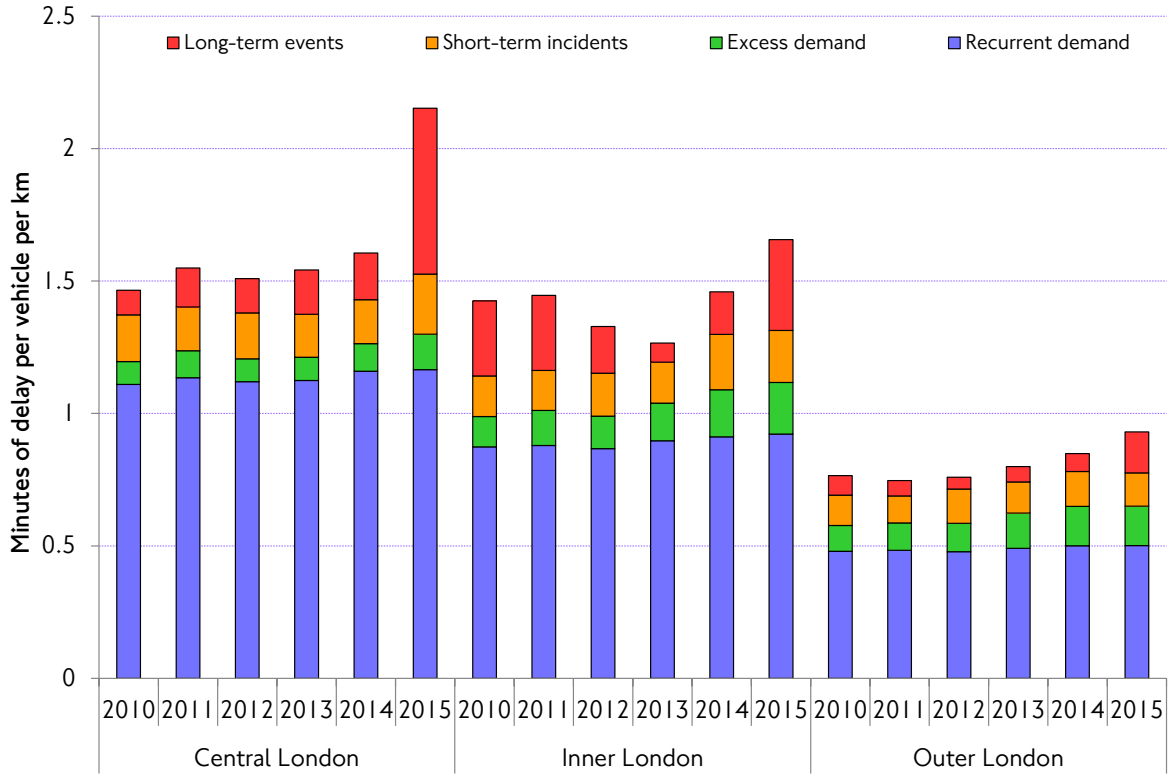
experienced demand. This excess demand accounted for £228m of delay in 2015, down 5 per cent from 2014.

AM peak delay per kilometre from 2014 to 2015 increased by 34 per cent in central London and 10 per cent in outer London. However, as the outer London area is larger and carries a greater traffic volume, the associated costs of congestion are £6m and £22m respectively. This supports the hypothesis that network changes in central London have a widespread impact across the city.

A significant conclusion from this work is that earlier research has underestimated the effect of incidents and works on network performance.

Figure 6.11 shows how these causes break down across the different functional areas of London, for the TLRN network, in the weekday morning peak period (07:00 to 10:00). It also shows how their contribution has varied across the years since 2010. In interpreting this graph – which shows average minutes of delay per vehicle kilometre – it is necessary to bear in mind the different traffic volumes in each area. Central London shows the highest average delay values, yet accounts for just 3 per cent of vehicle kilometres in London. Outer London, where delay is lowest on a per-kilometre basis, accounts for the large majority of traffic – 71 per cent – and hence its contribution to total congestion in London is that much greater.

Figure 6.11 Minutes of delay per kilometre on the TLRN. AM peak 07:00 to 10:00 working weekdays.



Source: TfL Surface Transport, Outcomes Delivery.

Particularly notable from the figure is the markedly increased contribution from long-term events, especially in central and inner London where it is up 142 per cent between 2014 and 2015.

A potential future application of this technique is to examine the effectiveness of congestion mitigation strategies, such as the Lane Rental Scheme.

6.6 Road traffic casualties

Summary

Recent years have seen substantial reductions in the number of killed or seriously injured (KSI) casualties from road traffic collisions in London. TfL has made significant progress by building new infrastructure that protects vulnerable road users and working with its partners to implement new ideas and technologies. This has enabled TfL to meet the former Mayor's target to reduce KSI casualties on London's roads by 40 per cent against a 2005-09 baseline six years early.

KSIs are now at their lowest level in London since records began and to build on this progress, the former Mayor set a new target for a further 50 per cent fall in KSIs by 2020 against the baseline.

In the 'A City for all Londoners' document the new Mayor announced his ambition for London to adopt a Vision Zero approach to road safety as part of the Healthy Streets agenda, for London to become a safer, more attractive city, promoting healthy lifestyles.

Casualty trends in London

Figure 6.12, indexed to the Government's 2005-2009 baseline for measuring progress, shows the long-term trend of casualty reduction in London since 2005.

In 2015 a total of 30,182 personal injury casualties were reported by the police in London. Of these, 136 were fatally injured, 1,956 were seriously injured and 28,090 were slightly injured.

Compared to 2014:

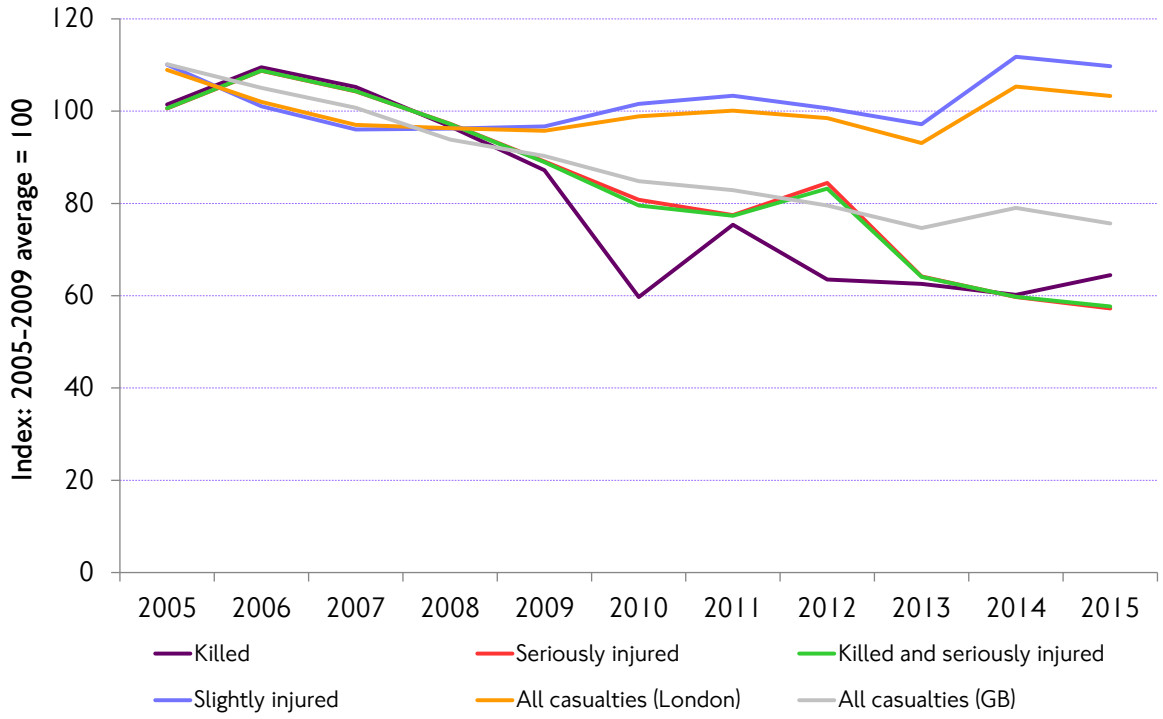
- Fatalities increased by 7 per cent, from 127 to 136, however this is 36 per cent down on the 2005-2009 baseline. The number of fatalities increased among motorcyclists from 27 to 36. However, pedal cyclist fatalities fell from 13 to 9, the second lowest level on record.
- There was a 4 per cent decrease in all serious casualties from 2,040 to 1,956, to the lowest level since records began.
- Slight casualties decreased by 2 per cent to 28,090 compared to 28,618.
- Overall casualties (all injury severities) decreased by 2 per cent compared with 2014 – largely driven by the decrease in slight casualties.

Despite overall trends of improved road safety for most road user groups, 2015 saw a concerning increase in the number of motorcyclist fatalities and serious injuries. TfL launched the first Motorcycle Safety Action Plan in 2014, and is working with its partners, including the police and the Motorcycle Industry Association, to maximise the impact of the programme. This includes funding for accredited motorcycle training centres, one-to-one training for motorcycle commuters and improving street design for motorcyclists with the UK's first Urban Motorcycle Design Handbook. TfL's ongoing motorcycle safety marketing campaign is also helping to tackle the main cause of fatal collisions, which is 'travelling too fast for the conditions'.

TfL's road safety strategy is focused on tackling the five key sources of road dangers which include; travelling too fast, distractions, carrying out risky manoeuvers, driving under the influence of drink or drugs and failing to comply with the laws of the road. Achieving this will help to halve the number of people killed or seriously injured on London's streets by 2020.

As part of TfL's drive to improve road safety awareness within the Capital, it has updated its London Collision Map with the latest road casualty data, which can be found at www.tfl.gov.uk/corporate/safety-and-security/road-safety/london-collision. By looking at the map, which has records dating back to 2005, road users can easily search for information about where and when most collisions occur.

Figure 6.12 Long term trend for road traffic casualties in London, by severity of injury. Index: 2005-2009 average baseline = 100.



Source: TfL Surface Transport - Strategy & Outcome Planning.

Table 6.5 shows casualties on London's roads for 2014 and 2015 compared to the 2005-2009 baseline. Changes in collisions and casualties during 2015 should be considered in the context of long-term casualty trends in London, as year-on-year fluctuations are not always indicative of long-term trends. It should also be noted that large percentage changes in small numbers might not be statistically significant.

In 2015 against the 2005-2009 baseline:

- Fatalities were 36 per cent below the 2005-2009 average.
- All KSI casualties were 42 per cent below the 2005-2009 average.
- Child KSIs were 55 per cent below the 2005-2009 average.
- Slight casualties were 10 per cent above the 2005-2009 average.
- Cyclist KSIs were eight per cent below the 2005-2009 average.
- Motorcyclist KSIs were 32 per cent below the 2005-2009 average.
- Pedestrian KSIs were 40 per cent below the 2005-2009 average.

Table 6.5 Road collision casualties in Greater London in 2015 compared with 2005-2009 average and 2014.

Casualty severity	User group	Casualty numbers			Percentage change in 2015 over	
		2005-2009 average	2014	2015	2014	2005-2009 average
Fatal	Pedestrians	96.0	64	66	3%	-31%*
	Pedal cyclists	16.6	13	9	-31%	-46%*
	Powered two-wheeler	43.4	27	36	33%	-17%*
	Car occupants	49.4	19	20	5%	-60%*
	Bus or coach occupants	2.4	0	1	n/a	-58%
	Other vehicle occupants	3.2	4	4	0%	25%*
	Total	**211.0**	**127**	**136**	**7%**	**-36%***
	Children (under 16 years)	**11.6**	**3**	**5**	**67%**	**-57%**
Fatal and serious	Pedestrians	1,216.4	779	730	-6%	-40%*
	Pedal cyclists	420.6	432	387	-10%	-8%*
	Powered two-wheeler	791.2	526	540	3	-32%*
	Car occupants	949.0	316	314	-1%	-67%*
	Bus or coach occupants	139.6	71	71	0%	-49%*
	Other vehicle occupants	109.8	43	50	16%	-54%*
	Total	**3,626.6**	**2,167**	**2,092**	**-3%**	**-42%***
	Child pedestrians	231.8	139	111	-20%*	-52%*
	Child pedal cyclists	32.8	13	17	31%	-48%*
	Child car passengers	42.2	6	12	100%	-72%
	Child bus or coach passengers	11.6	5	4	-20%	-66%
	Other child casualties	11.8	3	3	0%	-75%
	Children (under 16 years)	**330.2**	**166**	**147**	**-11%**	**-55%***
Slight	Pedestrians	4,214.0	4,834	4.653	-4%*	10%*
	Pedal cyclists	2,718.2	4,714	4,087	-13%*	50%*
	Powered two-wheeler	3,806.4	4,707	4,903	4%*	29%*
	Car occupants	12,426.8	11,487	11,491	0%	-8%*
	Bus or coach occupants	1,429.8	1,508	1,523	1%	7%*
	Other vehicle occupants	1,004.8	1,368	1,433	5%	43%*
	Total	**25,600.0**	**28,618**	**28,090**	**-2%***	**10%***
	Children (under 16 years)	**1,889.0**	**1,811**	**1,848**	**2%***	**-2%***

All severities	Pedestrians	5,430.4	5,613	5,383	-4%*	-1%*
	Pedal cyclists	3,138.8	5,146	4,474	-13%*	43%*
	Powered two-wheeler	4,597.6	5,233	5,443	4%*	18%*
	Car occupants	13,375.8	11,803	11,805	0%*	-12%*
	Bus or coach occupants	1,569.4	1,579	1,594	1%	2%
	Other vehicle occupants	1,114.6	1,411	1,483	5%*	33%*
	Total	**29,226.6**	**30,785**	**30,182**	**-2%***	**3%***
	Children (under 16 years)	**2,219.2**	**1,977**	**1,985**	**1%**	**-10%***

The asterisks indicate where changes are significant at the 95 per cent confidence level, applying the Poisson probability distribution. Significance testing helps to identify where change is associated with random change and where it is statistically significant. Given a set of two different numbers, the difference between these numbers is statistically significant where we are 95 per cent confident that this is not due to randomness.
Source: TfL Surface Transport - Strategy & Outcome Planning.

6.7 Road network: Customer perception and satisfaction of the TLRN

This section looks at aspects of customer satisfaction and perception of the Transport for London Road Network, based on TfL's ongoing customer surveys.

Overall evaluation of TLRN

In a similar way to that explained in section 4.4 of this report, overall customer satisfaction with the TLRN is measured on a quarterly basis and expressed in terms of a score out of 100. Recent scores have typically been around 70.

Overall customer satisfaction with the TLRN is typically lower than for the public transport networks, as shown by figure 4.10. This is partly due to opinions in online surveys being lower than in face-to-face surveys. Customer satisfaction with the TLRN is carried out as an online survey and it is estimated that if it were done face-to-face, like other TfL customer satisfaction surveys, the score would be higher by between 5 and 10 points. It is also of interest to understand what factors are driving these relative satisfaction levels.

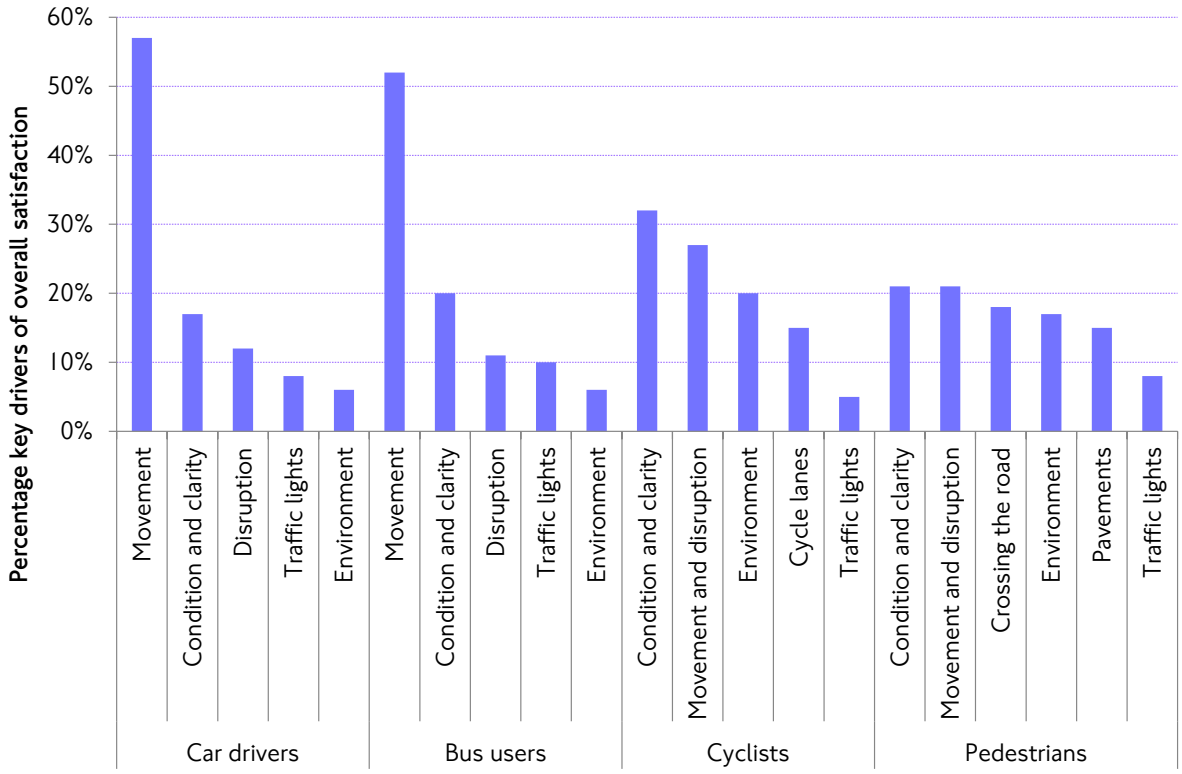
What this is showing us is, on the whole, TLRN tends to be performing well on those aspects that are more within TfL's control, but are less important to road users (for example, condition of traffic lights/street lighting/roads free from flooding). By contrast, speed of journey and traffic congestion, which are predominantly driven by overall demand for road use, stand out as areas of concern, with low satisfaction and high importance. Feeling in control of the journey and how well users share the road with each other are also identified as areas for improvement.

TfL is investing in the road network and working with London's boroughs to provide new facilities for cyclists and pedestrians, transform bridges, tunnels and pedestrian areas to make our roads safer and our road assets more reliable. Although only contributing around 7 per cent to overall delay, roadworks are perceived to be a major contributor to congestion and reduced in reliability. Timing and co-ordination of roadworks are critical to customer acceptance of the work so TfL is working with the boroughs, contractors and utility companies to ensure disruption is minimised.

Communicating simply and clearly why roadworks are taking place, how long they will take to complete and any changes to the timescale helps to mitigate dissatisfaction with roadworks. Advance warning allows road users to choose an alternative route while the work is taking place. At major construction sites TfL is also providing better information to support and help people navigate the site.

Figure 6.13 shows how the various drivers of satisfaction break down across several different road user groups.

Figure 6.13 Comparing drivers of satisfaction for different users. Key drivers of overall satisfaction.



Source: TfL Customer and Employee Insight.

6.8 Road based freight and servicing

Introduction and content

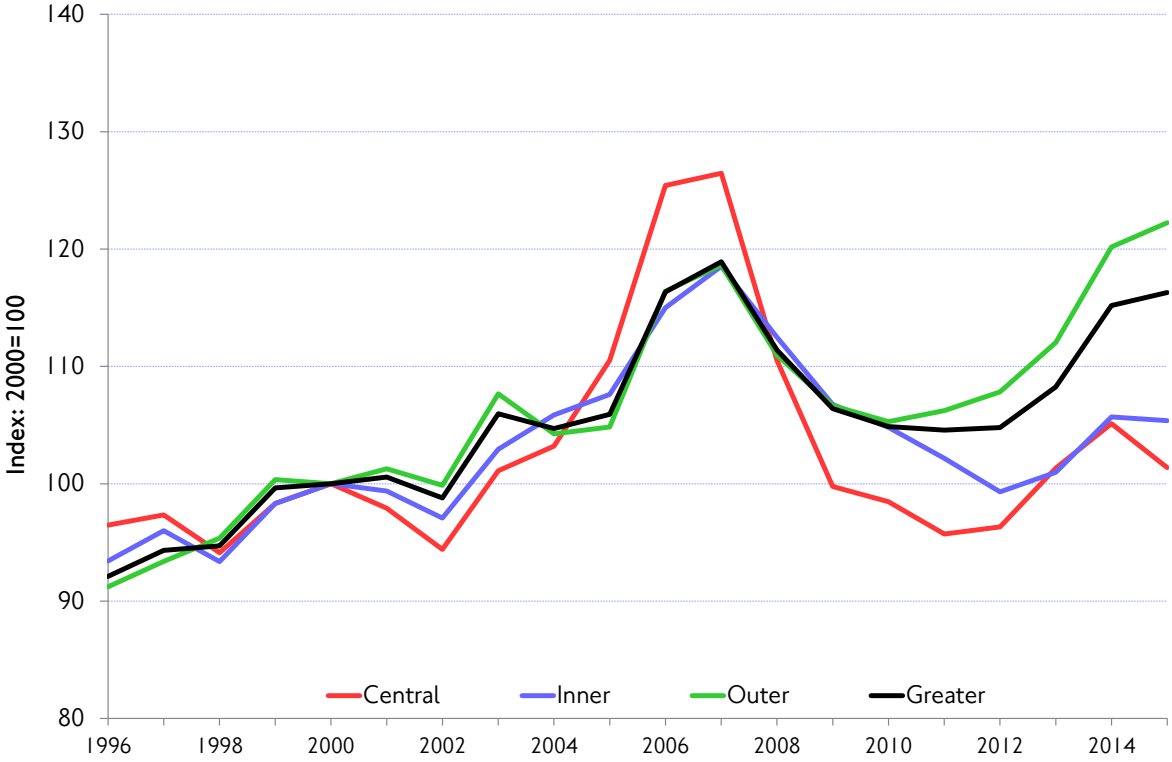
Road is by far the dominant mode for goods transport in London in terms of the weight of goods lifted – accounting for around 90 per cent of all tonnage. This section looks at trends in the volumes of road freight vehicles, in terms of vans and heavy goods vehicles.

Trend in volumes of vans

Vans (light goods vehicles or LGVs) have been increasing in absolute terms and as a proportion of total traffic in London over recent years. Figure 6.14 shows the trend in light goods vehicle traffic (vehicle kilometres) in central, inner, outer and Greater London. Figure 6.15 is the equivalent trend in the volume of light goods vehicles crossing the central, inner and boundary cordons, corresponding to central London, inner London and the GLA boundary respectively. Note that the counting cordons relate to a specific set of locations, which are optimised to measure radial traffic movements. They therefore may not be fully representative of overall traffic trends

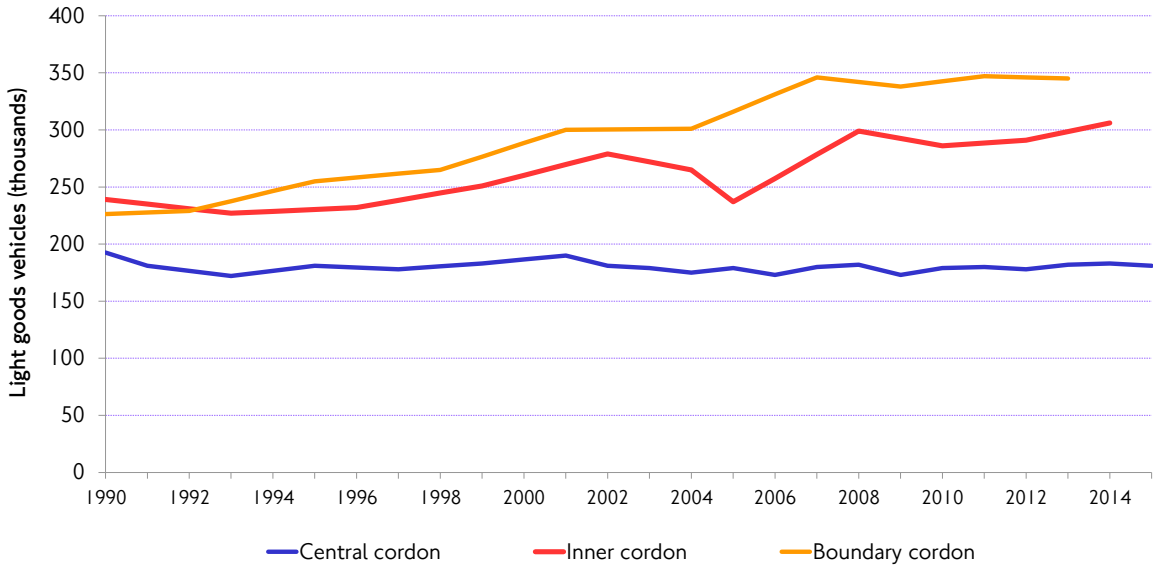
or levels 'within' the areas that they enclose, and therefore some differences between the two indicators may be expected.

Figure 6.14 Trends in LGV traffic (vehicle kilometres) in central, inner, outer and Greater London. Index: Year 2000=100.



Source: Department for Transport.

Figure 6.15 Daily number of light goods vehicles crossings at the three cordons: 24 hour flows, 1990-2015.



Source: TfL Surface Transport, Outcomes, Insight and Analysis.

Nevertheless, both figures 6.14 and 6.15 show evidence of a progressive if relatively slow increase dating back to at least the mid 1990s. On a long-run basis

based on figure 6.14, the average annual increase in vans (annual vehicle kilometres) over the period between 1996 and 2015 has been 0.3 per cent in central London, 0.6 per cent in inner London, 1.6 per cent in outer London and 1.2 per cent in Greater London as a whole. Cordon-based data shows a similar general trend, with average annual changes of -0.2 per cent at the central London cordon, 1.0 per cent at the inner cordon, and 1.8 per cent at the London boundary cordon since 1990.

LGVs were responsible for 14 per cent of the vehicle kilometres travelled by all motorised road vehicles in London in 2015, compared to 10 per cent in 1993 and 11 per cent in 2000.

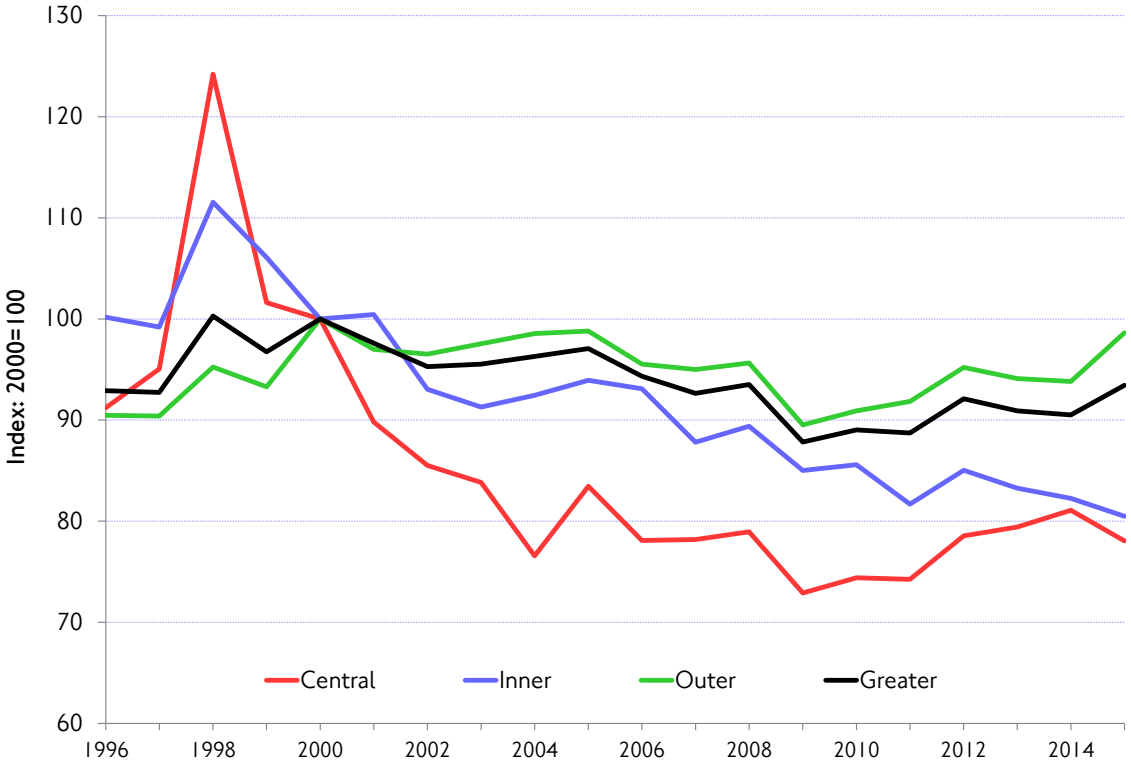
The most notable difference between figures 6.14 and 6.15 is the notional impact of the recession in the latter part of the last decade. Figure 6.14 shows this effect as being significant, with powerful growth pre-recession and an equally steep decline following it. Although perhaps intuitive, given the known connection between goods vehicle traffic and economic activity, the cordon data, however, does not show this feature.

Also notable – evident from both Figure 6.14 and 6.15, is that the rate of growth in central London has been relatively muted – the central cordon, for example, suggesting a generally flat trend over the past 25 years, and recent totals below those of the early 1990s. This may be considered surprising, given the acknowledged servicing needs of the growing central London economy, but it is not out of line for the equivalent trend for general traffic at this cordon (see figure 6.4), which fell by 25.6 per cent between 2000 and 2015.

Trends in the volume of lorries

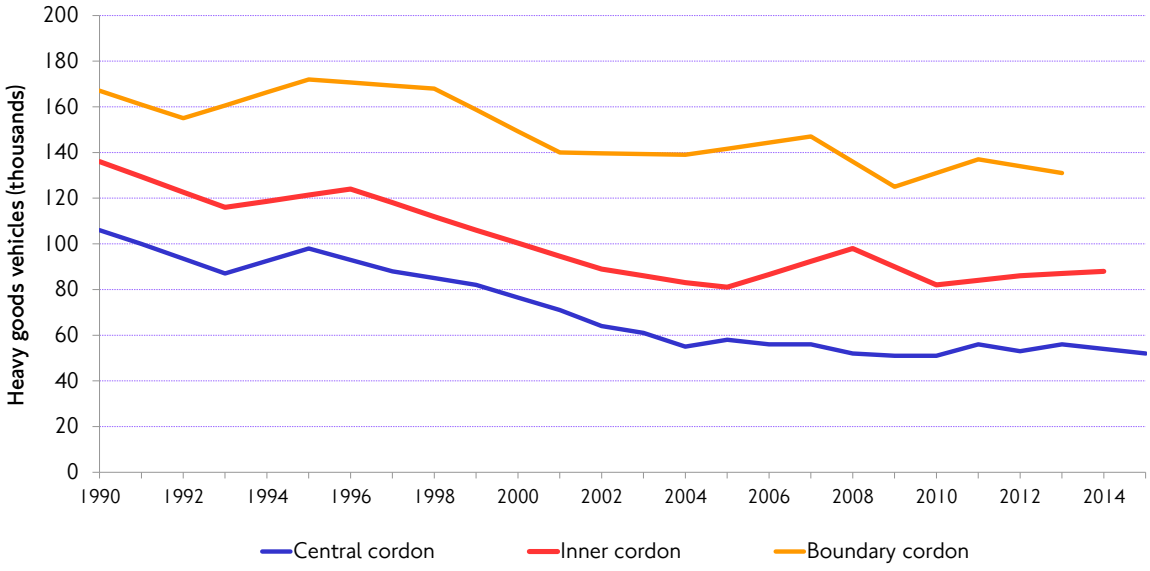
Figure 6.16 shows the trend in heavy goods vehicles traffic (vehicle kilometres) in central, inner, outer and Greater London. Figure 6.17 is the equivalent trend in the volume of heavy goods vehicles crossing the central, inner and boundary cordons, corresponding to central London, inner London and the GLA boundary respectively.

Figure 6.16 Trends in HGV traffic (vehicle kilometres) in central, inner and outer London. Index: Year 2000=100.



Source: Department for Transport.

Figure 6.17 Daily number of heavy goods vehicles crossing at the three cordons: 24 hour flows, 1990-2015.



Source: TfL Surface Transport, Outcomes, Insight and Analysis.

Looking first at the vehicle kilometre data, HGV traffic has declined steadily across all areas of London, and is 6.6 per cent lower than in 2000 at the Greater London level. However, HGV traffic grew in the latest year for the first time since 2012, driven by a 5.1 per cent increase in outer London. In 2015 HGVs accounted for 2.9 per cent of total vehicle kilometres in central London, 3.0 per cent in inner London,

3.8 per cent in outer London, and 3.6 per cent at the Greater London level. Especially notable was the sharp apparent decline in HGV traffic in central London between 2000 and 2010 – down by 25.6 per cent overall, although in more recent years this trend seems to have stabilised.

Cordon data (figure 6.17) also shows a long-term trend of decline in HGV volumes, in this case fairly consistently across all parts of London. On this basis the number of HGVs crossing the central cordon in 2015 was 32.0 per cent lower than in 2000, with equivalent reductions of 12.3 per cent for the inner cordon to 2014, and 12.2 per cent at the London boundary cordon (to 2013).

The volumetric trends for HGVs, alongside those for vans, are not what might immediately be expected in the context of a growing city over the past two decades and related trends such as the rise of internet shopping. In central London the long-term trends broadly reflect those for general traffic, but with an apparent 'substitution' effect, with vans making up an increasing proportion of traffic in recent years. The trends should also be seen in the context of the removal of effective road network capacity for general traffic – previously estimated by TfL at more than 25 per cent in central London between 1996 and 2009 (see Travel in London report 4, section 4.13), which means that vans and lorries are becoming increasingly visible as other motorised traffic declines, and as competition for declining overall road space intensifies.

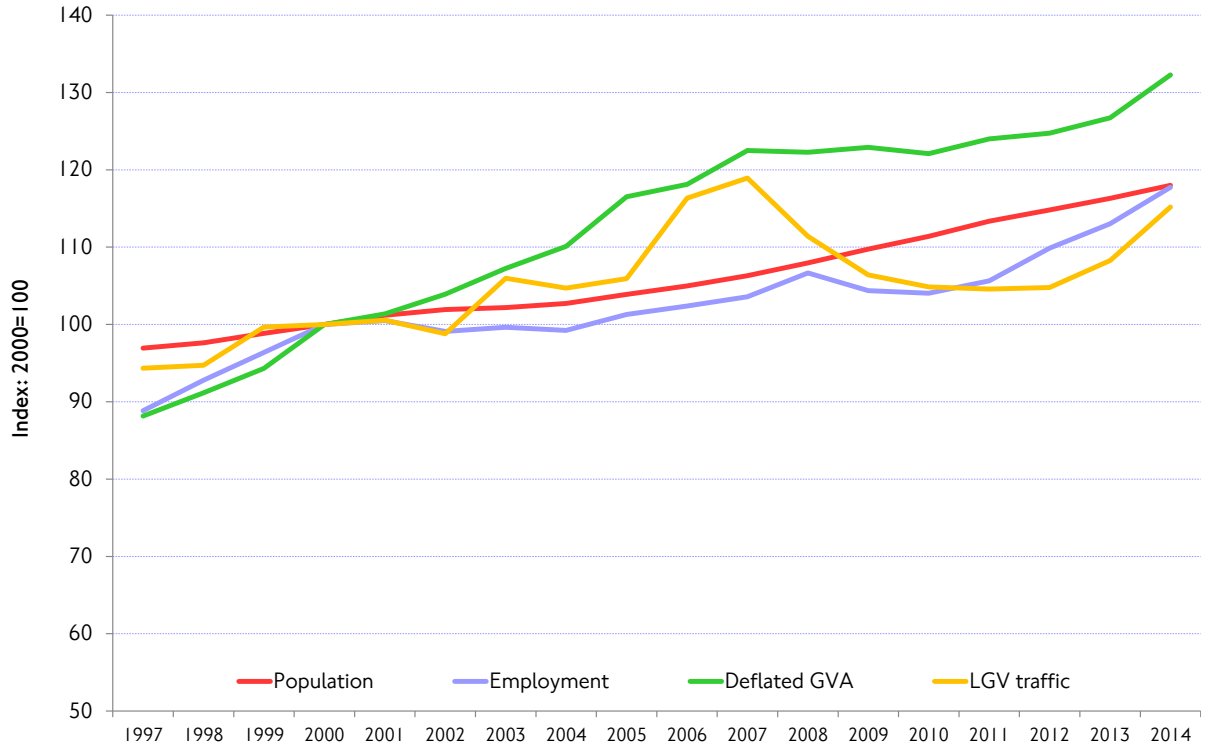
Goods vehicles in perspective – relationship to population, jobs and gross value added

All other things being equal, there should be a fairly stable relationship between goods vehicle traffic and population/economic activity. This section explores these relationships over the last 15 years. Growth in goods vehicle traffic has been more erratic than growth in population, jobs and GVA, probably reflecting the cyclical nature of the economy. However, over the period covered by the review, the overall scale of the relationship has not changed substantially.

By 2007, light goods vehicle traffic was 19 per cent higher than in 2000. Following a post-recession decline, however, by 2012 LGV traffic fell by 12 per cent from the 2007 high. Over the past three years, LGV traffic has started to increase again, and is 16 per cent higher than in 2000 (figure 6.18).

In contrast, population and employment in London have grown at a steadier rate, albeit with a small decline in jobs following the recession. Both population and jobs are around 20 per cent higher than in 2000. London GVA has grown at a faster rate, and is now 32 per cent higher than in 2000. London GVA stagnated between 2007 and 2012, in contrast to the declines in employment and LGV traffic over this period.

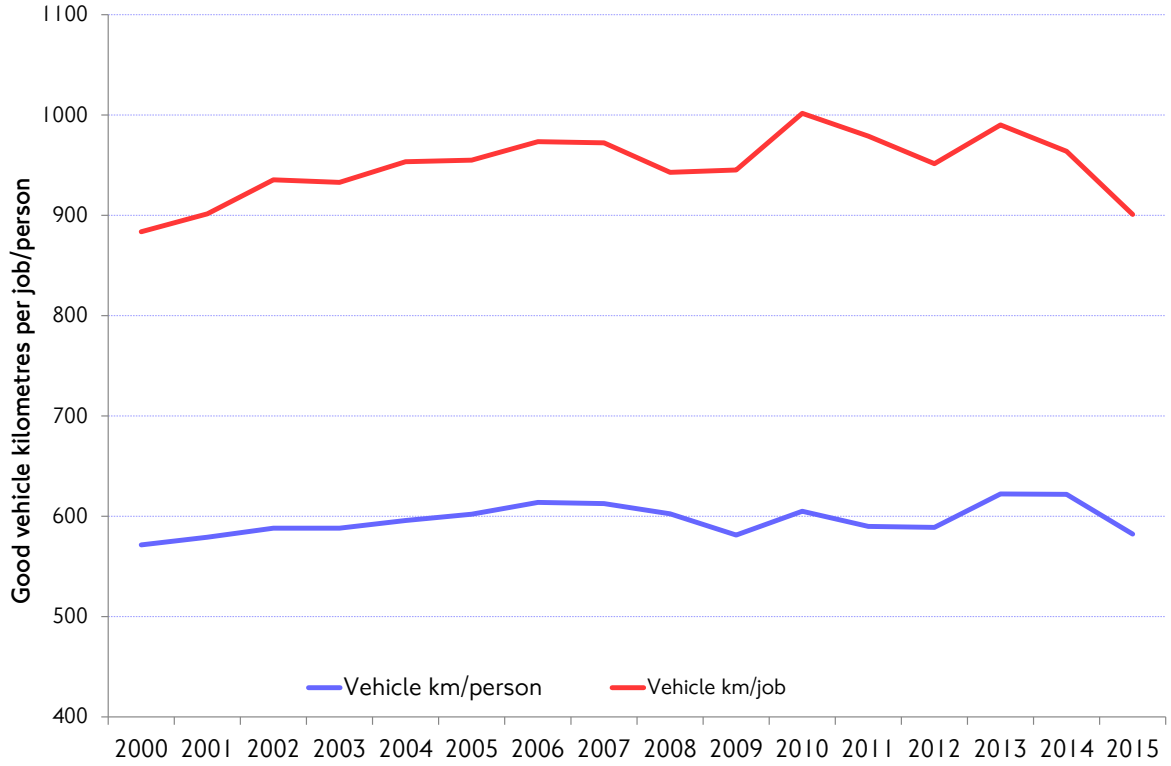
Figure 6.18 Trend in population, employment, GVA and LGV traffic. Index: 2000=100.



Source: TfL Planning, Strategic Analysis.

Looking at total goods vehicle traffic per London resident, the trend has been fairly stable (figure 6.19). The measure grew steadily until 2006, with significant variability in recent years. There are currently 582 goods vehicle kilometres per London resident each year.

Figure 6.19 Trend in goods vehicle traffic per London resident.



Source: TfL Planning, Strategic Analysis.

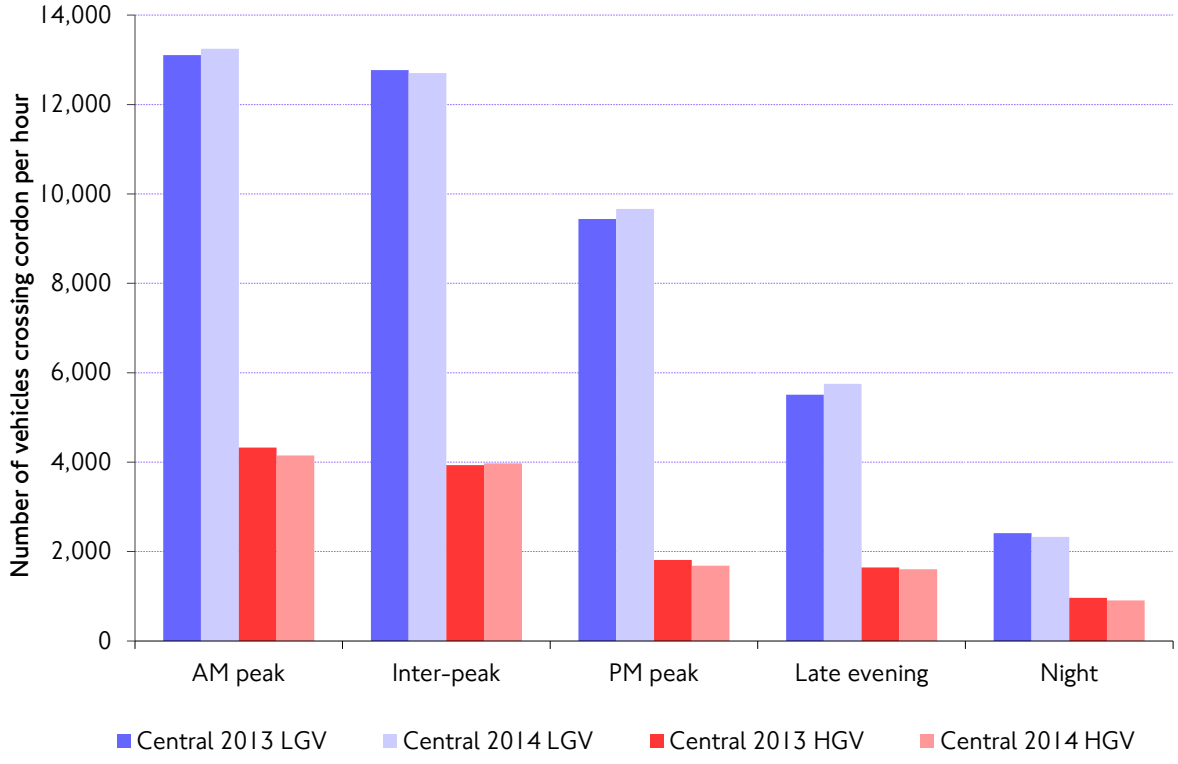
Comparing the number of goods vehicle kilometres per job in London (also figure 6.19), the trend is fairly similar, with an increase up to 2006 followed by a period of variable change. However, this measure has declined over the past two years, and there are currently 901 goods vehicle kilometres per year for each job in London.

Distribution of goods vehicle traffic throughout the day

The volume of goods vehicle traffic varies throughout the day and between different parts of London. In central London (figure 6.20), goods vehicle flows are highest in the morning and inter-peak periods. LGV flows are 37 per cent higher in the AM peak than the PM peak, with HGV flows 147 per cent higher.

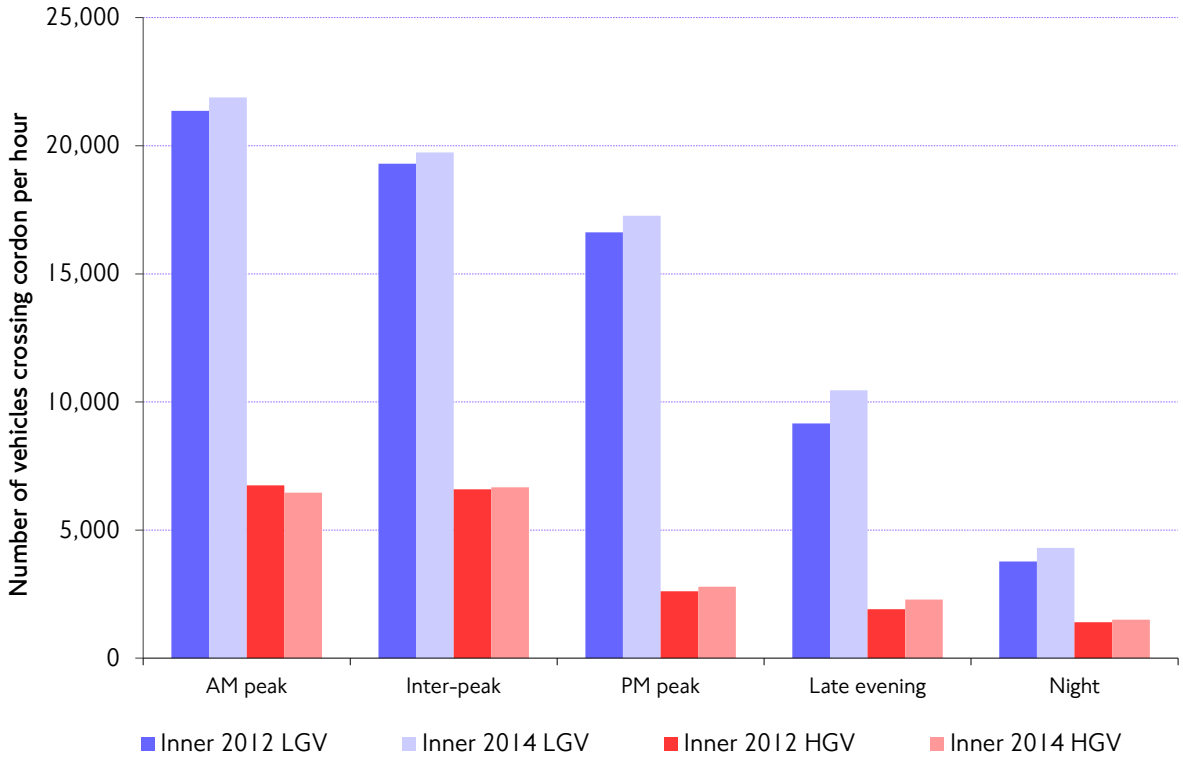
Goods vehicle flows across the inner cordon show a similar pattern, with flows highest in the AM peak period, although for HGVs flows in the inter-peak period are very similar. LGV flows in the PM peak period are around 21 per cent lower than in the morning peak (figure 6.21).

Figure 6.20 Hourly number of LGVs and HGVs crossing the central cordon by time period, 2013 and 2014.



Source: TfL Surface Transport, Outcomes, Insight and Analysis

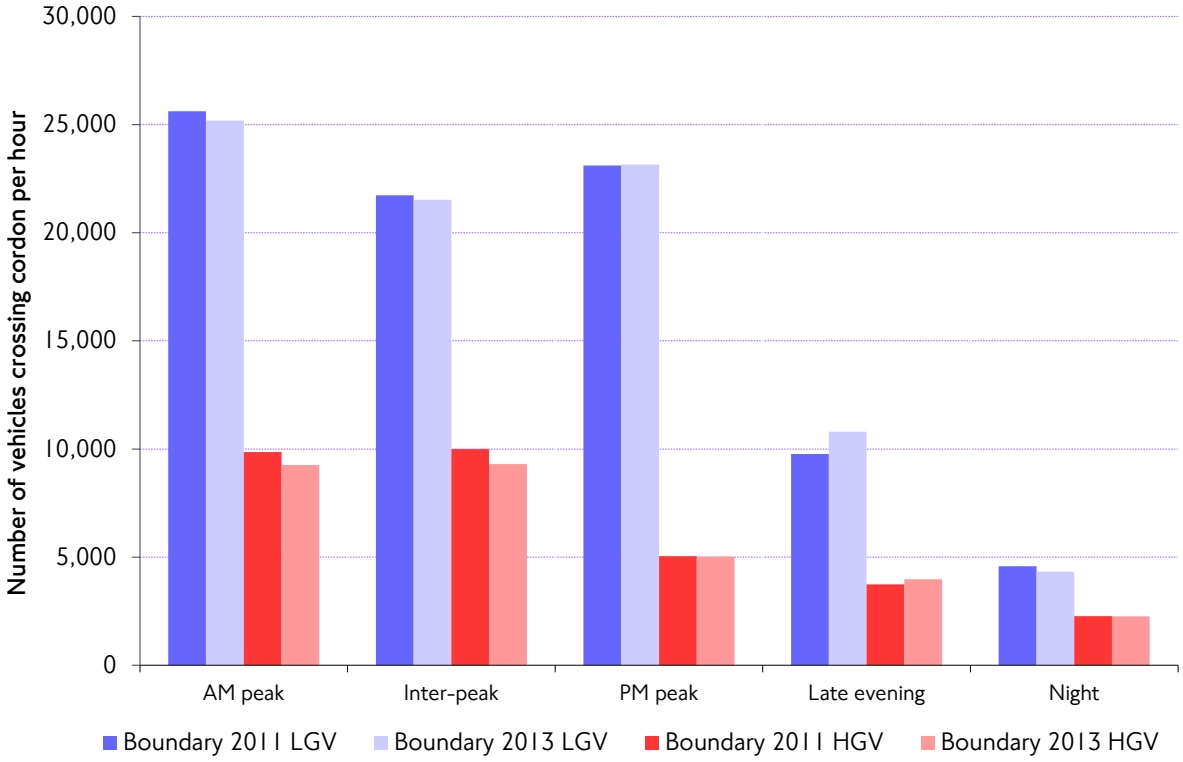
Figure 6.21 Hourly number of LGVs and HGVs crossing the inner cordon by time period, 2012 and 2014.



Source: TfL Surface Transport, Outcomes, Insight and Analysis

In contrast, the number of goods vehicles crossing the boundary cordon are fairly similar during the day, with flows only falling during the late evening. Again, HGV flows are highest in the AM and inter-peak periods (figure 6.22).

Figure 6.22 Hourly number of LGVs and HGVs crossing the boundary cordon by time period, 2011 and 2013.



Source: TfL Surface Transport, Outcomes, Insight and Analysis

6.9 Licensed taxis and private hire vehicles

This section looks at recent trends relating to licensed taxis and licensed private hire vehicles in London.

Licensed taxis

Figure 6.23 shows the trend in the number of licensed taxis and private hire vehicles (PHVs), along with their drivers, within London since 2008/09. The number of licensed taxis in London has remained fairly stable in recent years, although it has dropped by 3 per cent in 2015/16 to 21,813. The total number of licensed taxi drivers also dropped slightly to 24,888 in 2015/16, the lowest level since 2008/09.

Licensed private hire

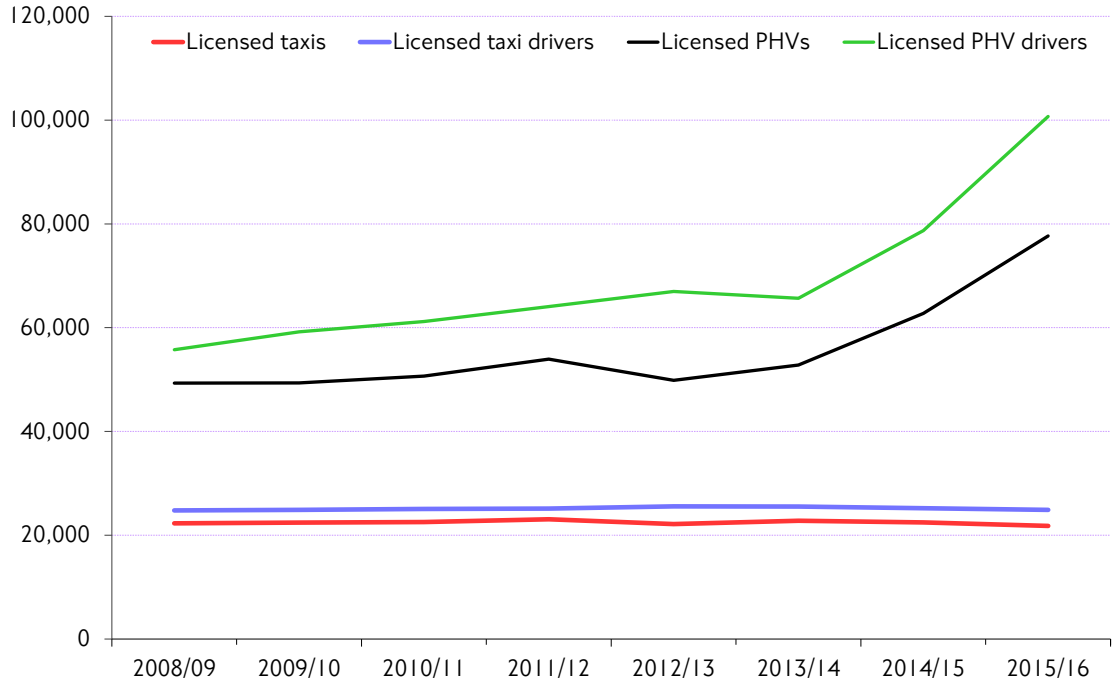
The number of PHVs has increased by 58 per cent since 2008/09, up to 77,687 in 2015/16 and up by 24 per cent in the most recent year alone. While the number of registered PHVs has grown in most years, the number reduced by 8 per cent from 2011/12 to 2012/13. This is likely to have been caused at least in part by the introduction of a 10–year age limit for PHVs in June 2012, meaning any PHVs older than this were not able to renew their registration from that date.

Meanwhile the number of licensed PHV drivers has increased by 81 per cent over the same period, up to 100,709 in 2015/16. From 2008/09 through to 2012/13 the

number of licensed PHV drivers grew steadily at an average rate of around 5 per cent per year. In 2013/14 there was a 2 per cent reduction in registered PHV drivers, perhaps attributable to a lagged effect of the introduction of the PHV age limit described above. In the last year though, the number of registered PHV drivers has grown by 28 per cent. One factor that has contributed to this acceleration is the launch of Uber's 'UberX' product in July 2013.

Although Uber was active in London from June 2012, at that time the firm operated only its 'UberLUX' product, offering premium minicab services at relatively high prices. The launch of UberX in July 2013 represented a change in London's PHV market where it became easier, and in many cases cheaper, for people to find and use minicabs. Demand for this service appears to have created a larger market than previously existed, leading to more registrations of PHV drivers.

Figure 6.23 Recent trend of licensed London taxis and private hire vehicles.



Source: Taxi and Private Hire, TfL Surface Transport.

Prevalence of PHVs in traffic in central London and recent trends

To help better understand the prevalence of PHVs in traffic in central London, given recent changes to this market, TfL undertook traffic counts and analysis of camera-based data during spring 2016. This section summarises the key results from this exercise.

In terms of prevalence in traffic, the spring 2016 surveys found that PHVs constituted 12 per cent of motorised traffic circulating in the Congestion Charging zone between the hours of 06:00 and 20:00. This was the first time that these vehicles had been specifically quantified – enhanced manual classified traffic counts were used at a sample of sites that had previously been used to quantify traffic in the charging zone as part of TfL's Congestion Charging impacts monitoring programme. Table 6.6 summarises the findings of these counts.

Table 6.6 Traffic composition in the central London Congestion Charging zone (vehicle kilometres). Representative weekday, 06:00 to 20:00, spring 2016.

	A roads	Bridges	Minor roads	TLRN	*Total (2016)*	*Percentage (2016)*	*Total (2007)*	*Percentage (2007)*
Private cars (excl. PHVs)	94,137	5,032	56,595	44,516	*200,280*	*18%*	*440,000[1]*	*33%[1]*
PHVs	58,888	3,465	42,547	25,678	*130,578*	*12%*		
Taxis	106,305	5,069	88,535	29,061	*228,970*	*20%*	*270,000*	*20%*
Motorcycles	35,338	2,046	28,578	22,671	*88,633*	*8%*	*120,000*	*9%*
Light goods	101,482	4,986	66,642	48,879	*221,989*	*20%*	*250,000*	*19%*
Medium goods	17,884	742	11,927	9,430	*39,983*	*4%*	-	*0%*
Heavy goods	8,061	587	3,922	6,658	*19,228*	*2%*	*70,000*	*5%*
All buses and coaches	41,637	2,537	5,644	10,050	*59,868*	*5%*	*60,000*	*5%*
Pedal cycles	68,629	5,600	33,261	37,386	*144,876*	*13%*	*110,000*	*8%*

Source: TfL Surface Transport, Outcomes, Insight and Analysis.
1. Separate values for cars and PHVs were not collected in 2007. These are the combined values for both types of vehicle.

While a direct comparison with previous counts undertaken in relation to Congestion Charging is not possible, the counts suggested that, over the period between 2007 and 2016:

- Total vehicle kilometres travelled in the central London Congestion Charging zone decreased from an estimated 1.34 million, weekdays between the hours of 06:00 to 20:00, in 2007 to 1.13 million in 2016 – a reduction of 15 per cent.
- Within this reduced total, the proportion of traffic circulating in the central London charging zone between 06:00 and 20:00 on working weekdays that is accounted for by vehicles with body type 'car' (not including licensed Hackney Carriages) decreased – from 33 per cent in 2007 to 30 per cent in 2016.
- Of this 30 per cent, the 2016 counts revealed that licensed PHVs accounted for12 per cent of traffic circulating in the charging zone, equivalent to 40 per cent – or four in every 10 – of all cars.
- Proportions of other vehicles in the 2016 counts were broadly comparable to those of 2007, within the context of reduced overall vehicle kilometres. However, the substantial increase in pedal cycle kilometres – up from 8 per cent of all vehicle kilometres in 2007 to 13 per cent in 2016 – is particularly noteworthy.

PHVs in central London had not previously been enumerated on this basis, therefore it was not possible, from these counts, to examine changes in the volumes of PHVs. This could, however, be approached through camera-based analysis which, on the basis of a limited sample and over a limited period of time, suggested that there had been large volumetric increases over recent years.

Table 6.7 Change in volumes of licensed PHVs observed circulating in the central London Congestion Charging zone (CCZ).

Total PHV entries to CCZ – first Friday in November

Time period	2013	2014	2015	% change 2013 to 2014	% change 2014 to 2015	% change 2013 to 2015
00:00-07:00	17,881	17,434	23,164	-2%	33%	30%
07:00-10:00	6,622	8,347	9,470	26%	13%	43%
10:00-16:00	13,099	16,465	20,002	26%	21%	53%
16:00-19:00	6,909	8,930	11,434	29%	28%	65%
19:00-00:00	15,273	20,548	28,978	35%	41%	90%
Total day	59,784	71,724	93,048	20%	30%	56%
CC hours	24,207	30,540	36,618	27%	21%	54%

Total PHV entries to CCZ – first Saturday in November

Time period	2013	2014	2015	% change 2013 to 2014	% change 2014 to 2015	% change 2013 to 2015
00:00-07:00	22,936	25,823	35,408	13%	37%	54%
07:00-10:00	4,446	5,181	6,344	17%	22%	43%
10:00-16:00	9,564	11,847	18,319	24%	55%	92%
16:00-19:00	5,940	7,956	10,978	34%	38%	85%
19:00-00:00	16,287	21,471	28,404	32%	32%	74%
Total day	75,872	92,432	122,476	22%	33%	61%
CC hours	17,498	21,669	31,363	25%	43%	79%

Source: TfL Surface Transport, Outcomes, Insight and Analysis.

Table 6.7 summarises results from this analysis, which compared a representative Friday and Saturday in November of each year between 2013 and 2015. Notable features of this comparison are that:

- Comparing sample Fridays in each year, the number of licensed PHVs observed circulating in the charging zone has increased by 56 per cent (24 hours) between 2013 and 2015. The equivalent increase on Saturdays was 61 per cent.
- The largest proportionate increases were seen during the late evening period on Fridays (an increase of 90 per cent between 2013 and 2015) and the mid-day period on Saturdays (an increase of 92 per cent).
- Over the same period, considering a 24 hour day, the number of licensed Hackney Carriages observed circulating within the charging zone decreased by14 per cent on the sample Friday, and by 8 per cent on the sample Saturday. The total number of vehicles licenced as PHVs in London increased by 36 per cent between late October in 2013 and 2015, compared to a 1 per cent decrease in licenced Hackney Carriages.

In considering these trends, it is necessary to bear in mind that overall traffic volumes within the charging zone have been falling for several years. Although there is evidence, therefore, of a substantial recent increase in PHVs, particularly in

central London, this has largely been in terms of a 'substitution' for other vehicles. Of themselves they are not therefore contributing directly to increased congestion, although congestion would be lower had this increase not taken place.

6.10 Key reference statistics

Table 6.8 Summary of key indicators of travel demand on London's roads.

Road traffic Mode and indicator	Units	2000 or 2000/01	2014 or 2014/15	2015 or 2015/16	Difference (%) 2015 or 2015/16 vs	
					2000	2014/15
Motor vehicle km – GLA	Billions per year	32.4	29.3	29.2	-9.9	-0.3
Motor vehicle km – central	Billions per year	1.3	1.0	1.0	-20.5	1.0
Motor vehicle km – inner	Billions per year	9.0	7.5	7.5	-16.8	-0.3
Motor vehicle km – outer	Billions per year	22.1	20.8	20.7	-6.4	-0.4
Central London cordon	'000 motor vehicles	1,512[1]	1,172	1,143	-24.4	-2.5
Inner London cordon	'000 motor vehicles	2,129[2]	1,938	n/a	n/a	n/a
Outer London cordon	'000 motor vehicles	2,567[1]	n/a	n/a	n/a	n/a
Thames screenline	'000 motor vehicles	963	790	n/a	n/a	n/a
Cycling						
Cycles – central cordon	Cycles counted thousand	51[1]	172	157	207.8	-8.7
Cycles – inner cordon	Cycles counted thousand	25[2]	69	n/a	n/a	n/a
Cycles – outer cordon	Cycles counted thousand	9[1]	n/a	n/a	n/a	n/a
Cycles – Thames screenline	Cycles counted thousand	30	95	n/a	n/a	n/a

1.2001
2.2002

Indicator	Units	2000 or 2000/01	2014 or 2014/15	2015 or 2015/16	Difference (%) 2015 or 2015/16 vs	
					2000	**2014/15**
Road network						
Average traffic speed – central London	Km per hour	n/a	13.6	12.2	n/a	-10.5
Average traffic speed – inner London	Km per hour	n/a	18.9	17.9	n/a	-5.4
Average traffic speed – outer London	Km per hour	n/a	30.6	30.0	n/a	-1.9
Average traffic delay – central London	Minutes per km	n/a	1.9	2.3	n/a	17.9
Average traffic delay – inner London	Minutes per km	n/a	1.4	1.5	n/a	6.7
Average traffic delay – outer London	Minutes per km	n/a	0.8	0.8	n/a	0.0

7. Supporting the economy, growth, homes and jobs

7.1 Introduction and contents

This chapter picks up several over-arching themes relating to the role that transport can play in supporting London's population and economic growth. It firstly looks at the scale of the future transport challenge – London is expected to grow to close to 10 million people by 2031 and to 10.5 million in 2041. This growth will bring increasing demand for travel, which must be foreseen and provided for by the transport networks.

It then addresses the particular challenge of providing adequate housing for Londoners, specifically illustrating the role that transport can play in 'unlocking' housing development – by providing connectivity to new areas and developments.

The chapter then looks at long-term travel trends for travel to central London – the 'Central Activities Zone' (CAZ), illustrating some of the important transport challenges in this area.

Finally, the chapter describes some new insight from a study to develop a 'travel segmentation' for London residents. This is important as it provides an improved basis for assessing the need for, and likely responses to, a range of interventions or policies on a spatially-disaggregate basis across Greater London.

7.2 Growth in population and jobs – the scale of the future transport challenge

Current and future population

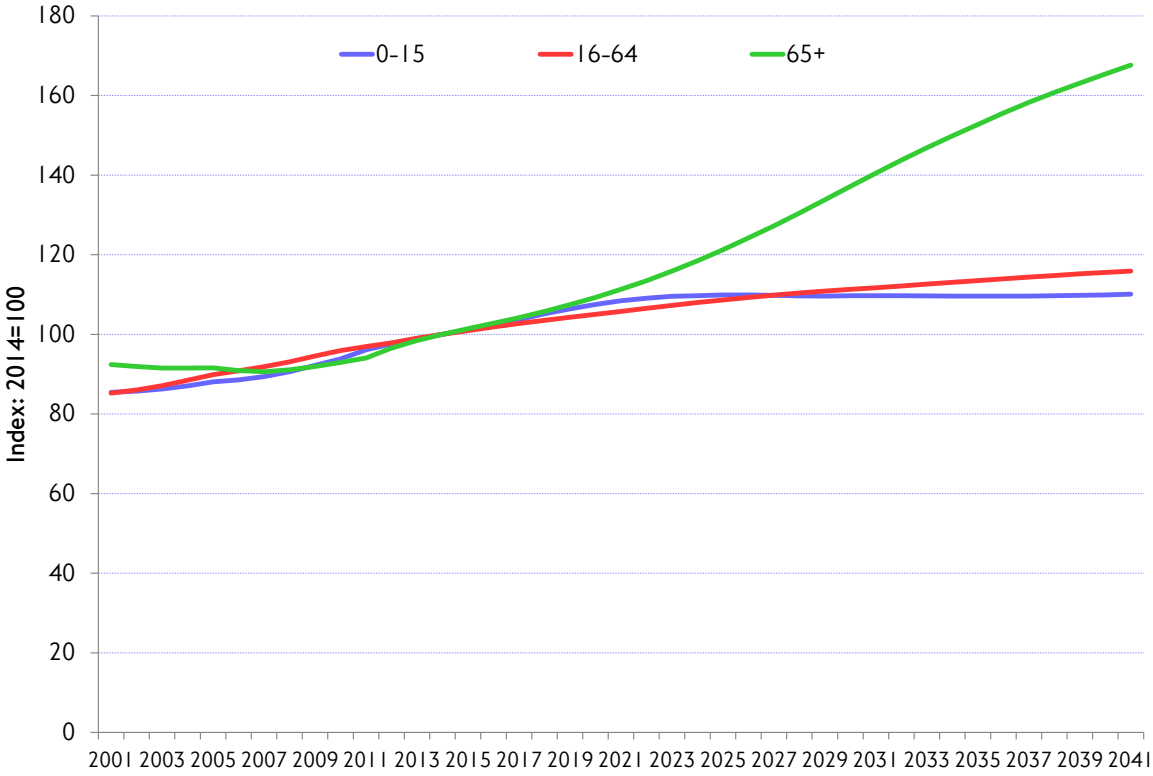
Since 2001, London's population has increased by more than 1.3 million people – more than the entire population of Birmingham. Population growth has been driven by two factors: a strong growth in the number of births in London (23 per cent increase since 2002) and high levels of net international migration. This has been partly balanced by people leaving London for the rest of the UK (ie net outward domestic migration). In 2015, London's population topped 8.6 million. The population is expected to continue to rise to close to 10 million by 2031 and 10.5 million by 2041.

The changing characteristics of London's population

As well as growth in numbers, London's population is also expected to change in terms of its composition. London's rapid population growth over the last decade has been driven particularly by younger people of working age, with very low growth in the numbers of older people. Younger people tend to live in smaller households, focused in inner London, and are less likely than average to own a car.

Projecting forward however, growth is expected to be much higher among those aged 65 and over, particularly from 2020. The number of London residents aged over 65 is therefore expected to be much higher in 2041 than at present (figure 7.1). People aged 65 and over tend to have lower overall trip rates and different journey purposes than those of working age people, with much less commuting and more leisure travel.

Figure 7.1 Population change by age group, 2001-2041.



Source: TfL Planning, Strategic Analysis.

Spatial aspects of population growth

The spatial aspects of this growth will have a key influence on where travel demand pressures will become particularly intense, and will also affect the character of that demand. For example, inner London residents tend to travel more, compared to outer London residents, and are more likely to use public transport. Outer London residents tend to use cars more, and so growth here may lead to a particular increase in car travel.

Concentration of future growth around London's Opportunity and Growth Areas, for example in the Growth Boroughs which hosted the 2012 Games in east London, should lead to growth that is more efficient – in transport terms – by offering the prospect of co-located homes and workplaces alongside high public transport connectivity.

Looking historically at the spatial distribution of population growth over the last decade, growth has been highest in the east sub-region and growth is expected to remain focused there, with about 40 per cent of London's population growth to 2041. This will mean an additional 600,000 people, about the same population as Glasgow, living in the east sub-region.

Current and future employment

London's employment has grown from 4.6 million jobs in 2000 to 5.6 million in 2015 and is projected to grow to 6.3m in 2031, and 6.8 million jobs by 2041.

London's employment profile has changed over the past 15 years, resulting in a shift from lower-density employment uses to higher density uses. These sectoral trends are projected to continue with manufacturing and wholesale expected to

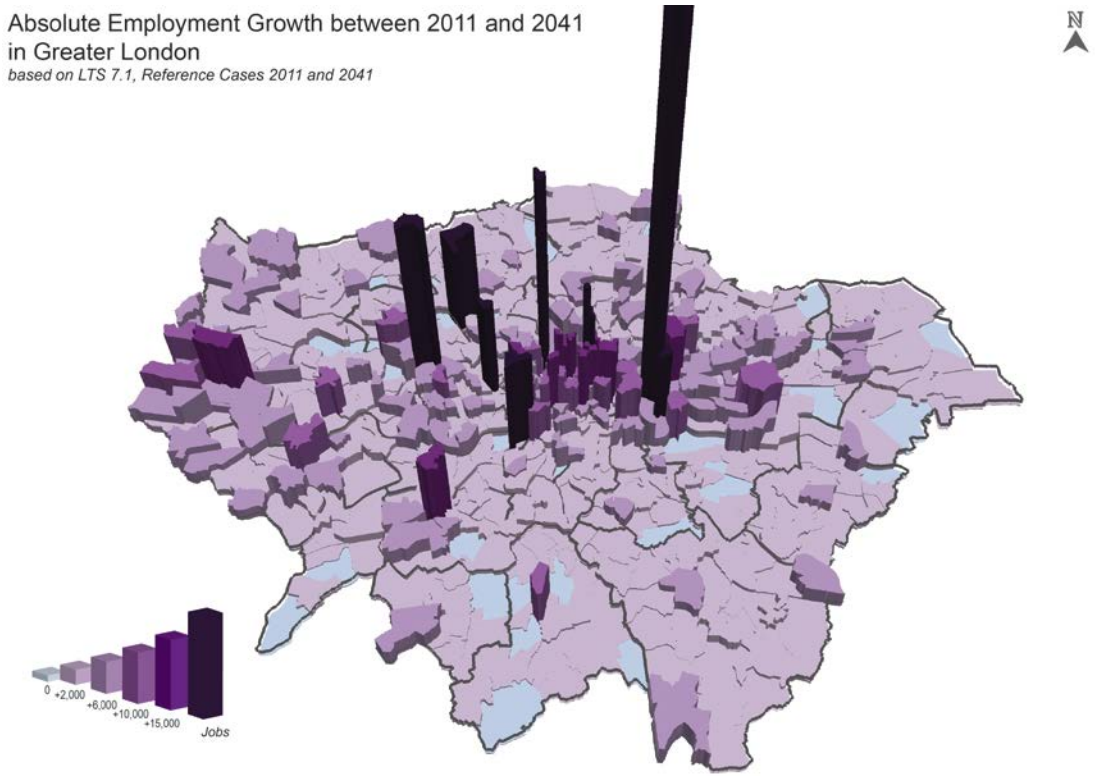
decline by 80 per cent and 40 per cent respectively by 2041, while professional services are expected to increase by almost 80 per cent. This is expected to have an impact on travel demand, with public transport mode shares expected to increase and the car mode share to reduce for travel to work.

Spatial patterns of future employment growth

Projecting forward to 2041 (figure 7.2), the largest growth in employment is expected in central and inner London where 1.4 million jobs are expected in the City of London and Westminster alone, with a further 1.4 million spread across the remainder of the central sub-region (Camden, Islington, Kensington and Chelsea, Lambeth, and Southwark).

London's Opportunity Areas will also play a key role in supporting the Capital's growth, with potential to support significant numbers of new homes and jobs (figure 7.2).

Figure 7.2 Employment change – 2011 to 2041.



Source: TfL Planning, Strategic Analysis.

Transport and London's economy

London is a global city specialising in high value internationally traded services. London benefits from an agglomeration driven growth process that is self-sustaining provided the conditions for its success are maintained – in particular access to a large and diverse labour market. Population growth is a concomitant of economic growth.

Ensuring the transport system provides adequate effective connectivity is critical to this. In practical terms this means:

- Sufficient quality of connections to a sufficiently wide range of locations to meet the housing needs of the potential workforce of the global employment centres.
- Transport capacity bottlenecks are tackled before they have a material impact on the willingness of the workforce to be employed in the global employment centres.
- London's success is due in no small part to its extensive integrated public transport network. Growth and expansion of economic activity and rising population increases the demand for travel and puts more pressure on the network.
- Efficient movement of people from, to and through the CAZ is vital to its continued success, so while the centralisation of activity brings agglomeration benefits there is also growth in demand for radial peak travel and a continuing 'tidal flow'.

The massive fixed costs (transport and place) mean that a very limited range of locations are capable of hosting growth in functions contributing to London's global employment:

- expansion around the CAZ periphery;
- densification of the existing CAZ; and
- a small number of satellite zones with excellent connections to the heart of the transport system – Isle of Dogs, Stratford, Old Oak Common.

7.3 Implications of London's growth for future travel demand

The demand for travel in London is constantly changing and will continue to do so as the city evolves. Analysing that change and forecasting the scale of the future challenge is critical to developing the right policy solutions to support London's future success.

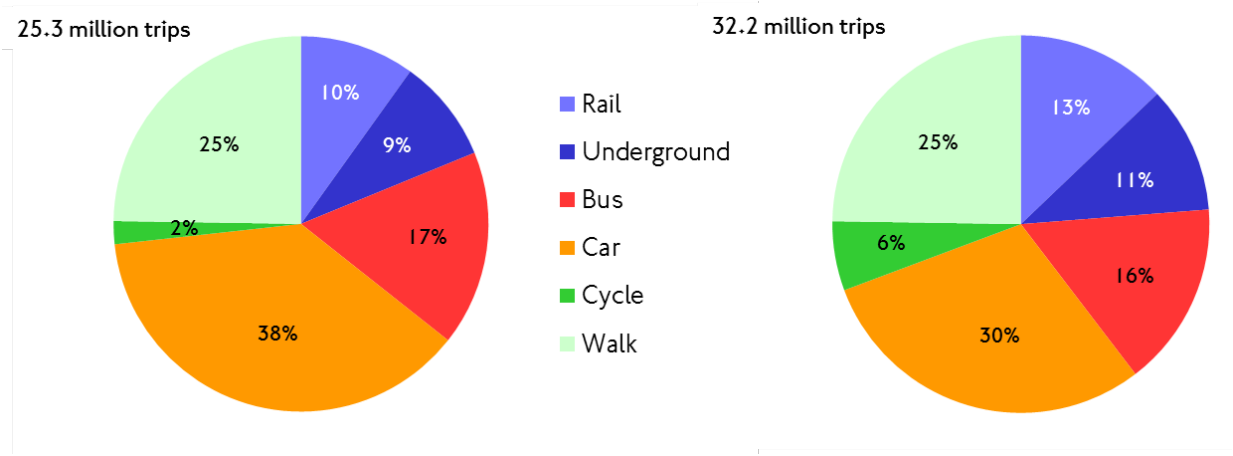
TfL's forecasts of future travel demand

TfL prepares forecasts of travel demand up to 25 years ahead. These forecasts take into account the main factors that influence travel demand, and include population and employment growth in London and the surrounding region, car ownership, the cost of using public transport and car, and expected changes to the transport system, as set out in the TfL Business Plan. The main conclusions from this work are that:

- Travel demand is expected to increase in proportion to the growth in population. TfL forecasts that the demand for travel in London will increase by around 7 million trips on an average day, from 25.3 million in 2011 to 32.2 million in 2041.
- Mode shares will change. Most of the additional travel demand will be met through more public transport, walking and cycling, with car mode share falling from 38 per cent in 2011 to 30 per cent in 2041.
- Strong growth in cycling. TfL forecasts assume a 5 per cent cycling mode share (at the journey stage level) will be achieved by 2026 and 6 per cent in 2041.
- Strong growth in public transport demand. Forecasts show an 87 per cent rail passenger kilometre increase coupled with a 65 per cent increase in Underground passenger kilometre from 2011 to 2041.

- In absolute terms road traffic is still expected to grow. This is driven by rising population, particularly in outer London.

Figure 7.3 Forecast change in mode share – 2011 to 2041.



Source: TfL Planning, Strategic Analysis.

7.4 Insight: Supporting new homes

London's housing challenge

A shortage of affordable homes can act as a drag on the attractiveness of London as a place to live and work. Furthermore, the housing crisis affects the city's attractiveness to business as the cost of housing affects all employees.

Building enough new homes and catering to the needs of all Londoners is extremely challenging. In recent years, some 270,000 homes in London have been granted planning permission but have not yet been built. Last year alone nearly 70,000 new homes were approved – but only around half have been delivered. This makes market-rate housing less and less affordable for many Londoners.

Growth is enabled by good connectivity and capacity: since 2000, 73 per cent of new residential development homes have been within 800 metres of a rail or Tube station. Transport provides access to jobs and services, and creates places where people want to live, hence well-connected areas have high population and/or workplace density. Many of the areas with greatest capacity for development have poor connectivity, which has directly limited private sector investment in housing.

While London's economy has grown, not all Londoners have shared in the benefits. The Capital has become more unaffordable as rents and the cost of travel have risen faster than incomes. Some parts of London are among the poorest performing in England in terms of income, crime, housing overcrowding and affordability.

Currently, only half of the homes London needs are being built. London's Growth Areas have the potential to provide 570,000 new jobs and at least 300,000 new homes. Around 49,000 new homes are required every year in London over the next two decades, due to rapid population growth and an existing backlog of need.

A variety of types of homes will be needed, with the breakdown of the total need estimated to be 34 per cent one-bedroom homes, 18 per cent two-bedroom homes, 26 per cent three-bedroom homes and 22 per cent four-bedroom or more.

During the past 10 years the number of new housing completions has not exceeded 25,000 in any single year. Since the Second World War, the largest number of completions in a single year was 37,400 in 1970. Over the past 10 years, the annualised rate of new housing completions in London was 0.9 per cent while the annualised growth in population was 1.4 per cent.

Understanding the effect of transport on development in policy and practice

Transport provision is taken into account directly during the planning process. The London Plan sets out in its Sustainable Residential Quality matrix (SRQ matrix) appropriate ranges for the density of 'habitable rooms' and residential units in new housing developments. These ranges are determined by the public transport accessibility level (PTAL) and the 'setting' or character of the area, which is either central, urban or suburban.

The appropriate densities recommended in the London Plan SRQ matrix range from 35-55 units per hectare in suburban areas of low public transport accessibility up to 215-405 units per hectare in central areas of high public transport accessibility.

In practice, there are further considerations that determine what density of housing is delivered at any given site and when it is delivered. Each site has unique local conditions, and for this reason the potential of a site based on measures such as public transport accessibility can be different to what is deliverable at a site given the effect of market forces.

Research recently carried out by the London School of Economics and Political Science (LSE) for the GLA found that across London, on average, the density of new residential developments exceeds the upper bound of the range set out in the SRQ matrix. This highlights that, while policy is important in influencing housing development, it does not determine the extent or nature of housing delivery. Given the increasing focus on transport acting as a catalyst to unlock housing delivery, it is therefore important to monitor these effects in addition to using assumptions based on them as part of the planning process.

There are a wide range of transport schemes that have had a catalytic effect on housing delivery in London to a greater or lesser extent. One obvious example was the 'Metroland' development in areas newly served by the Metropolitan Railway in the early part of the 20th century.

More recently, the Jubilee line extension, which opened in 1999, has had the effect of catalysing development along many parts of its route. The effects of the increased public transport accessibility have been realised over a period of many years, with some areas, such as Bermondsey, seeing increased residential development relatively soon after delivery of the scheme, and others such as Canning Town only more recently seeing this effect.

The long lag in the effect of transport accessibility on housing development makes monitoring a challenge in part because the full impact of a scheme cannot be observed for many years after its delivery, and because many other factors may influence housing delivery during this period. In the case of the Jubilee line, this is particularly relevant to Stratford, which has undergone substantial redevelopment since the completion, but has also been the focus of large-scale redevelopment effects in east London based around hosting the 2012 Games.

Similar effects on housing delivery over a long time period can be expected from Crossrail. Some effects on London's housing market have already been observed before the scheme has been delivered, and delivery of housing in areas where public transport accessibility will be improved by Crossrail can be expected to continue for years.

Identifying the effect of transport improvements on housing delivery for smaller scale schemes can be challenging because the scale of the effects may not be as pronounced, but the more localised nature of the impacts can make them easier to measure. A case study below sets out of the effect on housing developments and business moves in the areas around stations on the East London line extension, which was completed in 2011. Further analysis of this nature for a wider range of schemes could begin to build a strong body of evidence to better document the link between transport accessibility and housing development in London.

How transport can contribute to meeting London's housing needs – East London line case study

In 2010, London Overground began operating between Dalston Junction, New Cross and West Croydon on completion of the upgrade of the East London line between New Cross and Shoreditch and the construction of new stations at Hoxton, Haggerston and Shoreditch (which replaced the old Shoreditch station at a new site).

The opening of Hoxton, Haggerston and Shoreditch stations represented a huge improvement in public transport connectivity for their immediate surrounds, while other stations on the line also saw improvements in public transport relative to the service that had been operated on the East London line previously (and to a greater extent relative to the lack of service during the closure of the line between 2007 and 2010).

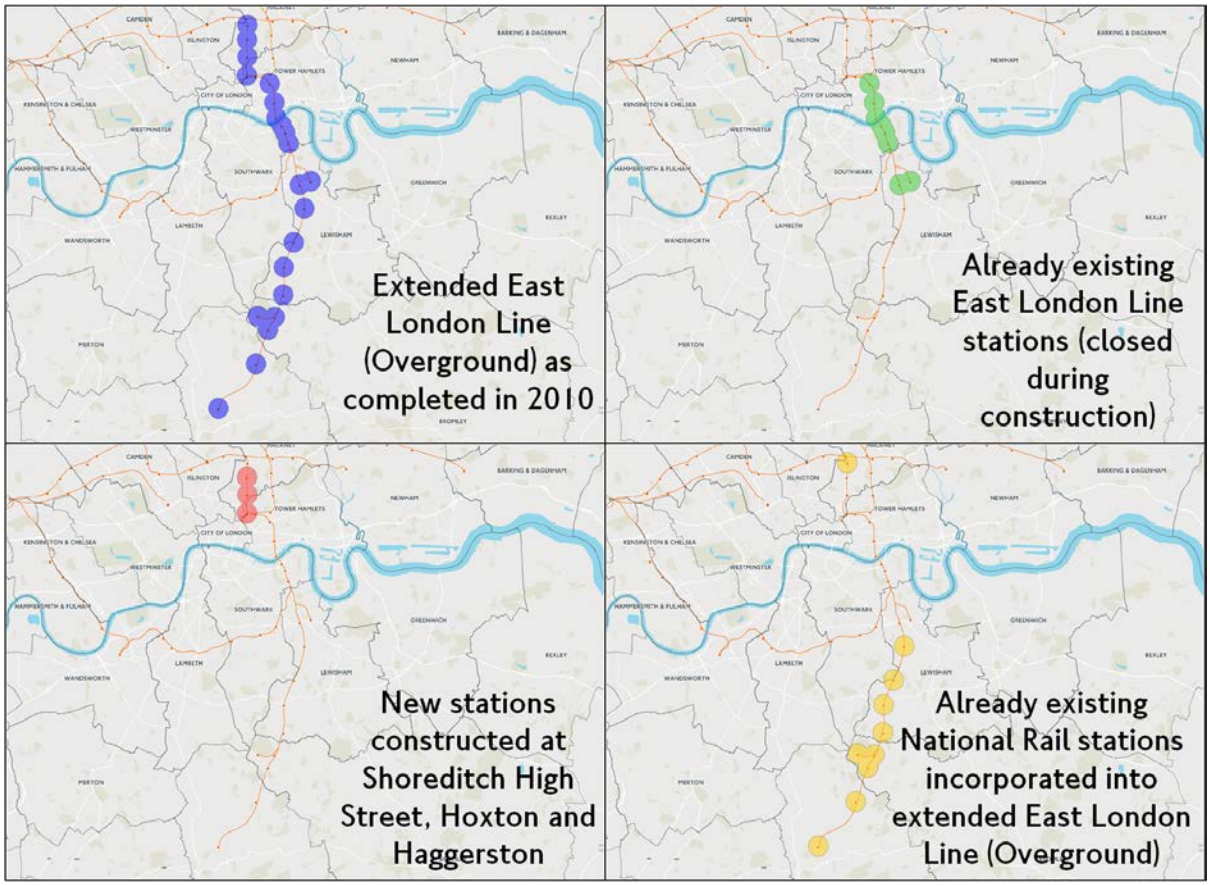
One aim of the East London line extension was to encourage regeneration in the area through improved transport accessibility. Qualitatively, changes such as new housing developments or the arrival of new businesses have been observed over recent years, but given that changes such as these are common in many parts of London, it is difficult to estimate precisely the effect that the improved transport infrastructure has had on development in the area.

Nonetheless, analysis has been carried out relating to business moves and new housing developments in the relevant area and over the relevant time period to assess whether the effect of the London Overground can be seen in quantitative terms. This analysis uses the Royal Mail database of mail redirections and new builds to determine the number of businesses moving to the area in the immediate vicinity of the newly opened Hoxton, Haggerston and Shoreditch stations, and the number of new build homes being constructed.

The analysis defines distance bands around different groups of stations:

- All stations where London Overground operations were introduced.
- Stations on the pre-existing East London line.
- New or reopened stations at Hoxton, Haggerston and Shoreditch.
- Existing National Rail stations incorporated into London Overground.

Figure 7.4 Definitions of buffers around East London line extension stations.



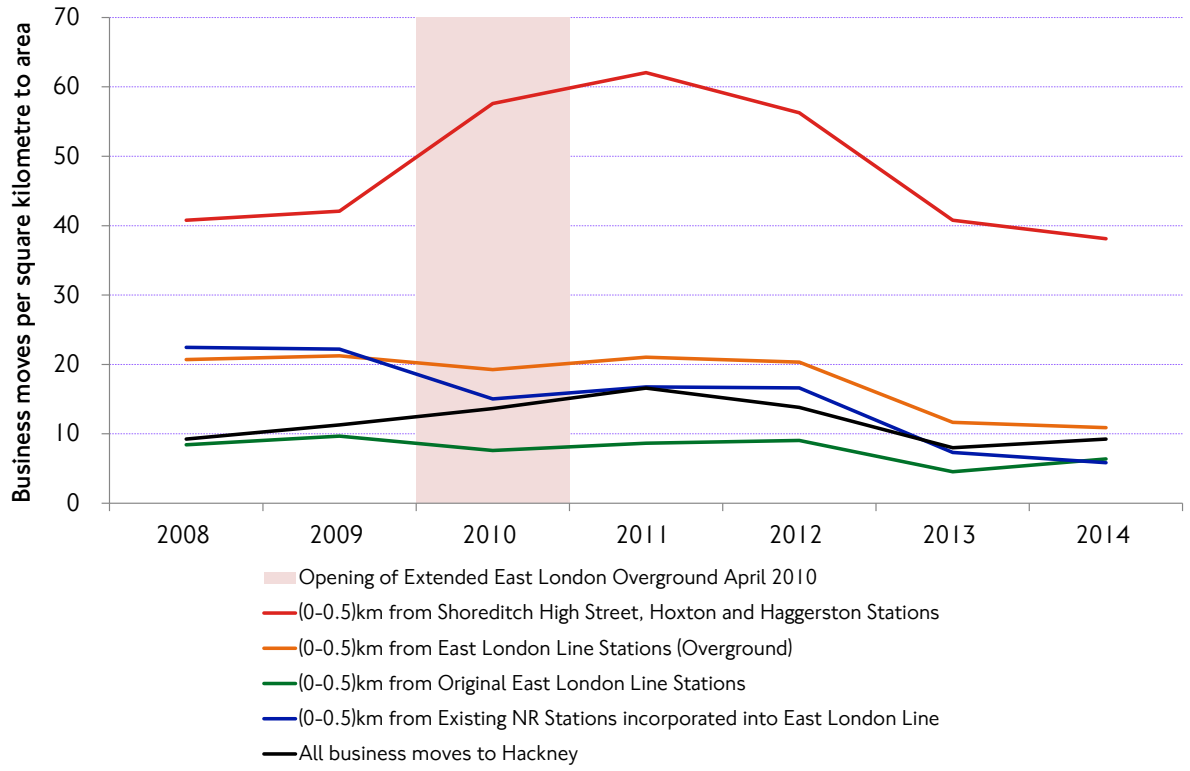
Source: TfL Planning, Strategic Analysis.

Business moves

Examining the number of business moves to within 500 metres of stations in each of the four categories highlighted in figure 7.4 shows that there was an increase in the number of businesses locating to the immediate area around Hoxton, Haggerston and Shoreditch stations in 2010, the year London Overground began operating, and for the two following years.

As shown in figure 7.5, no such pronounced effect was observed in the immediate vicinities of the stations in the other categories, suggesting that the smaller scale improved accessibility at these stations in comparison to the opening of Hoxton, Haggerston and Shoreditch was not sufficient to generate an observable 'unlocking' effect on the attractiveness of the areas to businesses.

Figure 7.5 Number of business move destinations per square kilometre in range 0 to 0.5 kilometres from stations.



Source: TfL Planning, Strategic Analysis.

Completion of new build homes

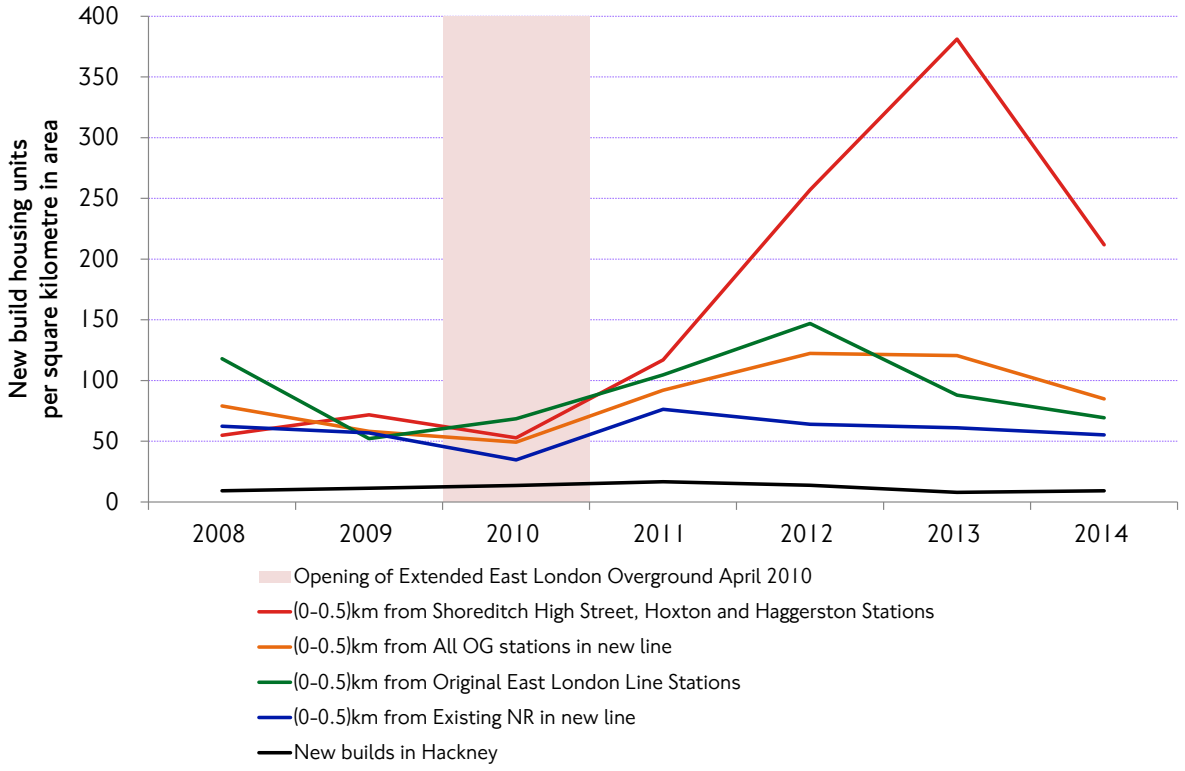
The same categorisation of the areas around the stations was used to explore whether any effect could be observed on the completion of new build homes similar to that observed for business moves.

Again, there was an effect in areas within 500 metres of Hoxton, Haggerston and Shoreditch stations, but in this case the effect appeared to occur two to three years after the start of London Overground operations. There was an increase in the number of new build units per square from 50 per year in 2008 and 2009 to more than 350 in 2013. The time lag of this effect may be due to constraints such as the time taken to gain planning permission before new developments can be built, or due to developers aiming to complete new builds two or three years after the service began operating to ensure the improvement in accessibility is widely recognised and the sale value of the properties is maximised.

As with business moves, no strong effect of an increase in new build residential completions was observed for the stations on other parts of the East London line extension. Figure 7.6 shows that there were some small increases in the number of new build units around stations on other parts of the line, but that these increases were not of the same magnitude as those around the new Hoxton, Haggerston and Shoreditch stations. This again suggests that any improvement in service level at the pre-existing stations was not of a large enough scale to cause an observable effect on new build residential developments.

While in all cases the stations in the other categories saw an increase in new builds in the year after the extended line opened, these increases peaked at different times to those around Hoxton, Haggerston and Shoreditch stations, and did not rise to levels obviously higher than the background rate of development before 2010. In order to identify whether significant 'unlocking' effects can be observed at sites such as this with improved rather than new services further monitoring and research would be necessary across a number of schemes.

Figure 7.6 Number of new build housing units delivered per square kilometre in range 0 to 0.5 kilometres from stations.



Source: TfL Planning, Strategic Analysis.

7.5 Travel demand and public transport capacity to the Central Activities Zone

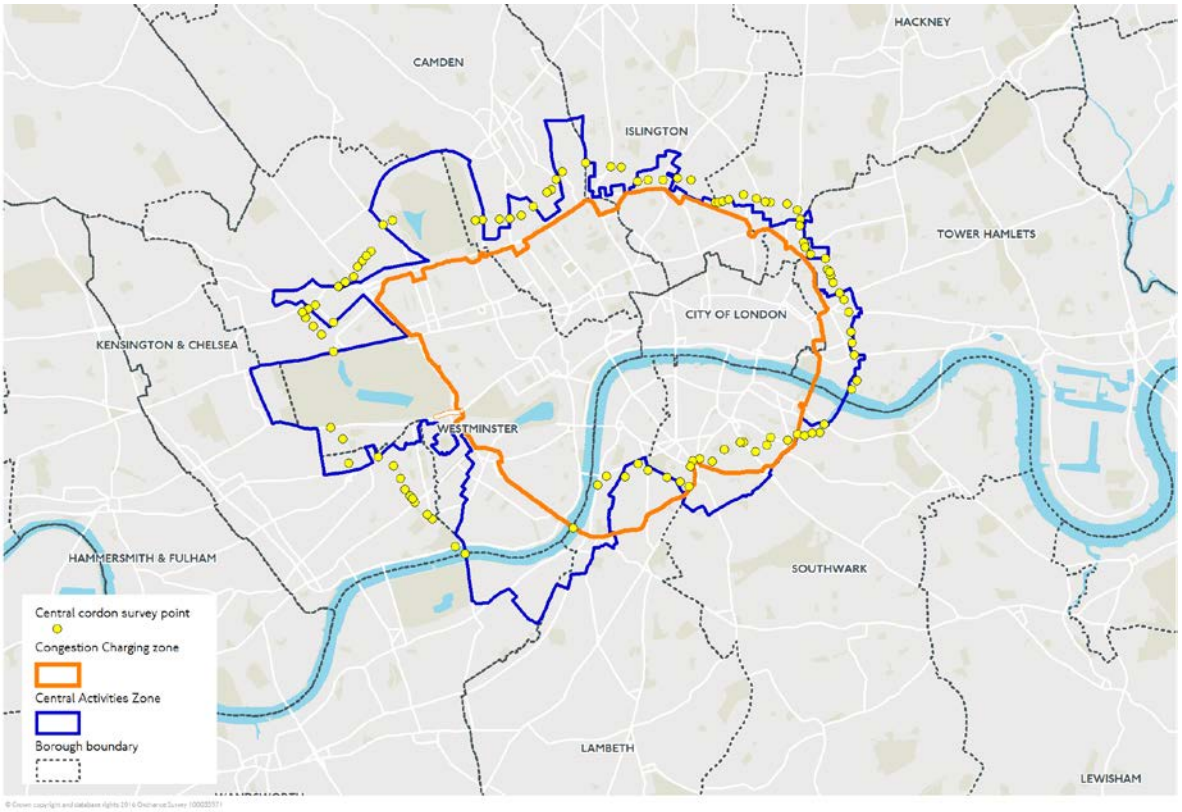
The Central Activities Zone (CAZ)

The Central Activities Zone is the global iconic core of London and hosts a multiplicity of high value activities. It is distributed across 10 boroughs and includes the northern part of the Isle of Dogs. It is one of the world's most attractive and competitive business, retail and cultural locations. Over the last decade, the CAZ has changed very significantly in a number of ways, for example population has grown by around 22 per cent and there are half a million new jobs. Public transport capacity has increased substantially and the walk and cycle offer has also been improved. Traffic in the CAZ has fallen by around 20 per cent.

The CAZ boundary reflects the functional centre of London, but it is not ideally aligned with established indicators of travel demand. Traditionally, these have been surveyed on the basis of a 'central statistical area' or on the basis of the Congestion Charging zone. More recently, a separate survey has enumerated travel to the Isle of

Dogs. This means that there are no precise measurements of travel demand to the CAZ. However, indices or time-series based on the available historic indicators are both useful and relevant.

Figure 7.7 Alternative definitions of central London for the purpose of estimating travel demand.



Source: Strategic Analysis, TfL Planning

The northern part of the Isle of Dogs has very close relationships with the CAZ in terms of world city financial and business service functions. These two areas are of strategic importance to London. Between 2014 and 2036, more than 400,000 new jobs are projected to be created in the CAZ and the northern part of the Isle of Dogs. This will create more demand for travel to these areas, as well as demand for freight and servicing trips to support this growing workplace population.

Travel demand to the central area in the weekday morning peak period

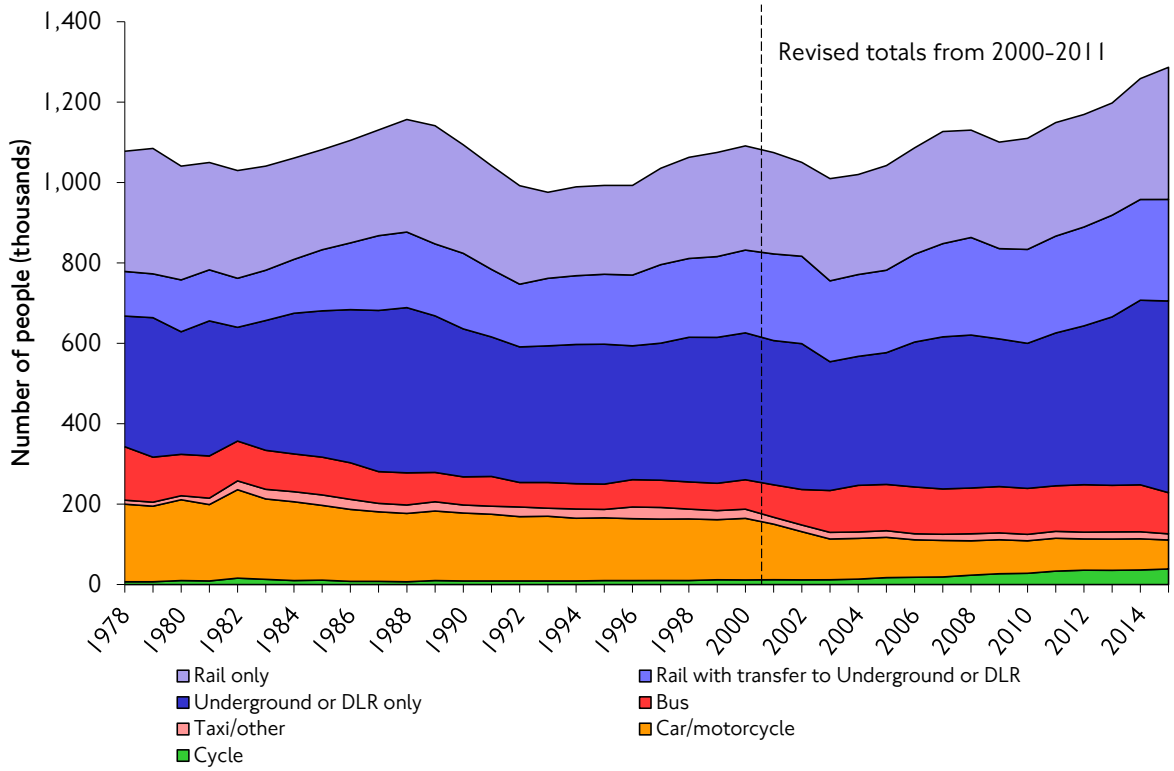
Based on the central London statistical area definition (figure 7.7), the numbers of people entering central London during the weekday morning peak period (07:00 to 10:00) has been monitored since the 1970s through a long-established yearly count, taken in the autumn. The Central Area Peak Count (CAPC) survey covers all modes except walking and those travelling in commercial vehicles or travelling as part of their job (for example, licensed taxi drivers). Most of these people are commuting to work in central London, and this indicator provides a good picture of this one specific, but important, aspect of travel in London.

Long-term trends

Figure 7.8 shows the trend for the total number of people entering central London over the past 37 years. The year 2015 saw the highest number of people entering

during the morning peak since the current survey started in 1978 – 1.29 million. The total number of people entering has varied relatively little over most of the period covered by the survey. These variations tend to follow the economic cycle in central London and interestingly have shown no clear trend over much of the period – although the trend over recent years has been sharply upwards.

Figure 7.8 People entering central London in the weekday morning peak, 1978 to 2015.



Source: TfL Planning, Strategic Analysis.

Change between 2014 and 2015

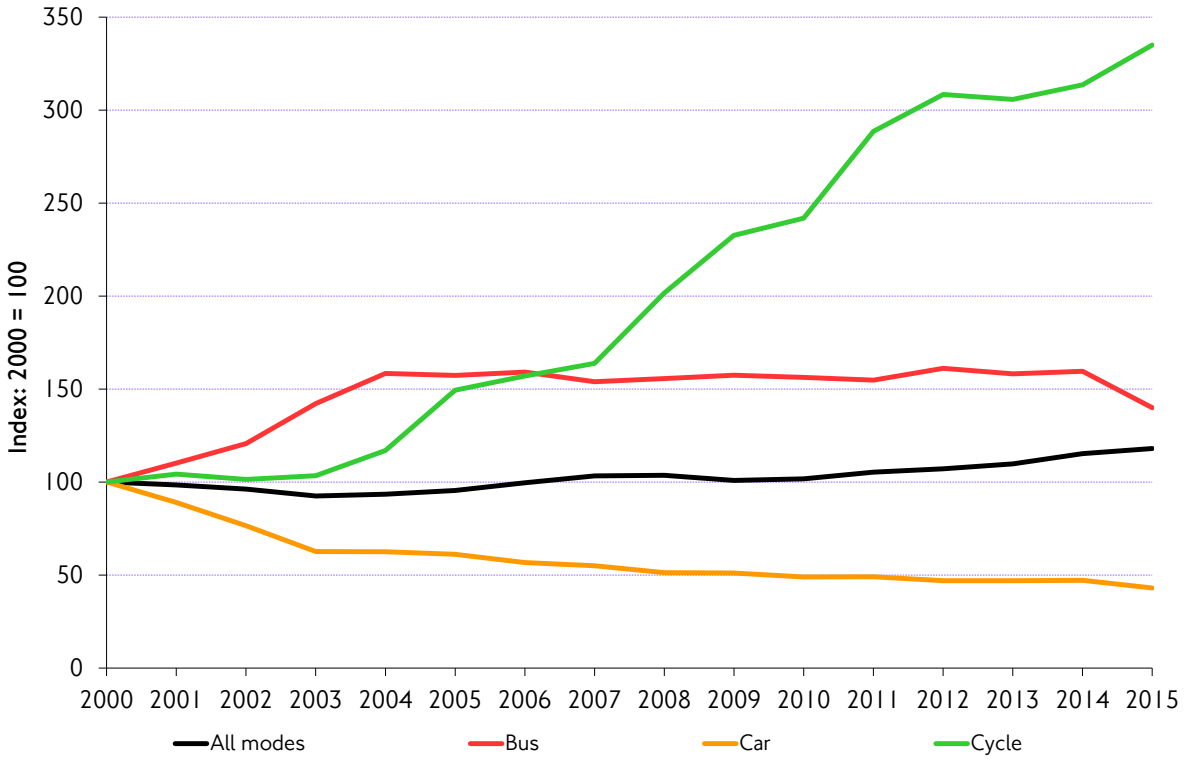
Between 2014 and 2015 the number of people entering the central cordon in the morning peak by all modes increased by 2.2 per cent. This increase mainly reflected more people entering central London by rail modes, with the number of people using rail up by 9.3 per cent and the number of people using Underground or DLR up by 3.8 per cent. The increase has also been driven by more people cycling to central London, which was up by 6.7 per cent in 2015, more than double the increase of 2.6 per cent between 2013 and 2014.

However, in the latest year, the number of people entering central London by bus decreased by 12.3 per cent. This large year-on-year fall on this mode is likely to be the result of congestion caused by infrastructure works that took place in 2015. The largest reductions in the number of bus passengers occurred between 09:00-10:00, when congestion was at its most severe. There were also reductions in car and coach passengers, down by 8.5 per cent and 19.4 per cent respectively

Changes in mode share

Within a relatively stable overall total and in the context of a relatively consistent rail-based mode share of more than 80 percent, there have nevertheless been some substantial shifts in the relative shares of the various modes of transport used to travel to central London, particularly affecting road-based modes. These are best appreciated with reference to figure 7.9, which looks at the most recent 15 years and plots changes in the use of the principal road-based modes as an index against the position in year 2000 (see also table 7.1).

Figure 7.9 Trends by road based mode of transport for people entering central London during the weekday morning peak. Index year 2000=100.



Source: TfL Planning, Strategic Analysis.

Key developments over this 15-year period have been:

- Broadly flat total morning peak travel to central London until 2003, followed by a generally rising trend for the rest of the decade, with the level in 2015 being 17.9 per cent above that of 2000. The increase between 2014 and 2015 was 2.2 per cent, and that from 2008 was 13.8 per cent.
- A reduction of more than half – 57 per cent – in the number of people using the car. The impact of the introduction of Congestion Charging in 2003 is visible in the figure, but is not the only factor involved in this dramatic shift away from private transport for these journeys.
- An increase in the use of bus occurring in the early half of the last decade, followed by stable bus mode share between 2003 and 2013 and a decrease in the latest year.
- A 223 per cent increase in cycling to central London, during the weekday morning peak period, again mirroring wider trends for this mode.

There has been growth on all rail modes since 2000; however interpretation of the use of rail services is not straightforward. This is because CAPC counting cordon coincides with the main central London rail termini, where interchange between National Rail and Underground services takes place.

Looking at the numbers in table 7.1:

- Some 25 per cent more people used National Rail in 2015 compared with 2000.
- Of the 581,400 people using National Rail, 252,700 (22.7 per cent more than in 2000) transferred to Underground or DLR services on arrival at the central London rail terminus.
- There was a 30.5 per cent increase in the number of people using the Underground or DLR without transferring from National Rail.
- The total number using Underground/DLR services rose by 27.7 per cent over this period.

The net outcome of all these changes over the period since 2000 has been that the mode share for public transport (all modes) for weekday morning peak travel to central London increased from 85 per cent to 91 per cent. The mode share for travel by car has more than halved, falling from 13 per cent to 5 per cent (table 7.1). The cycling mode share has trebled, up from 1 per cent in 2000 to 3 per cent in 2015 (table 7.2).

Table 7.1 People entering central London in the weekday morning peak, by mode of transport, 2000 to 2015.

Thousands of people

Year	All modes	National rail	Rail only	Rail of which transfer to LU/DLR	LU or DLR only	LU and DLR	Bus	Coach/ minibus	Car	Taxi	Two-wheeled motor vehicles	Cycle
2000	1,091	465	259	206	365	571	73	15	137	8	17	12
2001	1,075	468	252	216	359	574	81	10	122	7	16	12
2002	1,050	451	234	217	363	580	88	10	105	7	15	12
2003	1,010	455	254	201	320	522	104	10	86	7	16	12
2004	1,020	452	249	204	321	524	116	9	86	7	16	14
2005	1,042	465	260	205	328	533	115	9	84	8	16	17
2006	1,087	483	265	218	361	579	116	8	78	7	15	18
2007	1,127	511	279	232	378	610	113	9	75	6	15	19
2008	1,131	510	267	243	381	623	114	11	70	7	15	23
2009	1,101	490	265	225	367	592	115	11	70	6	15	27
2010	1,110	510	276	234	361	594	114	10	67	6	14	28
2011	1,149	523	282	241	380	621	113	11	67	6	14	33
2012	1,169	526	280	246	395	641	118	11	64	6	14	36
2013	1,198	532	279	253	419	672	116	11	64	6	13	35
2014	1,259	551	301	251	459	710	117	11	65	6	13	36
2015	1,287	581	329	253	477	730	102	9	59	6	13	39

Source: TfL Planning, Strategic Analysis.

Table 7.2 Mode shares of people entering central London in the weekday morning peak, 2000 to 2015.

Percentage

Year	All modes	National rail	Rail only	Rail of which transfer to LU/DLR	LU or DLR only	LU and DLR	Bus	Coach/ minibus	Car	Taxi	Two-wheeled motor vehicles	Cycle
2000	100	43	24	19	33	52	7	1	13	1	2	1
2001	100	44	23	20	33	53	8	1	11	1	2	1
2002	100	43	22	21	35	55	8	1	10	1	1	1
2003	100	45	25	20	32	52	10	1	8	1	2	1
2004	100	44	24	20	31	51	11	1	8	1	2	1
2005	100	45	25	20	31	51	11	1	8	1	2	2
2006	100	44	24	20	33	53	11	1	7	1	1	2
2007	100	45	25	21	34	54	10	1	7	1	1	2
2008	100	45	24	21	34	55	10	1	6	1	1	2
2009	100	44	24	20	33	54	10	1	6	1	1	2
2010	100	46	25	21	33	54	10	1	6	1	1	3
2011	100	46	25	21	33	54	10	1	6	1	1	3
2012	100	45	24	21	34	55	10	1	5	1	1	3
2013	100	44	23	21	35	56	10	1	5	1	1	3
2014	100	44	24	20	36	56	9	1	5	0	1	3
2015	100	45	26	20	37	57	8	1	5	0	1	3

Source: TfL Planning, Strategic Analysis.

Relationship of CAPC demand trend to transport capacity and wider growth in central London

Although weekday morning peak travel demand, as measured by CAPC, has shown signs of strong growth in recent years, the longer-term trend is more cyclical – as might be expected given the cyclical influences on the central London economy more generally. While the impact of the various recessions over the last four decades can be clearly seen in the trend, the overall level of demand as measured by this indicator in 2015 is just 11.2 per cent higher than that measured in 1988 (figure 7.8).

Furthermore, there have been some significant changes in transport provision. The development of the Thameslink network is an obvious example, although factors such as the expansion of the bus network in the first half of the last decade, and the more recent Tube upgrade programme, are also significant, as well as other smaller-scale developments, such as the development (in this context) of the DLR network and the more recent East London line extension (part of the London Overground network).

In simple terms, given the increase in factors driving travel demand to central London, as well as the provision of substantially more capacity, it might be expected that the CAPC survey would have shown a higher net growth over the period covered by figure 7.8.

One potential reason is that CAPC as a survey – while reliable and consistent in its own right – is not an ideal reflection of wider changes in total demand to central

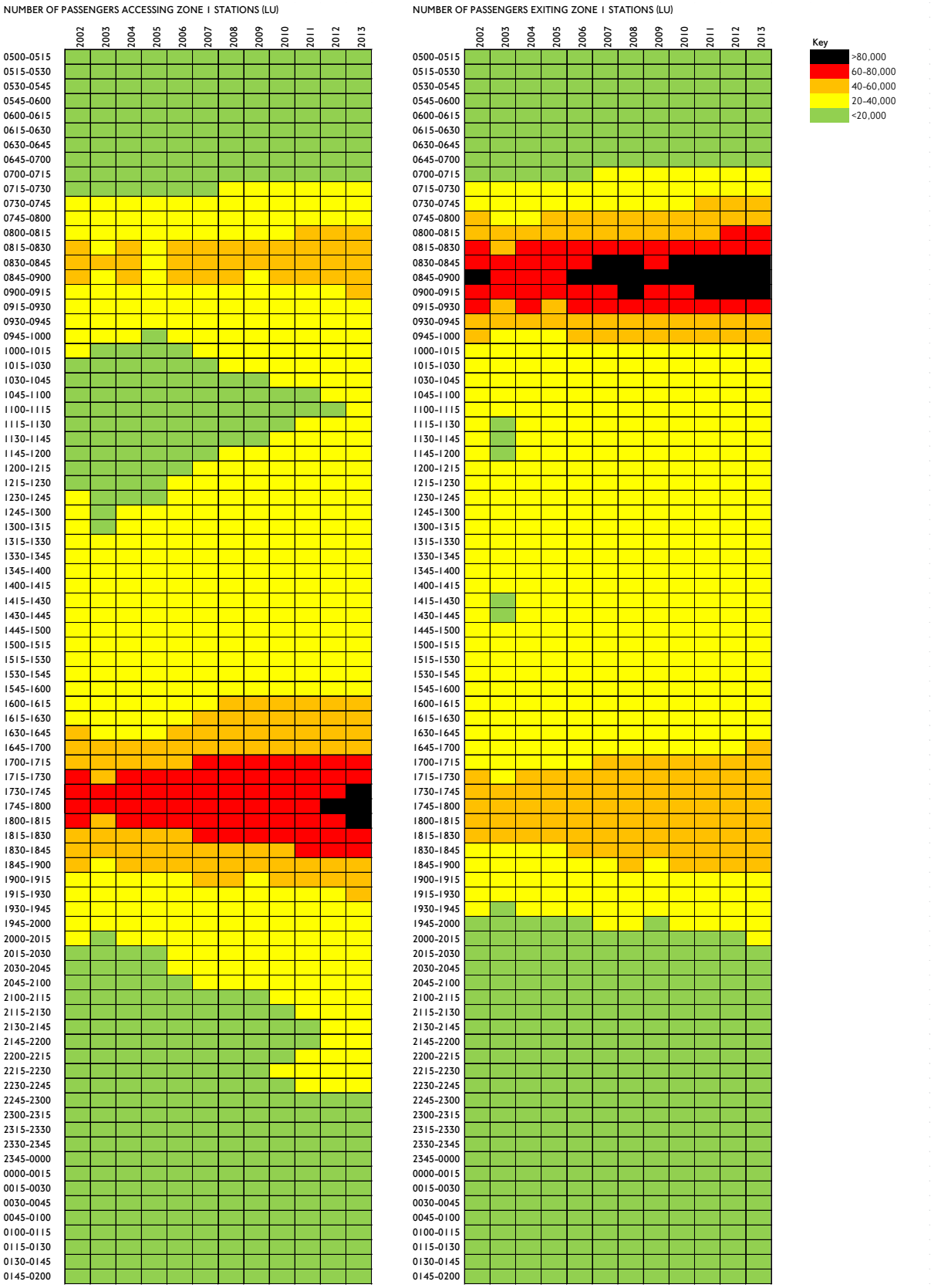
London. For example, it does not cover the non-peak period and is not ideally aligned spatially with some of the areas experiencing highest growth (for example it does not include Docklands or most parts of the 'city fringe'). Furthermore, it also has some known methodological features that limit its ability to show change in the context of changing transport networks and working patterns. This means that CAPC data presents a partial and, potentially, misleading picture of travel trends. Itemised below are some of the major limiting features of CAPC. While these do not invalidate the survey itself or the time series presented above, they should be borne in mind when interpreting the CAPC data.

- CAPC data cover the period 07:00 to 10:00 on working weekdays in the inbound direction only. Growth outside the morning peak, and growth in 'through' travel (not enumerated, but consuming capacity on the networks) is not therefore reflected. An example of the latter is travel to/from the Isle of Dogs through central London, from an origin outside the CAPC area, reflecting a change in London's economic geography.
- People are enumerated when they 'emerge' in the central area from the transport networks or, in the case of road travel, when they cross a cordon bounding the survey area. If a person goes first to a work location in the earlier part of the peak, and then makes a second trip to a second central London work location, still within the peak, that second trip may either not be enumerated or may be double-counted, in terms of the primary objective of CAPC.
- There are known to have been several historical discontinuities in the data. The more recent of these have been corrected (although the net effect of these corrections was very small), but it remains uncertain how comparability between surveys was assured, for example, during the 1980s with the opening of Thameslink.
- Finally, in addition to a possible increase in non-peak travel, changing working patterns will mean that, over the period covered by the survey, the link between working at a location in central London and having to make a peak-time work trip everyday will have become more tenuous.

Peak spreading on London Underground in central London

Two pieces of evidence shed some more light on this issue. The first is a consideration of peak spreading in relation to the Underground. Figure 7.10 originates from London Underground's RODS (Rolling Origin and Destination) survey. It shows the intensity of demand at quarter-hour intervals across a 24-hour day, for stations in fare Zone 1, and how this has changed for each year between 2002 and 2013. Both access to stations and egress from stations are considered, on the left and right halves of the graphic respectively, with egress most closely reflecting the CAPC survey.

Figure 7.10 Access and egress to Zone 1 stations by time of day.



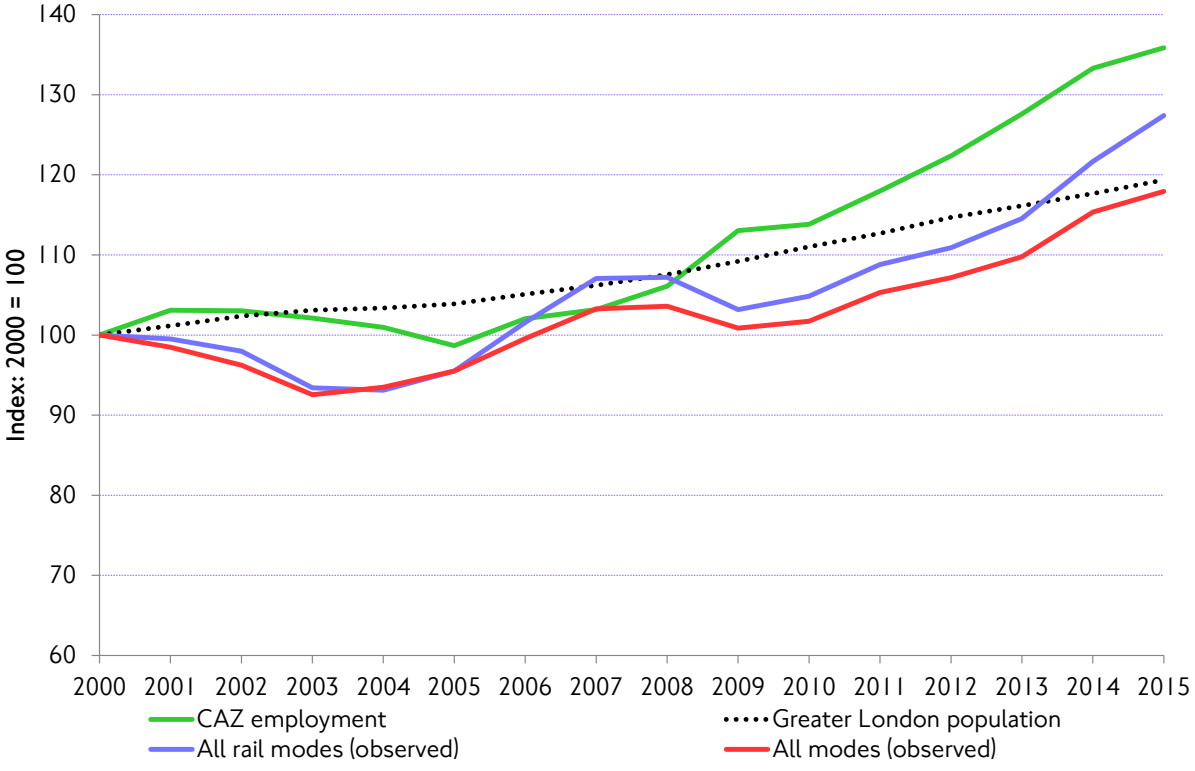
Source: RODS survey data.

The increase in the general intensity of demand over the period can be appreciated in terms of the progressive darkening of colours from left to right, ie over time, on both sections of the graphic. Looking first at egress (the right-hand side of the graphic), however, there is little evidence of the intensity of demand spreading significantly outside of the period covered by the CAPC survey (07:00 to 10:00). Rather, there is a clear trend of increasing demand within the time period covered by CAPC – the number of Underground exits recorded by CAPC increased by 15.9 per cent over the period between 2002 and 2013, and demand has spread from the 'peak of the peak' to other parts of the three-hour survey period.

Perhaps the most dramatic changes shown by figure 7.10 are in terms of the number of people accessing (entering) LU stations in fare Zone 1. Here there has been clear intensification across much of the day, affecting the inter-peak and (notably) later evening periods.

The second piece of evidence is an exploration of the relationship of the CAPC trend to key demand drivers – population and employment growth (figure 7.11). Here, the cyclical nature of the trends is clearly apparent, but the main feature shown by the graphic is the overall close nature of the relationship between employment and CAPC demand, suggesting that future employment remains a good predictor of overall travel demand to central London.

Figure 7.11 Relationship of AM peak travel demand to central London to GLA population and jobs in the Central Activities Zone.



Source: TfL Planning, Strategic Analysis.

Development of London Docklands

Over the past 25 years, London's Docklands has developed as an area of high-density high-value employment, primarily in financial and business services, to

complement the historic centre of these activities in central London. Development has been concentrated in the Isle of Dogs, 3km east of the City of London, generating a significant number of trips and adding to travel demand to and from the eastern sub-region. Transport networks have also been extended in parallel with this development, most notably the Jubilee line extension which opened in 1999, as well as development of the DLR network.

The Isle of Dogs Cordon Survey

With the regeneration of London Docklands during the late 1980s, TfL instituted a similar cordon-based count survey to cover the Isle of Dogs. As well as the AM peak period this survey covers an extended weekday (05:00 to 23:00). Taken together, therefore, the travel trends revealed by both CAPC and the Isle of Dogs survey provide valuable insight into the growth and dynamics of travel to these two key central London employment hubs.

This survey counts trips into and out of the Isle of Dogs on a designated working day each autumn (except in 2009 when no survey was carried out). All trips that have an origin or destination within the Isle of Dogs or cross the boundary cordon are included. Through trips on the Jubilee line or DLR and interchange trips between the two rail modes that do not start or end in the Isle of Dogs are excluded on the basis of interchange surveys carried out on the same day. Internal trips within the Isle of Dogs are also excluded.

An additional cordon, inside the Isle of Dogs cordon, closely bounding Canary Wharf, is identified and used to measure the number of trips to and from Canary Wharf, including those to and from points within the Isle of Dogs. Canary Wharf is a major centre of employment within the Isle of Dogs, located at the northern end of the Opportunity Area.

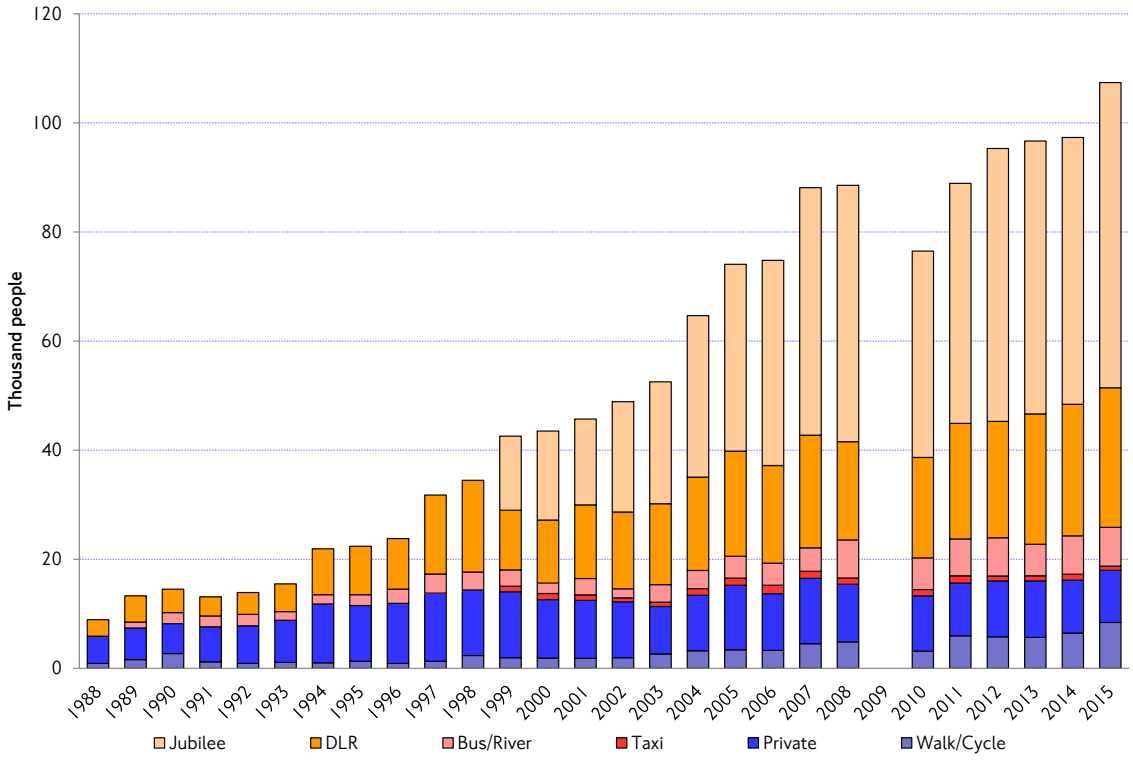
Inbound mode shares in the morning peak period

Figure 7.12 shows travel to the Isle of Dogs since 1988, the year in which construction started at Canary Wharf. It shows the number of people entering the Isle of Dogs during the weekday morning peak (between 07:00 and 10:00) by mode.

Before the opening of the Jubilee line extension in 1999, private vehicles had the highest mode share – accounting for 50 per cent of trips between 1991 and 1994, before falling to 35 per cent by 1998. During the same period, the DLR increased its share from 30 per cent to almost 50 per cent. The share for bus travel fluctuated between 7 per cent and 15 per cent.

The opening of the Jubilee line extension immediately accounted for one third of inbound morning peak travel, while the DLR share dropped to 26 per cent, private vehicles to 28 per cent and bus to 7 per cent. By 2015, the Underground had increased its share to more than 50 per cent, with private vehicles falling and then plateauing at 10 per cent. Walking and cycling now account for 8 per cent of inbound morning peak travel, and a quarter of inbound peak morning trips were taken on the DLR. These travel patterns reflect wider trends in London, with sustained and substantial shift in mode share away from private vehicles towards public transport.

Figure 7.12 Morning peak travel to the Isle of Dogs (including Canary Wharf) by mode of transport, 1988 to 2015.



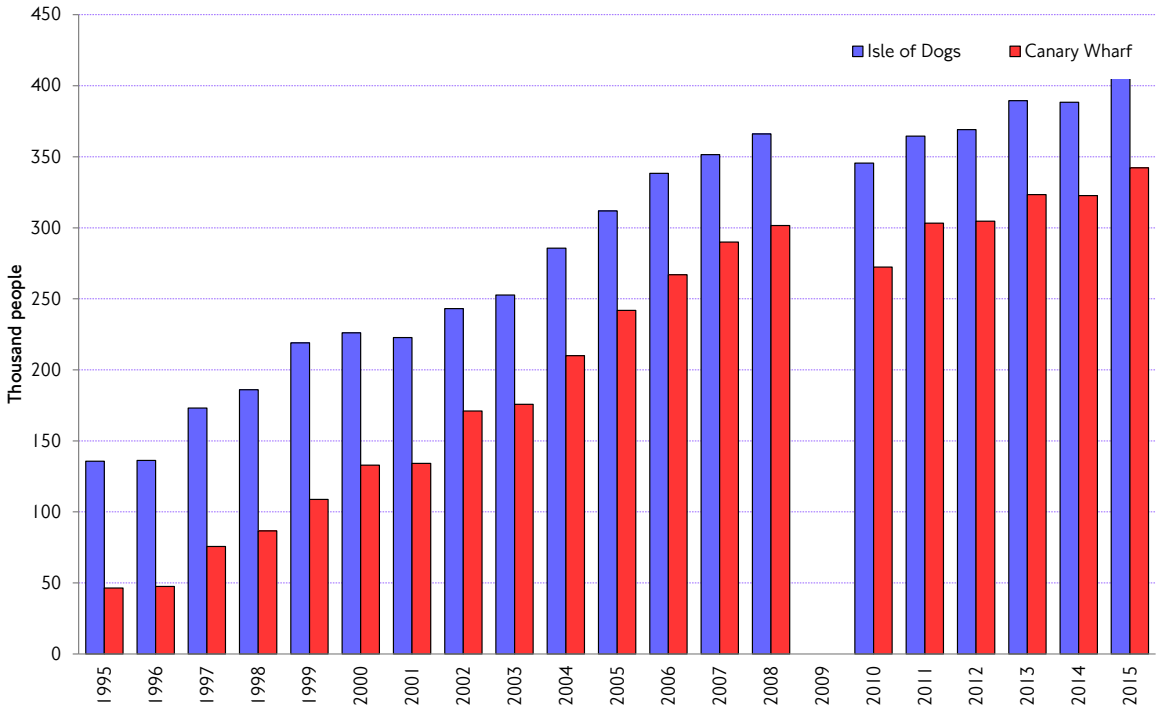
Source: TfL Planning, Strategic Analysis.

Trends in daily travel to and from the Isle of Dogs

Figure 7.13 shows that between 1995 and 2015 the number of people travelling to and from the Isle of Dogs (on a weekday between 05:00 and 23:00) increased by 200 per cent, while travel to and from Canary Wharf increased six-fold. As a share of the Isle of Dogs cordon crossings, travel to and from Canary Wharf accounted for 84 per cent of trips in 2015.

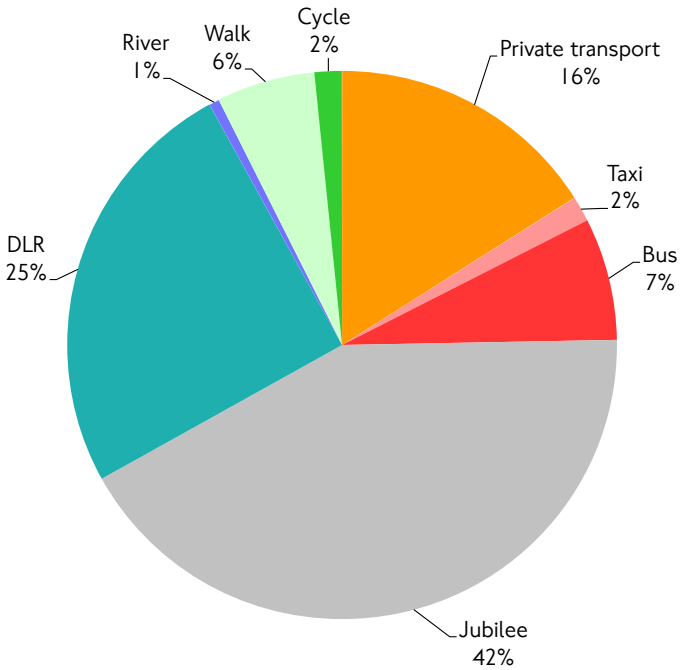
Growth slowed in the wake of the financial crisis in the late 2000s, however by 2015 annual daily trips increased year-on-year by 5 per cent and were at their highest ever level. Of these trips, 16 per cent were made by private transport, 76 per cent by public transport, 7 per cent were walked or cycled, and 1 per cent were made by river. The Jubilee line carried 171,939 passengers with a 42 per cent mode share, while the DLR carried more than 100,000 passengers, with one quarter of the mode share to and from the Isle of Dogs (figure 7.14).

Figure 7.13 Daily travel to and from the Isle of Dogs and Canary Wharf, between 05:00 and 23:00 hours, 1995 to 2015.



Source: TfL Planning, Strategic Analysis.

Figure 7.14 Mode share to and from the Isle of Dogs, 2015.



Source: TfL Planning, Strategic Analysis.

Within each weekday, travel to and from the Isle of Dogs shows the typical profile, similar to travel to central London, with pronounced peaks associated with commuting: a narrow peak in the morning between 07:00 and 10:00 and a flatter and more dispersed evening peak between 16:00 and 19:00 (figure 7.15). The figure also shows the overall growth since 2001.

Figure 7.15 Hourly distribution of travel to and from the Isle of Dogs.

Source: TfL Planning, Strategic Analysis.

Travel trends by transport corridor

Table 7.3 shows a comparison of corridor shares between 2014 and 2015. Corridor shares have remained constant in recent years, with the western corridor being accountable for the majority of trips (61 per cent) to and from the Isle of Dogs. At 32 per cent, the eastern corridor accounted for approximately one third of trips in 2015. The difference between trips on the western and eastern corridors are most marked during the morning and evening peaks; at some points there are more than twice the number of trips to and from the west than to or from the east. During off-peak hours the split between the east and west corridor is much more even. This suggests that it is journey to work trips (predominantly made in the peaks) that are biased to the west, while other trips, for example shopping trips, are more evenly distributed between the two corridors. Private transport has a significantly higher share of trips in the eastern corridor (28.7 per cent) compared to the western corridor (11.3 per cent). Bus use is also higher in the eastern corridor (15.5 per cent) compared to the western corridor (3.7 per cent). Some 87 per cent of the trips in the southern corridor are made by DLR and the remainder of the trips are walk or cycle trips through the Greenwich foot tunnel.

Table 7.3 Daily travel to and from the Isle of Dogs between 05:00 and 23:00 by corridor.

Corridor	2014		2015		Percentage trips change
	Person trips	Corridor share	Person trips	Corridor share	
West	237,659	61%	249,597	61%	4.8%
East	122,699	32%	128,938	32%	4.8%
South	28,071	7%	28,918	7%	2.9%
Total	**388,429**	**100%**	**407,452**	**100%**	**4.7%**

Source: TfL Planning, Strategic Analysis.

7.6 Insight: Developing a travel-based segmentation of London residents – the Transport Classification of Londoners

Segmentation divides a population into defined subgroups with common characteristics, wants, needs and priorities. Small geographical areas are typically highly homogenous in terms of the type of people living in them. It is therefore possible to characterise these areas in terms of the typical behaviour, characteristics or attitudes of the people living in them. The segments can be used to understand the choices people make. Figure 7.16 demonstrates the benefits of segmenting a population and the sort of questions about people that the segmentation can help us understand.

Figure 7.16 Uses of a travel segmentation.

Source: TfL Planning, Strategic Analysis.

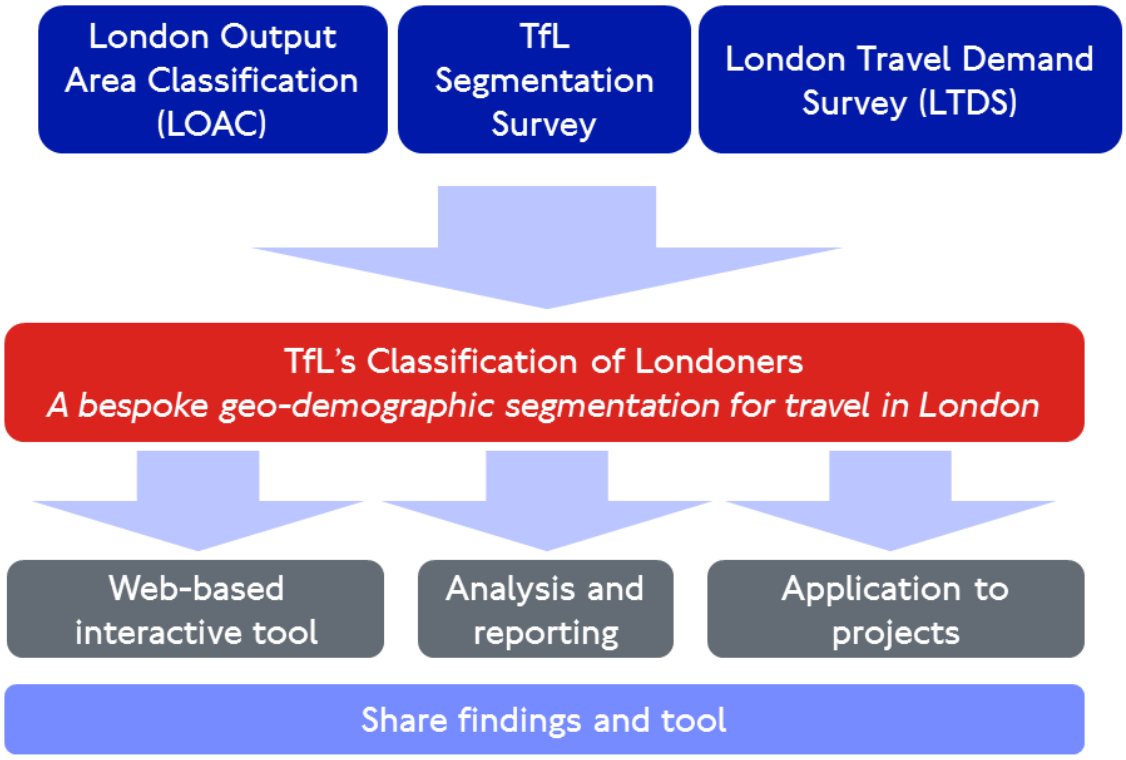
TfL has produced segmentations in the past that were limited to individual modes of travel. These have been widely used, for example in the Analysis of Cycling Potential (http://content.tfl.gov.uk/analysis-of-cycling-potential.pdf). This applied

TfL's 2009 cycling segmentation to trips currently made by motorised modes that had the potential to be cycled to identify areas with the greatest potential for cycle growth.

While these single mode segmentations have been valuable, a new segmentation was required that covers all modes of travel and also tells us more about people's motivations and reasons for choosing why and how they travel. This new segmentation is called the Transport Classification of Londoners (TCoL). It is relevant to all modes, easy to understand and use and capable of being used for a variety of purposes across TfL and beyond.

Figure 7.17 shows the process of the project from the combination of data sources through to sharing the outputs and the developed tool.

Figure 7.17 Developing a segmentation survey.

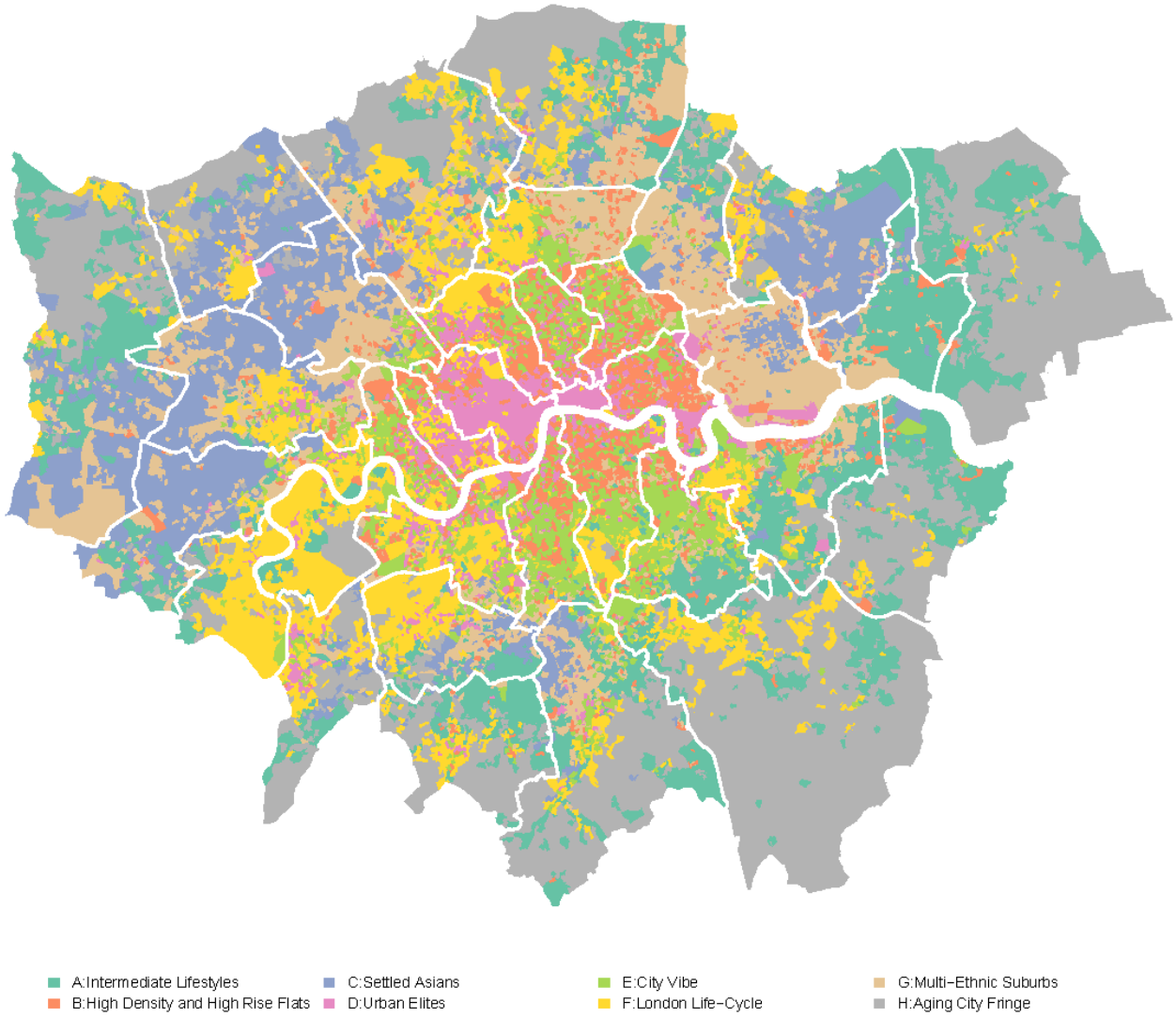


Source: TfL Planning, Strategic Analysis.

Developing a segmentation

The basis for the segmentation is the London Area Output Classification (LOAC) developed by the GLA and University College London (UCL) using Census 2011 data, (see: https://data.london.gov.uk/dataset/london-area-classification). Figure 7.18 shows the distribution of the LOAC eight 'super groups': intermediate lifestyle, high density and high use flats, settled Asians, urban elites, city vibe, London life-cycle, multi-ethnic suburbs and ageing city fringe.

Figure 7.18 London Output Area Classification.



Source: TfL Planning, Strategic Analysis/London Datastore.

The eight super groups are further divided into 19 groups and 49 sub-groups. To check the LOAC was a suitable base for our transport segmentation a series of checks were undertaken, including:

- The extent to which trip rates and mode shares varied by LOAC super-group, group and sub-group.
- The extent to which LOAC super-groups, groups and sub-groups distinguished between household types and by working status.

It was concluded that LOAC sub-groups had the best explanatory power and would be workable with the other key datasets.

To improve the knowledge of people's travel behaviour choices, a new survey was completed with 5,395 Londoners. Respondents answered questions about a set of recent journeys for a range of purpose including commuting, travel to school, shopping and visiting friends or family. They were asked about the frequency they made these journeys, the modes of transport used as well as their reason for using

those modes. They were also asked about which other modes they might consider using or why they might reject them.

Analysis of the survey results provided data about travel behaviour patterns to use in defining the segmentation:

- 24 per cent do not use the car at all but 15 per cent use their car for more than two-thirds of trips.
- Less than 1 in 10 don't use rail at all.
- Bus is less likely to be used for the majority of trips – just 4 per cent of Londoners use bus for two-thirds or more of their trips.
- A fifth do not walk at all (all the way).
- More than three-quarters never cycle and just 1 per cent use bike for more than two-thirds of trips.

Several alternative approaches were investigated to establish people's propensity, or likelihood to change their travel behaviour. The preferred approach is based on an index based on the number of modes respondents said they had changed their use of in the last 12 months. This was tested against three descriptive variables – lifestage, dominant mode and LOAC group – which showed considerable variability in each case confirming their usefulness in defining segments. A strong relationship was found between the propensity to change index and respondents' stated intentions to make changes in the future.

The LTDS survey data was used as an independent source of travel behaviour data to validate the travel behaviour at a segment level and fine tune the definitions of the segments. Figure 7.19 shows the relative use of different modes of travel for the different segments.

Figure 7.19 The relative use of main mode for each segment.

	Car use	Bus use	Rail	Underground	Walk	Cycle
Affordable transitions						
Educational advantage						
Family challenge						
Urban mobility						
City living						
Students and graduates						
Suburban moderation						
Settled suburbia						
Detached retirement						

Source: TfL segmentation survey 2015.

A Transport Classification of Londoners (TCoL)

There are 25,053 Output Areas in London each with an average population of 326. TCoL classifies these Output Areas into nine segments and 32 sub-segments with

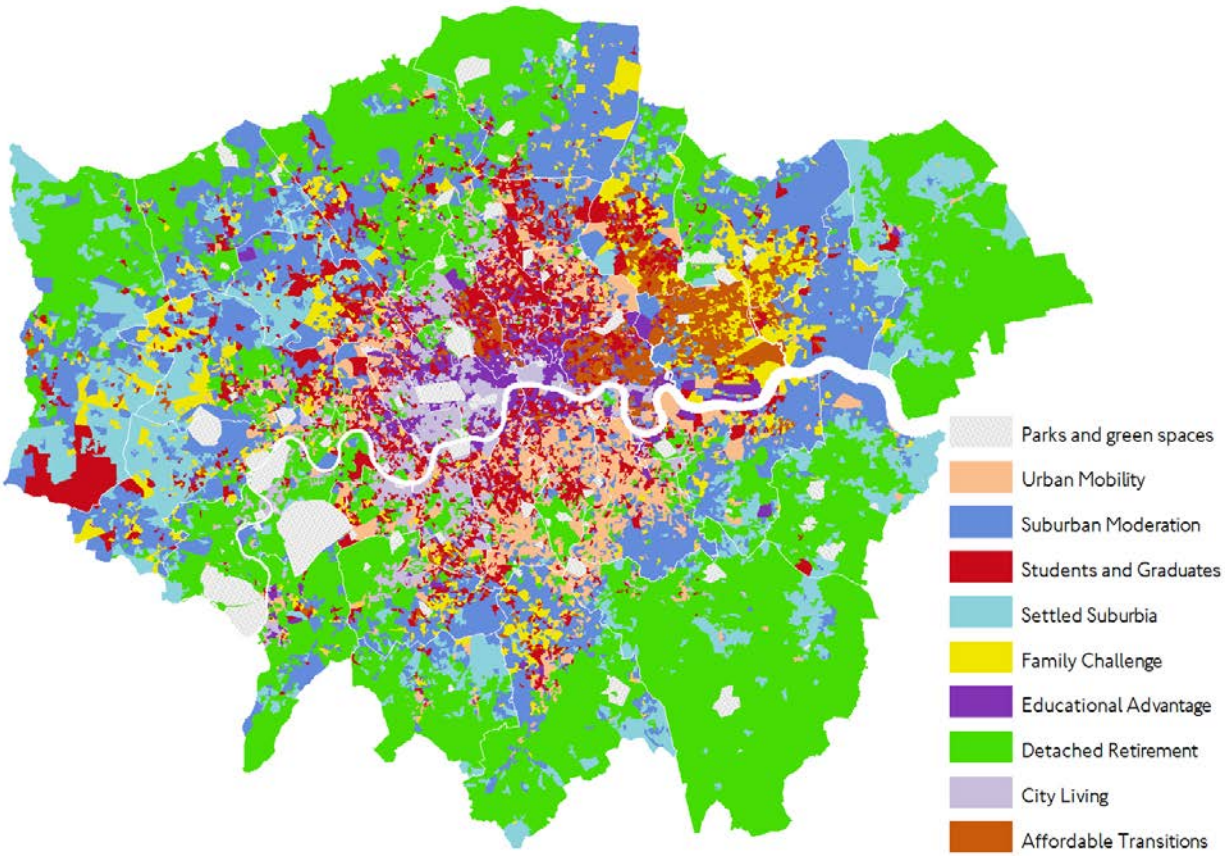
varying traits and propensity to change. The classification is based on travel behaviour and key demographics which are known to influence behaviour such as life stage and income. There is a particular focus around people's propensity to change behaviour which itself is closely related to life stage. Each segment and sub-segment is described on the basis of typical demographic traits plus a series of key indicators as shown in figure 7.20.

Figure 7.20 Characteristics of TCoL segments.

	Who we are	How we travel
Affordable transitions	People in this segment are likely to be experiencing life transitions such as starting a first job or a new family. As a consequence they exhibit the most change of any segment.	Their car use is generally quite low and use of public transport correspondingly high. Walking is average but cycling above average.
Educational advantage	Mainly living in central London, people in this segment tend to be highly educated and have above average incomes. A low proportion have children living in the household.	This segment relies on public transport and walking, with very low car use. They have a high propensity for change.
Family challenge	The Family Challenge segment includes a high proportion of young families. With average to low incomes, finances are tough for this segment.	Car ownership and use is around the average for this segment, as is their use of active modes, while bus use is well above average.
Urban mobility	Typically young working adults with no children and reasonable incomes living in inner (though not central) London.	The urban mobility segment has low car use and relatively high levels of cycle use. Bus use is also high, while walking and Undergound use is average.
City living	The City Living segment is characterised by very high incomes and locations in trendy parts of London (Westminster/Kensington/Chelsea).	Those in the city living segment have very high levels of Undergound use while also above average use of bus, rail, walking and cycle hire.
Students and graduates	Based mainly in inner London, this segment includes a relatively high proportion of students and recent graduates. Incomes are average, as are their levels of change.	Car use low so rely on public transport and active modes for travel, particularly bus and walk.
Suburban moderation	Predominantly located in outer London the suburban moderation segment is likely to have at least one child at home and has around the average level of change	Car use is high, with use of public transport and active modes below average.
Settled suburbia	This segment has similarities to Suburban Moderation but with somewhat lower incomes and lower levels of change.	Car use is high and use of active modes particularly low. Use of bus, rail and Underground also well below average.
Detached retirement	Typically in the "empty nest" or retired lifestage groups, the detached retirement segment is looking to live in greener suburbs on the fringes of London.	Travel is dominated by the car with some use of rail, but very little bus or active modes.

Source: TfL segmentation survey 2015.

Figure 7.21 The distribution of TCoL segments across London.



Source: TfL segmentation survey 2015

In the centre, the wealthy 'city living' and 'educational advantage' segments predominate. Further out in the north and south east and to a lesser extent west of inner London, live the 'students and graduates' and 'urban mobility' segments.

'Suburban moderation', 'settled suburbia' and 'detached retirement' segments dominate outer London.

East London looks notably different from elsewhere, with even the outer areas dominated by the 'affordable transitions' and 'family challenge' segments.

The propensity to change travel behaviour varies considerably between the TCoL segments. This is also true of people's propensity to currently use each main mode (car, bus, rail, Underground, walk, cycle) and their attitudes toward them. Indicators have been developed which look specifically at some more common behavioural changes:

- Reduce car use,
- Increase bus, and
- Increase walk.

Figure 7.22 shows the indices developed for these behavioural changes. In each case a value of 100 is what would be expected of a typical Londoner in the general population. Where a value is less than 100 this means that segment are less likely than the whole population to make that change and where the value is greater than 100 they are more likely. These indices show the relative likelihood of change. For

example, the 'affordable transitions' segment is 1.7 times as likely to change as someone in the 'detached retirement' segment shown by their change index values of 136 and 80 respectively.

Table 7.22 Propensity to change travel behaviour for the TCoL segments.

Label	Change index	Propensity to reduce car use	Propensity to increase walking	Propensity to increase cycling
Affordable transitions	136	182	130	164
Educational advantage	117	69	171	113
Family challenge	116	137	144	55
Urban mobility	110	157	141	142
City living	102	87	91	102
Students and graduates	100	96	83	106
Suburban moderation	97	99	90	138
Settled suburbia	89	91	72	42
Detached retirement	80	53	68	55
All Londoners	100	100	100	100

Source: TfL segmentation survey 2015.

TfL has developed profiles of each segment and these will be available via the London Datastore. TfL will be using the understanding that TCoL gives us to support the development of new policies to better target intervention. The full report is available at: https://maps.cdrc.ac.uk/#/metrics/ruralurban/default/BTTTFTT/10/-0.1500/51.5200/.

8. Improving the environmental performance of transport

8.1 Introduction and content

This chapter looks at aspects of the evidence base relating to local air quality and carbon dioxide (CO_2) emissions in London. It begins by describing the latest update to the London Atmospheric Emissions Inventory (LAEI) – the key tool for air quality analysis and policy development. The LAEI has been comprehensively updated during the course of the last year, and this chapter summarises both the content of the update and the main outputs – in terms of estimates of current emissions and concentrations of key air quality pollutants (NO_x, NO_2 and PM_{10}), – together with estimates of past trends and future projections. This is complemented by a look at trends over the last decade or so in measured ambient air quality in London – where examination of how individual monitoring sites deviate from 'average' behaviour can shed light on the relative effectiveness of policies to tackle air quality.

The chapter then proceeds to illustrate the spatial distribution of poor air quality across London and its relationship to two aspects of urban life – multiple deprivation and urban walkability. It then outlines work that TfL is currently doing to develop a set of vehicle emissions factors for London that more accurately reflect the actual emissions performance of vehicles operating in London – both in terms of the emissions performance of the vehicles themselves (ie technology aspects), but also better reflecting the nature of the 'drive cycle' typically experienced by vehicles operating in London.

8.2 The London Atmospheric Emissions Inventory – the evidence base for developing air quality policy

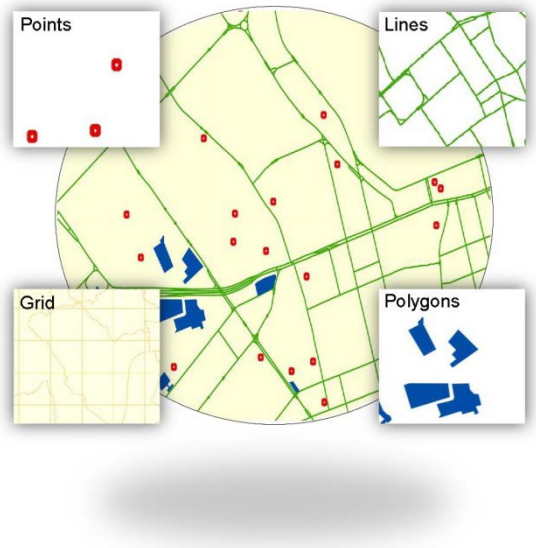
Introduction

The LAEI is a compilation of geographically referenced datasets of pollutant emissions and sources in Greater London and up to and including the M25 motorway ring. The base year for the current LAEI is 2013, with back projections to 2008 and 2010 and forward projections to 2020, 2025 and 2030.

Overview of the LAEI

Wherever possible, the LAEI uses the most spatially disaggregate data on polluting activities that is readily available for each source type. Emissions are calculated by geographical source type; point, polygon, line and area as illustrated by figure 8.1.

Figure 8.1 LAEI source geographies.



Source: London Atmospheric Emissions Inventory 2013 via London Datastore.

The LAEI2013 includes the following key pollutants:

- Oxides of nitrogen (NOx).
- Particulate matter with aerodynamic diameter < 10 µm (PM_{10}) including from combustion/exhaust, tyre wear, brake wear and resuspension sources.
- Particulate matter with aerodynamic diameter < 2.5 µm ($PM_{2.5}$) including from combustion/exhaust, tyre wear, brake wear and resuspension sources.
- Carbon dioxide (CO_2).

Additionally, the LAEI includes a number of subsidiary pollutants, including:

- Sulphur Dioxide (SO_2).
- Non Methane Volatile Organic Compounds (NMVOC).
- Benzene (C_6H_6) and 1,3-butadiene (C_4H_6) (which are part of NMVOCs).
- Methane (CH_4).
- Ammonia (NH_3).
- Carbon Monoxide (CO).
- Nitrous Oxide (N_2O).
- Heavy Metals Cadmium (Cd), Mercury (Hg) and Lead (Pb).
- Benzo[a]pyrene (BaP).
- PolyChlorinated Biphenyl (PCB).
- Hydrogen Chloride (HCl).

The source categories in the LAEI are detailed in figure 8.2.

Figure 8.2 Emission source categories in the LAEI.

Industrial and commercial	Industrial processes	Large: Part A process Small: Part B process Non-road mobile machinery exhaust
	Heat and power generation	Solid and liquid fuel combustion Gas combustion Gas oil combustion
	Natural gas supply	Gas leakage
	Waste	Waste and waste-water handling Waste transfer Small-scale waste burning
	Construction	Non-road mobile machinery exhaust Construction and demolition dust
Domestic	Heat and power generation	Solid and liquid fuel combustion Coal combustion Gas oil combustion Gas combustion
	Machinery	Non-road mobile machinery (NRMM)
Transport	River	Passenger shipping Commercial shipping
	Road	Motorcycle Taxi Car - petrol, diesel, electric Vans - petrol, diesel, electric HGVs - Artic, Rigid TfL Buses Other bus/coaches
	Rail	Passenger Freight
	Aviation	Aircraft and airport activities
Miscellaneous	Agriculture	Combustion Livestock Other agriculture
	Forestry	Biosynthesis

Source: London Atmospheric Emissions Inventory 2013 via London Datastore.

Uses of the LAEI

The LAEI provides an analytical evidence base, essential for strategy and policy development and planning for London. The primary functions of the inventory are strategic emissions modelling, concentrations modelling and air quality mapping. These processes can be used to identify existing pollution hotspots in London, the contribution of different sources, and to forecast future changes to air quality.

The LAEI has been used throughout the development and refinement of the Ultra Low Emission Zone (ULEZ) proposals for London (see: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone), initially, through highlighting the need to improve air quality, by providing current and forecast future air quality maps and comparisons to EU limit values and identifying the key contributors to pollution hotspots. The inventory formed the basis of the assessment of the impact of the ULEZ policy options, by assessing the impact of changes in the vehicle fleet on emissions and concentrations in London. Combined with population data, the resulting air quality maps can assess the impact of proposals on the pollution exposure of Londoners.

In addition to the emissions and air quality data provided in the inventory, baseline information can be extracted on vehicle fleet composition, traffic flows and vehicle kilometres across London.

TfL coordinates the development of the inventory in collaboration with the GLA, who provide information on non-transport emissions sources in London. Besides its core function informing TfL and GLA strategy and policy development, the inventory provides evidence for London Boroughs Local Air Quality Management (LAQM), planning and health functions. Boroughs are provided with a dashboard of useful data summaries and statistics alongside access to the full inventory. The inventory air quality maps inform the declaration of air quality focus areas, where further local action is required to reduce public exposure to levels above the air quality limit values.

The inventory is publically available, directly helping to raise awareness and understanding of London's air quality. It also informs public information systems such as pollution forecasts.

Methodology enhancements for 2013 update to the LAEI

Full details of the method used to produce the LAEI2013 are provided in the methodology documents that accompany the inventory. Some of the more significant developments for this iteration of the inventory are detailed below.

Road transport

There are three approaches to improving the estimation of road traffic emissions in the LAEI to ensure that the baseline projections and future policies are best represented:

- Improve the underlying vehicle activity data (flow and speed).
- Improve the categorisation (technology and euro standard fleet compositions).
- Improve the emissions function of the vehicles.

Improvements undertaken for the LAEI2013 are:

Activity data improvements

- There has been a comprehensive update of traffic flow on the road network using the latest data from TfL and DfT.
- The traffic growth projections incorporated in LAEI2013 have been spatially disaggregated by zone and borough, TLRN links and motorways.
- The LAEI2013 minor road network, used to spatially represent emissions in London, is now based upon the Ordnance Survey Integrated Transport Network (as is the major road network).
- A major revision of the way buses are treated has been implemented and includes TfL bus traffic, speed and technology composition by individual route derived from iBus data. There has been a commensurate development of the emissions model to incorporate this bus route data, including a private coach update and assimilation of urban buses outside the Greater London area.
- An update of vehicle speeds has been implemented using sub-link level data derived from global positioning system (GPS) vehicle tracking (TrafficMaster).

Categorisation improvements

- There has been a major revision to the London vehicle stock model and proportion of petrol/diesel disaggregated by zones (ULEZ, Inner Ring Road (IRR), inner, outer and external) and the inclusion of electric vehicles (EV). The update used the latest ANPR (Automatic Number Plate Recognition) based vehicle ages and proportion of petrol/diesel/EV, using information provided by DfT, AEA-Ricardo and TfL.

Emission functions improvements

- A new set of emission factors and emission degradation correction factors (from COPERT 4 v10 and v11) has been implemented for all pollutants and vehicle types into the LAEI emissions model.
- Cold starts have been updated using trip start data from a recent London Transporatation Studies (LTS) model forecast and developed to include taxis and year-dependent data.

Shipping, rail and domestic and commercial gas

- Emissions factors improvements.
- Population growth updated and spatial distribution improvements.

Non-road mobile machinery (NRMM)

- Emissions from construction plant and equipment.
- Spatial distribution based on the GLA planning database and the London Plan.
- NRMM Supplementary Planning Guidance incorporated.

Further information

The LAEI is available on the London Datastore which includes output emissions data, air quality maps and methodology documents (see: https://data.london.gov.uk/dataset/london-atmospheric-emissions-inventory-2013).

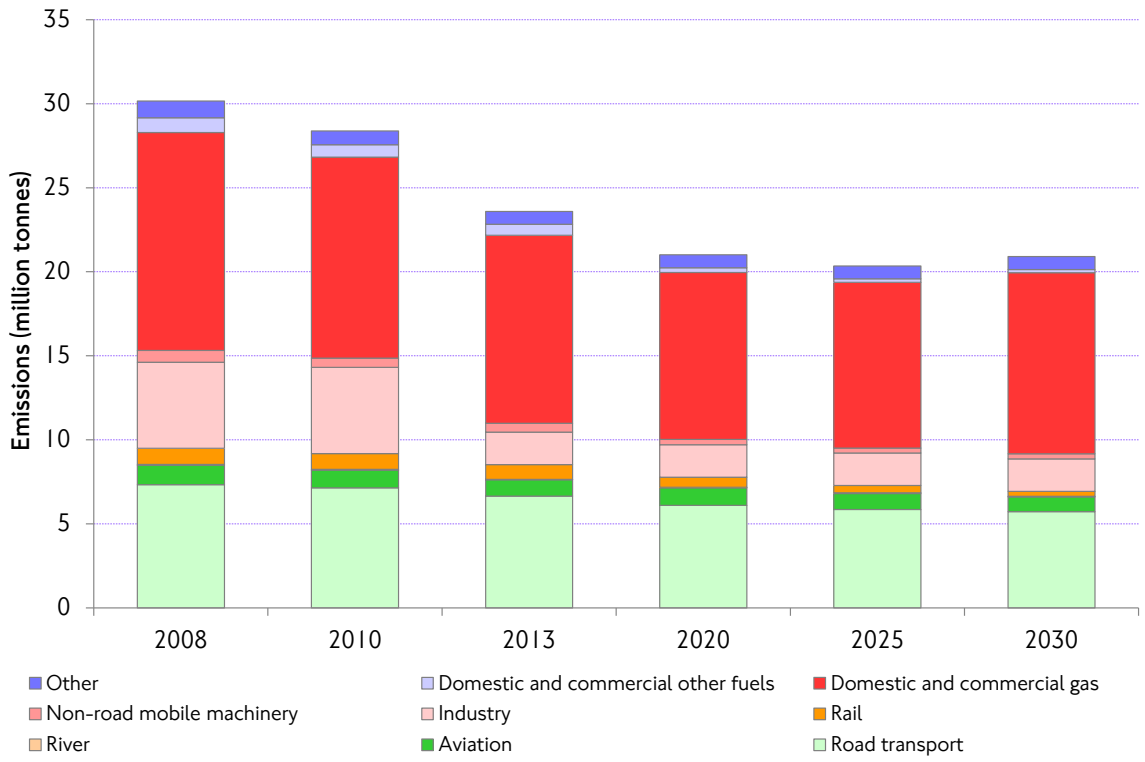
8.3 Emissions – recent trends and future projections

LAEI2013 emissions projections for Greater London are shown below for CO_2 and the key pollutants, NOx and PM_{10}, for the base year of 2013 and the inventory back (2008, 2010) and forward (2020, 2025 and 2030) projection years.

Trends in CO_2 emissions – all sources

Emissions of CO_2 are expected to fall up to 2025 as efficiency improvements outweigh any increase in activity in London. From 2008 to 2013 emissions fell by 22 per cent. Emissions are expected to fall by 11 per cent on 2013 levels by 2020, and by 14 percent by 2025. By 2030, further increases in efficiency are not sufficient to outweigh the expected increase on activity due to population growth in London.CO_2 emissions are expected to increase slightly above 2025 levels, but not reaching 2020 levels, and remain 11 per cent below 2013 levels. In 2013, 28 per cent of total CO_2 emissions were from road transport, with the greatest contribution being from domestic and commercial gas (47 per cent).

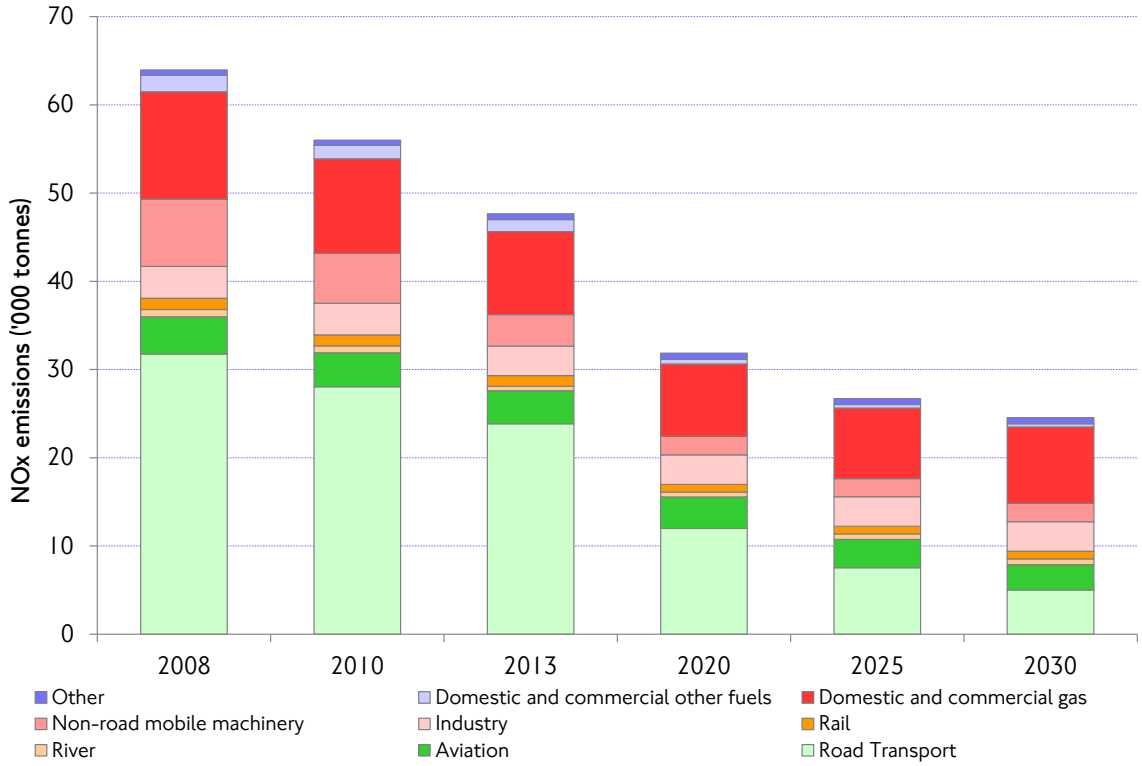
Figure 8.3 Emissions trend and main source categories – CO_2.



Source; London Atmospheric Emissions Inventor 2013 via London Datastore.

Trends in NO_x emissions – all sources

Figure 8.4 Emissions trend and main source categories – NO_x.



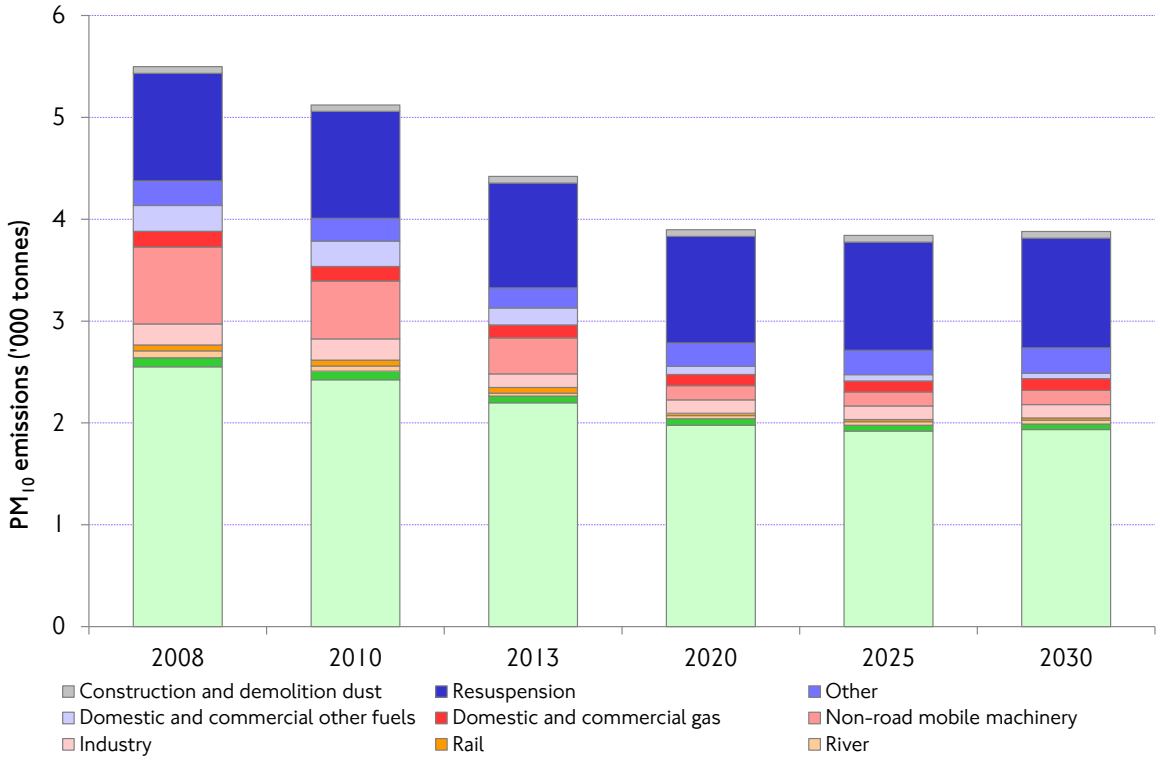
Source; London Atmospheric Emissions Inventory 2013 via London Datastore.

Emissions of NOx are forecast to fall over the period of the inventory projections, mainly due to reductions in road transport emissions. Total NOx emissions in London fell by 25 per cent over the period 2008 to 2013. Projected reductions in NOx emissions are most significant in the period leading up to 2025 as the vehicle fleet in London becomes cleaner, brought about by technological advances and policies (such as ULEZ) to encourage their early uptake. Against 2013, NOx emissions are expected to fall by 33 per cent to 2020, 44 per cent to 2025 and 48 per cent to 2030.

Trends in PM_{10} emissions – all sources

Emissions of PM_{10} are expected to fall up to 2025, mainly due to reductions in road transport emissions and significant reductions in NRMM emissions up to 2020. Total PM_{10} emissions fell by 20 per cent over the period 2008 to 2013. Against 2013, PM_{10} emissions are expected to fall by 12 per cent up to 2020 but plateau from 2020.

Figure 8.5 Emissions trend and main source categories – PM_{10}.

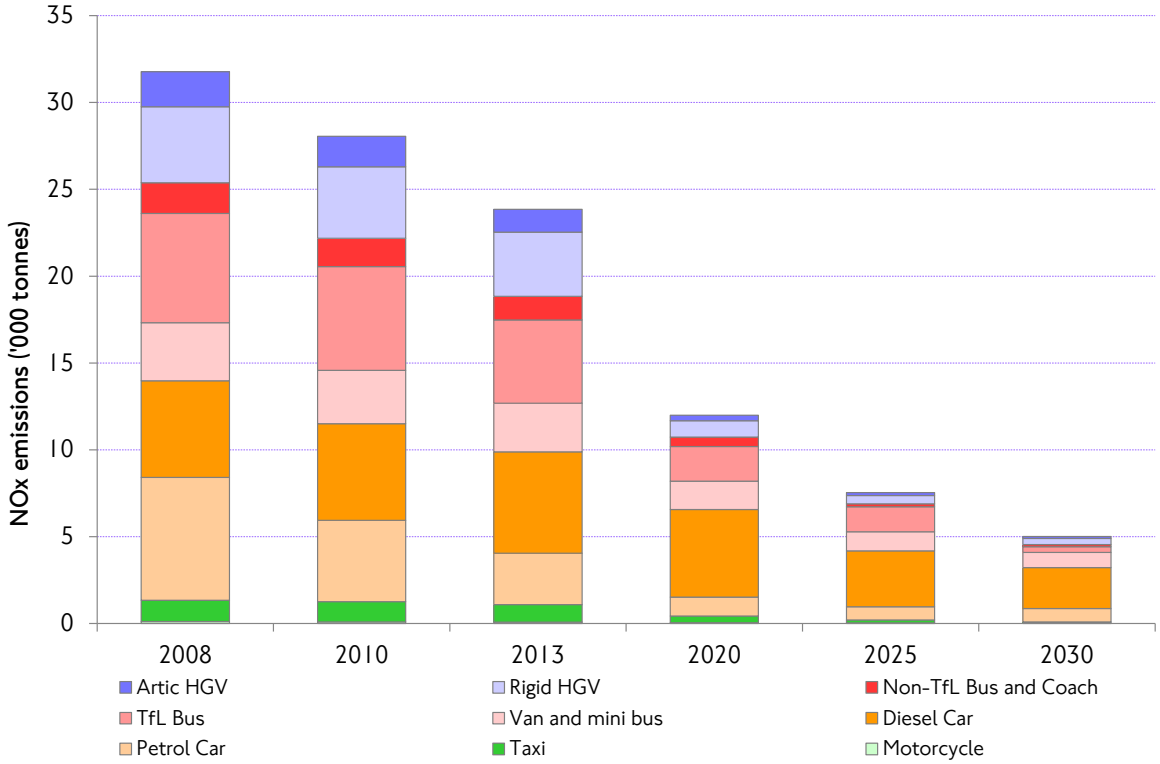


Source; London Atmospheric Emissions Inventory 2013 via London Datastore.

Trend in emissions from road transport

In 2013, emissions from road transport comprised 50 per cent of total NOx and PM_{10} emissions in London. Figures 8.6 and 8.7 show the various components of this road traffic emission in more detail.

Figure 8.6 Trend in emissions from road transport – NO_x.

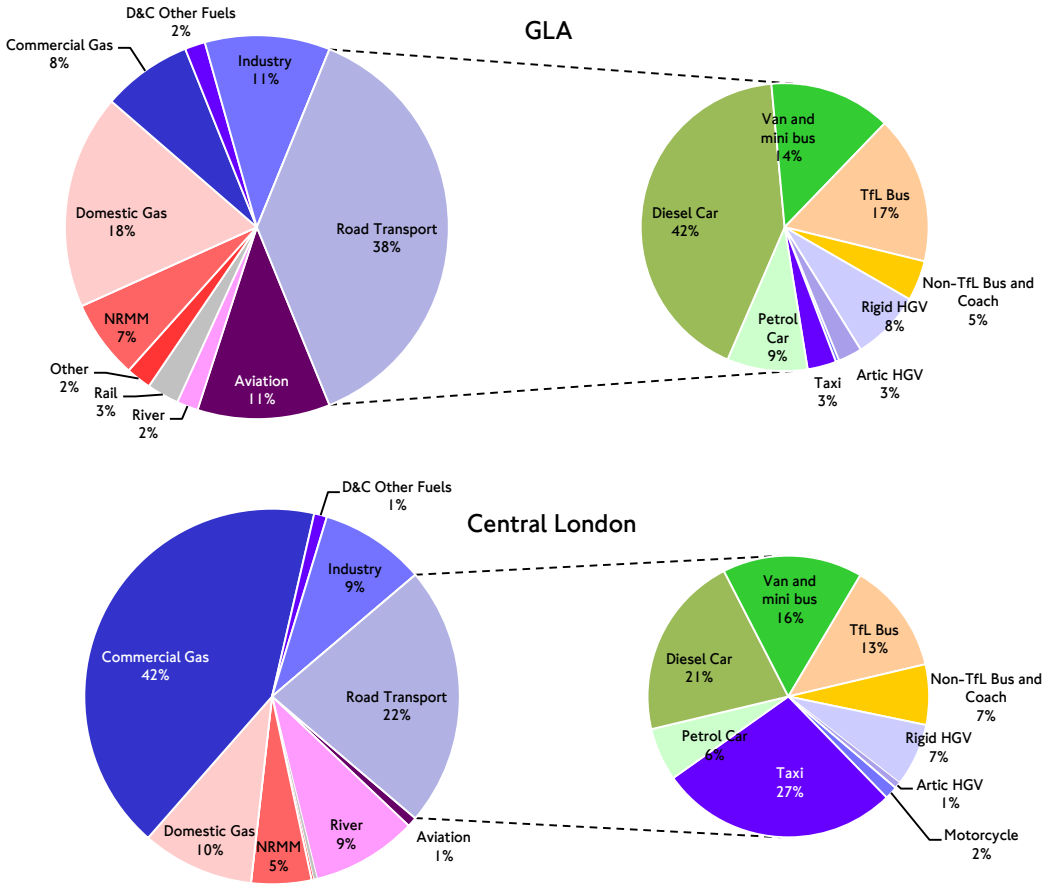


Source; London Atmospheric Emissions Inventory 2013 via London Datastore.

Looking first at figure 8.6, the most significant reduction in NOx emissions are from TfL buses, as TfL bus improvements deliver significant NOx reductions over time across London, and particularly within central London from 2020 due to the ULEZ package of measures which include Euro VI and hybrid buses. Significant reductions in NOx from HGVs can also be seen in 2020 when ULEZ will be in place. Taxi emissions are also forecast to reduce significantly between 2013 and 2020, with the introduction of the zero emission capable taxi in 2018. Little reduction in emissions from cars is expected prior to the introduction of ULEZ in 2020, and there was a slight increase in 2013 compared to 2010 due to the failure of European emissions standards to reduce emissions from the fleet.

The spatial disaggregation of the inventory is vital to being able to understand the variation of emissions across London and develop policies to meet the unique needs of each area. Figure 8.7 shows the distinct differences between NOx emissions sources in central London, compared to the whole of Greater London in 2020.

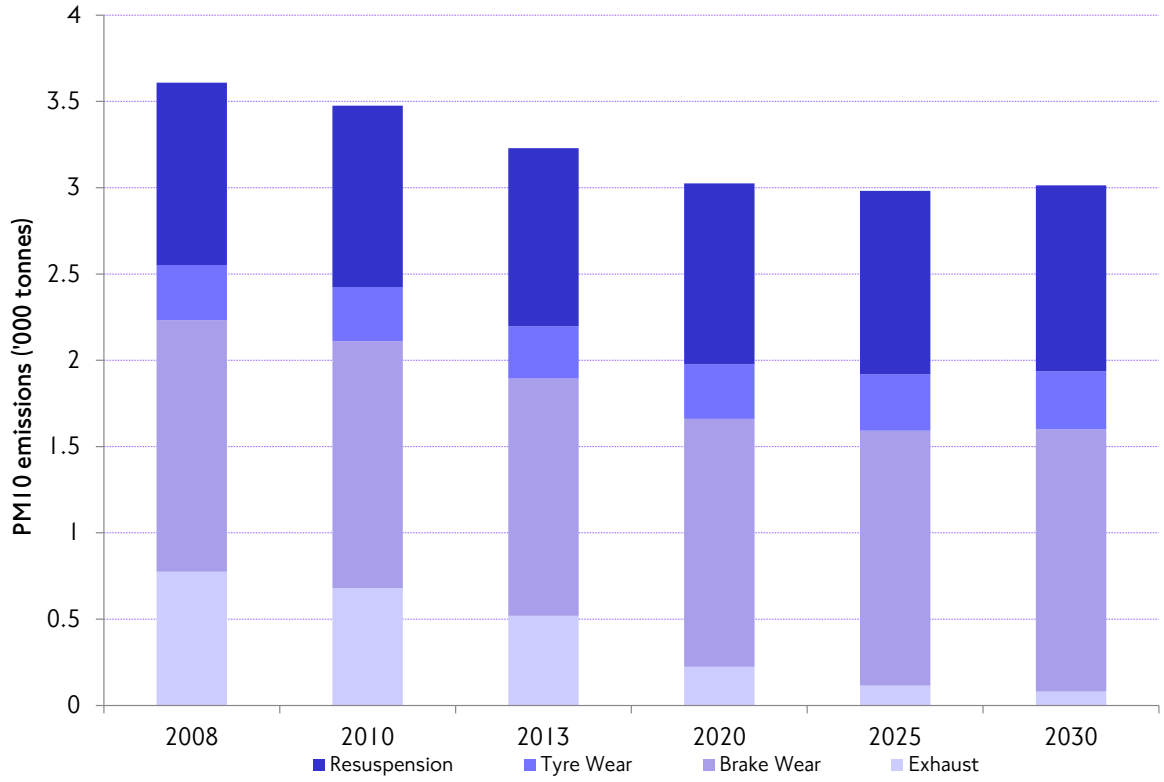
Figure 8.7 Comparative NO_x emissions by source for 2020 – Greater London and central London compared.



Source: London Atmospheric Emissions Inventory 2013 via London Datastore.

Road transport emissions dominate NOx emissions across the whole of Greater London. However, in central London, where ULEZ will be in place and there is greater public transport provision, emissions of NOx are dominated by the high density of commercial gas emissions. There is also a distinct variation in the contribution of aviation and river transport, with the latter making a larger contribution in central London and the former in Greater London. Breaking down emissions into vehicle types illustrates the dominance of diesel cars across Greater London, which is narrowly overtaken by taxis in central London.

Figure 8.8 Trend in emissions from road transport – PM_{10}.

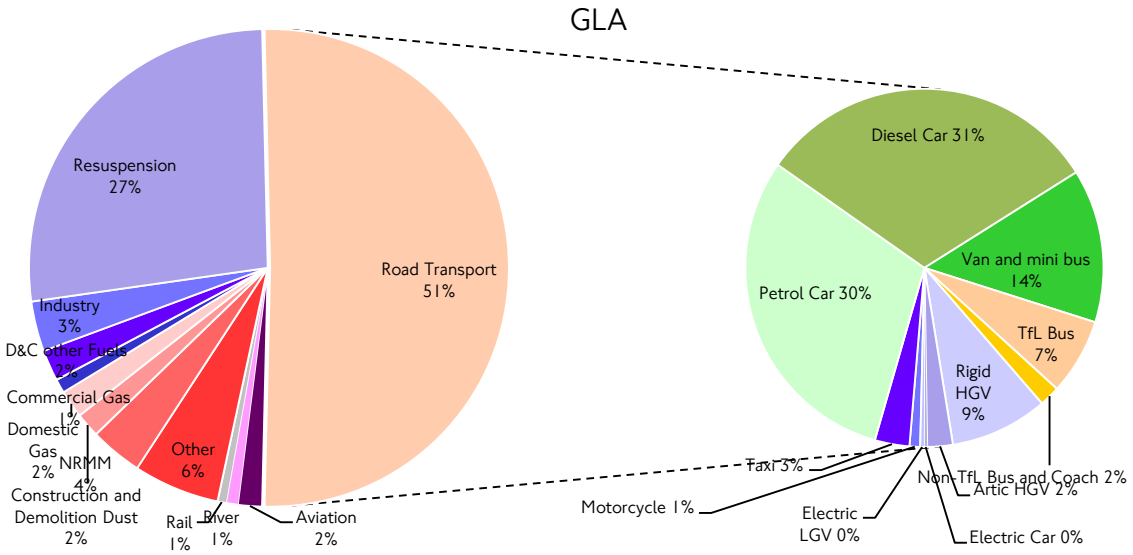


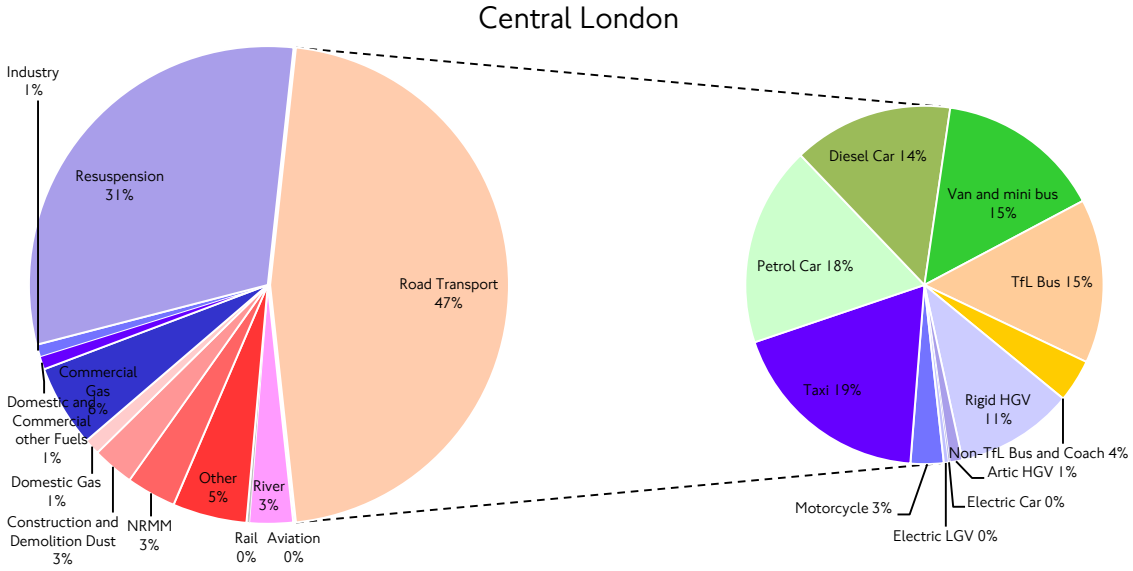
Source; London Atmospheric Emissions Inventory 2013 via London Datastore.

The rate of reduction in PM_{10} emissions from road transport is less pronounced than NOx as improvements to vehicle exhaust emissions and policies (namely the Low Emission Zone) were put in place earlier and have already taken effect, however tyre and brake wear and resuspension components of PM_{10} remain. From 2020, PM_{10} emissions show a slight upward trend due to these non-exhaust contributions. Currently, reductions in vehicle kilometres provide the main mechanism to reducing non-exhaust contributions over time.

The geographical variation in PM_{10} emissions is illustrated below in figure 8.9. While the variation in broad source categories is less distinct between central and Greater London, there is distinction in the contribution of vehicle types; particularly the dominance of emissions from cars across Greater London and the greater contribution of taxis and buses in central London.

Figure 8.9 Comparative PM_{10} emissions by source for 2020 – Greater London and central London compared.





Source; London Atmospheric Emissions Inventory 2013 via London Datastore.

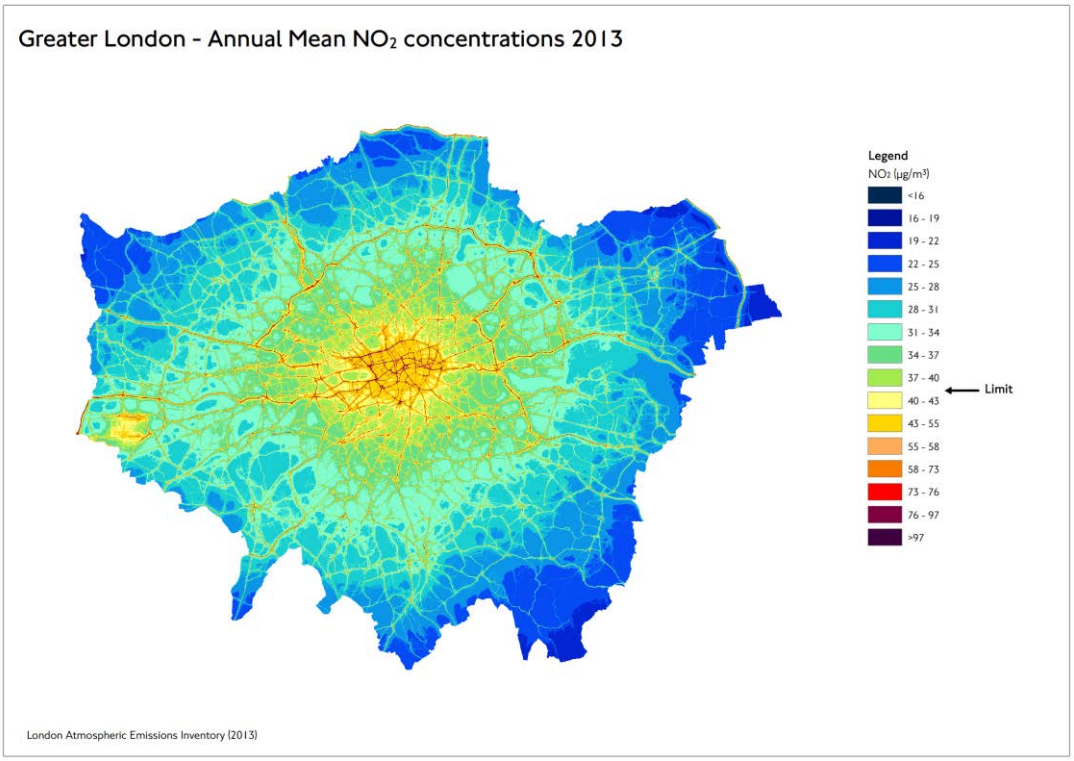
8.4 Concentrations – recent trends and future projections

Air quality concentration maps, produced using the LAEI and validated against monitoring data, are illustrated below. These indicate the geographical extent of exceedance of the limit values and can be used to determine the exposure of the residential population.

In 2013, areas totalling 190km^2 exceeded the NO_2 annual mean limit value, including the major road network, central London and Heathrow airport (figure 8.10). Approximately 1.9 million people in London, equating to 23 per cent of the population, were living in areas with average NO_2 concentrations above the EU limit

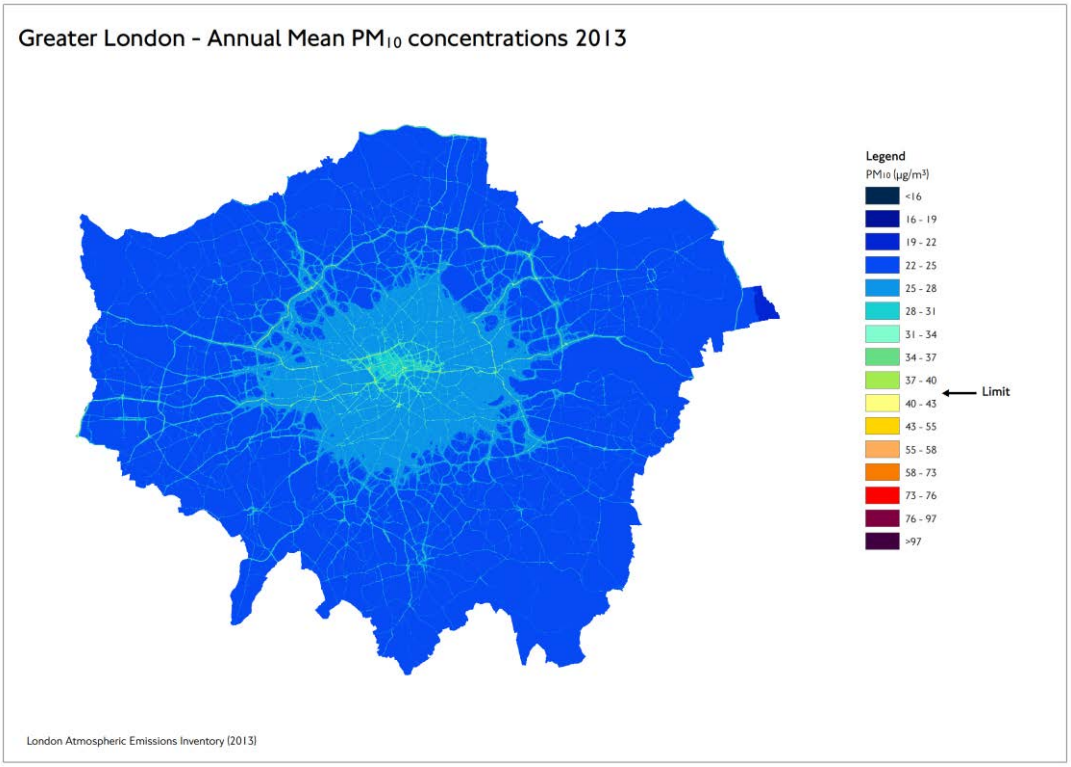
value, the majority in inner London. PM_{10} concentrations meet EU limit values, aside from an area of around 1 km^2 with no residential exposure. Concentrations are still higher towards central London, with its higher density of emissions sources (figure 8.11).

Figure 8.10 2013 - annual mean NO_2 concentrations.



Source; London Atmospheric Emissions Inventory via London Datastore.

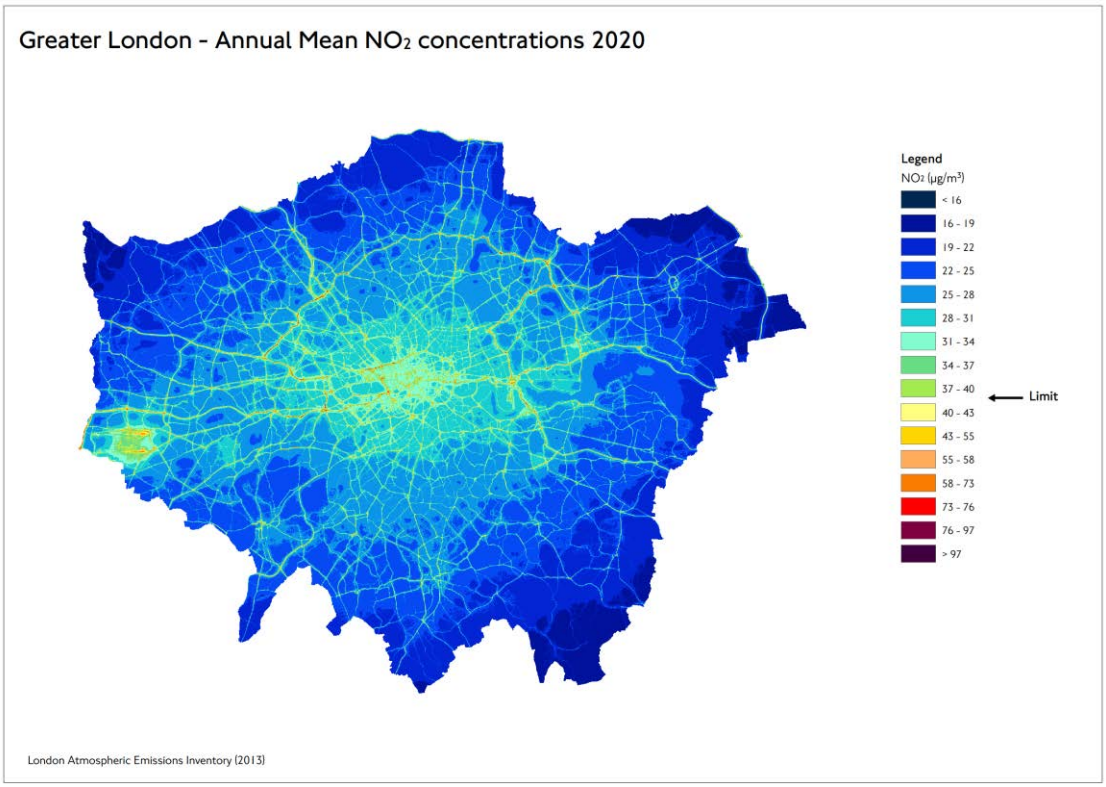
Figure 8.11 2013 - annual mean PM_{10} concentrations.



Source; London Atmospheric Emissions Inventory via London Datastore.

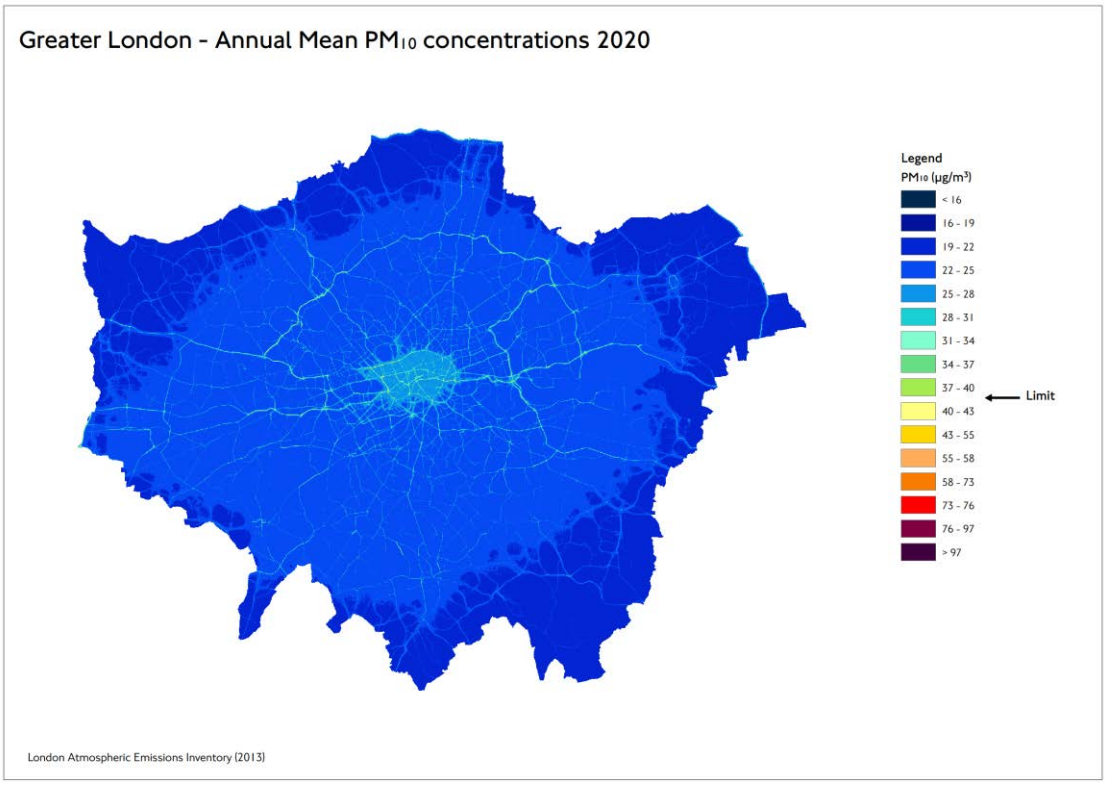
Air quality maps for 2020, indicate that if NOx emissions reduce as expected, there will be significant improvements in air quality, particularly in central London where ULEZ will be in place. Areas exceeding the EU limit values for annual mean NO_2 will reduce to 33 km^2, remaining immediately adjacent to the busiest roads and Heathrow airport (figure 8.12). The residential population in these areas is expected to be in the region of 72,000, less than 1 per cent of London's population. PM_{10} concentrations are also expected to decline but to a lesser extent (figure 8.13) as vehicle exhaust emissions have already reduced significantly. Tyre and brake wear and resuspension of PM_{10} remain relatively stable due to the stability of vehicle kilometre trends.

Figure 8.12 2020 - annual mean NO_2 concentrations.



Source; London Atmospheric Emissions Inventory via London Datastore.

Figure 8.13 2020 - annual mean PM_{10} concentrations.



Source; London Atmospheric Emissions Inventory via London Datastore.

Air quality maps for 2025 show further improvements in air quality, with significant reductions in population exposed to concentrations exceeding NO_2 limit values (figure 8.14). PM_{10} and $PM_{2.5}$ concentrations are also expected to reduce over time, however these pollutants are heavily influenced by the contributions from sources outside London, and road transport sources are dominated by brake and tyre wear and resuspension, which remain largely constant (figure 8.15).

Figure 8.14 2025 - annual mean NO_2 concentrations.

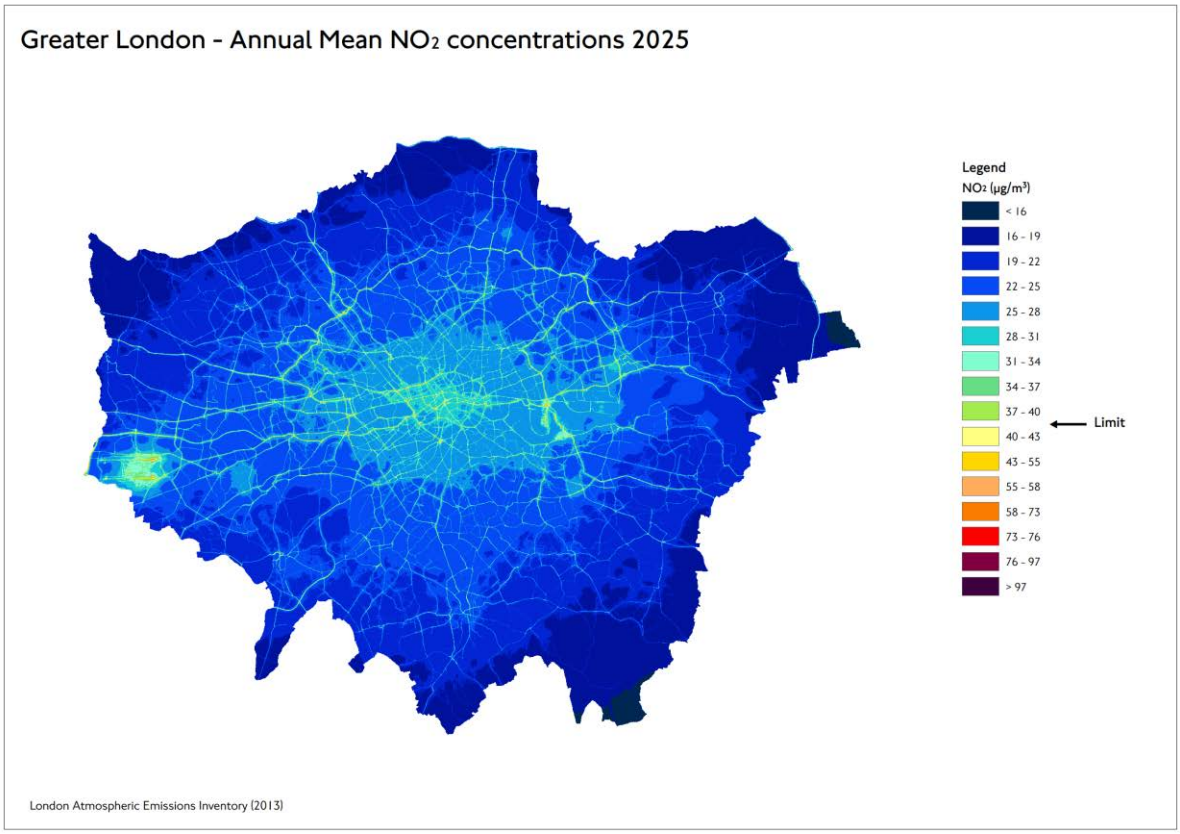
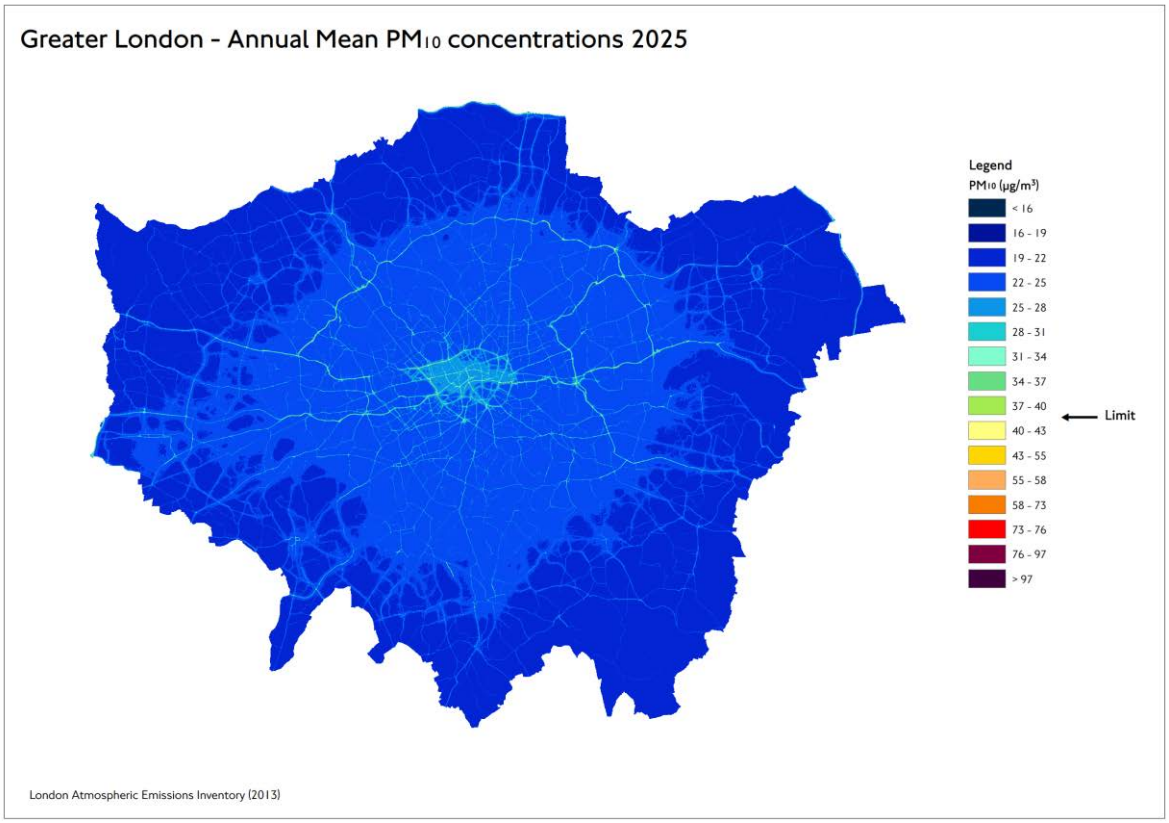


Figure 8.15 2025 - annual mean PM_{10} concentrations.



Source; London Atmospheric Emissions Inventory via London Datastore.

8.5 Recent trends in London's ambient air quality

London has a comprehensive air quality monitoring network, funded by London boroughs, the GLA, TfL, Defra, Heathrow Airport and several of London's Business Improvement Districts. Many of these sites are part of the London Air Quality Network (LAQN), managed by King's College London, and some are also part of the Defra Automatic Urban and Rural Network (AURN) UK Network used for compliance reporting (see: https://www.londonair.org.uk/LondonAir/Default.aspx).

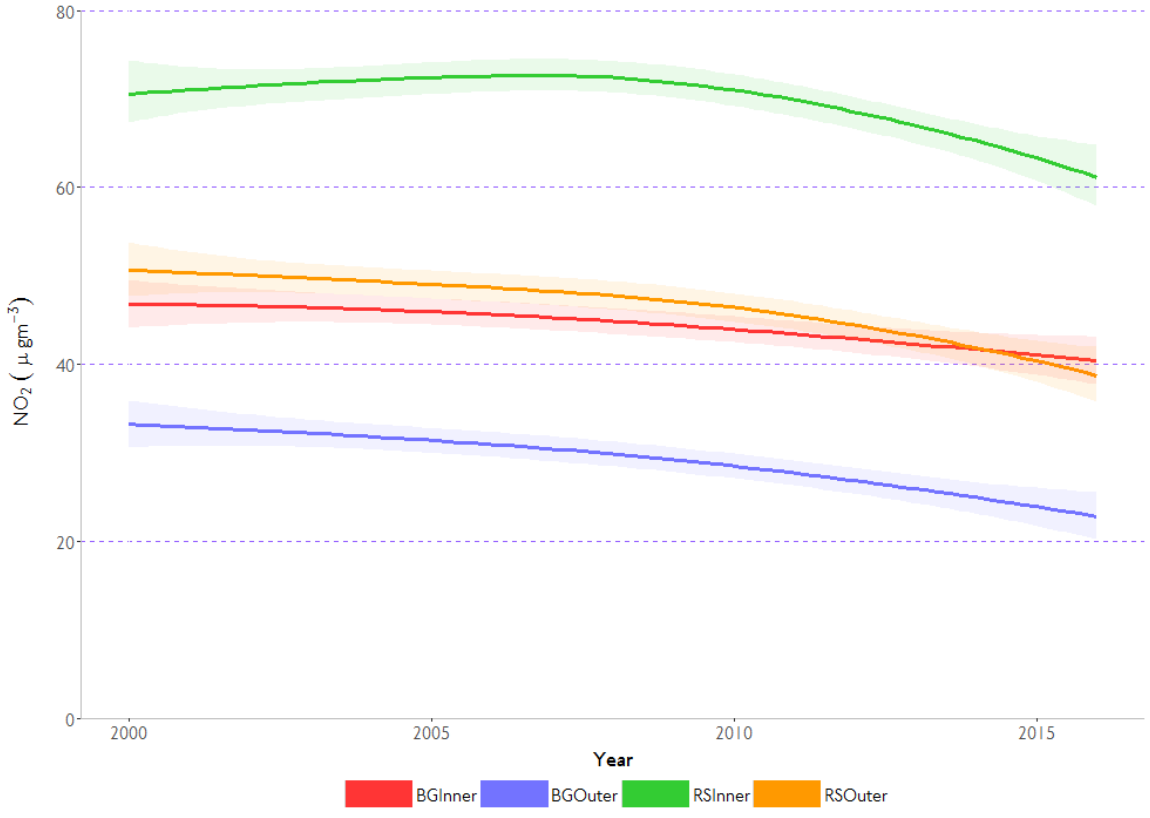
Overall trends in ambient air quality

This network provides unique opportunities to understand trends in London's air quality. One way to view air quality monitoring data is to group monitors based on their location and distance from the roadside and look at the average concentrations.

Figures 8.16 and 8.17 show the general (average) trend over the last decade or so for nitrogen dioxide (NO_2) and particulate matter (PM_{10}) concentrations at sites that are part of the LAQN, grouped by site type. Roadside monitors (RS) are within 5 metres of roads, while 'background sites' (BG) are located away from major sources of pollution.

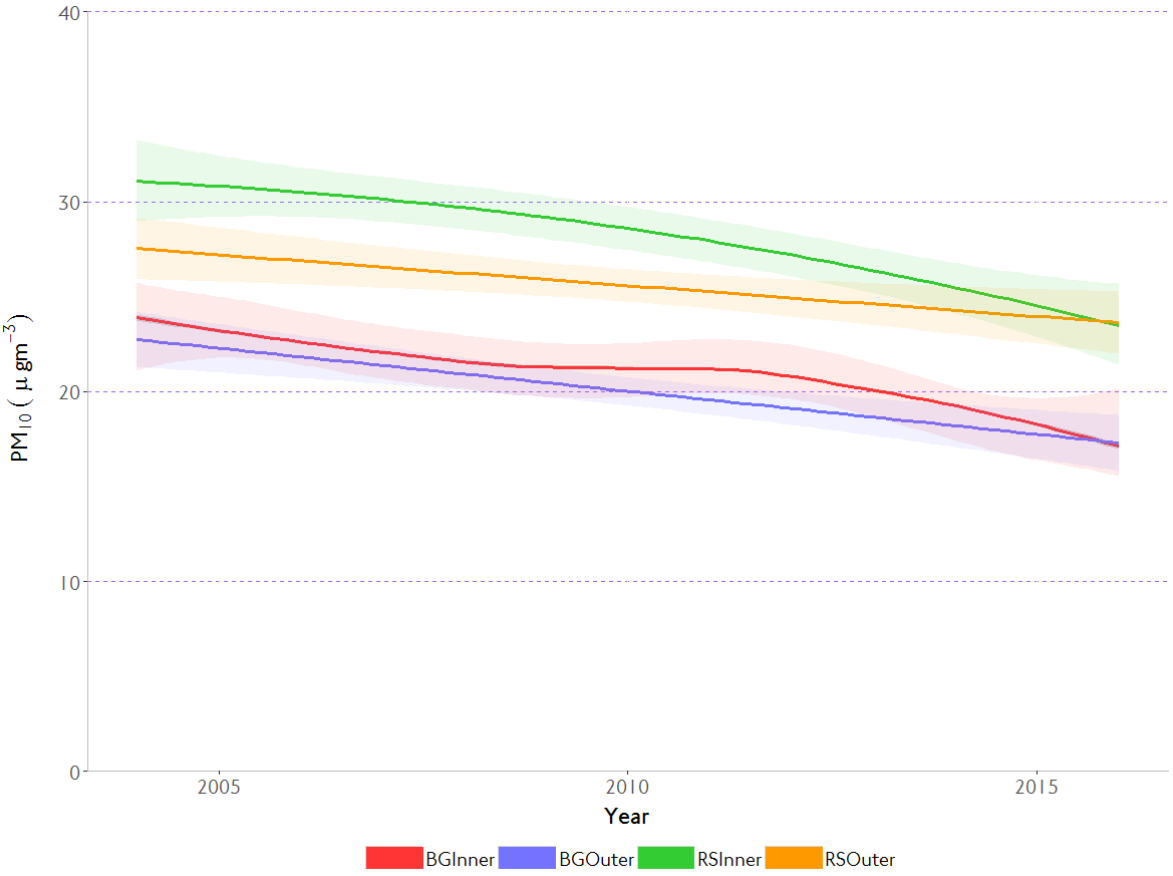
Overall, there has been a gradual reduction in NO_2 and PM_{10} concentrations at background sites in inner and outer London and at outer London roadside sites. Inner London NO_2 roadside sites have shown a more variable trend but have seen a steeper decline from 2012. This decline is also reflected in the inner London PM_{10} roadside sites.

Figure 8.16 Trends in NO_2 in London – 2000 to 2016.



Source: the London Air Quality Network and analysis by King's College London.

Figure 8.17 Trends in PM_{10} in London – 2004 to 2016.



Source: the London Air Quality Network and analysis by King's College London.

These reductions are important as they show, overall, that air quality is improving in London. This is supported by analysis at most individual monitoring sites, although the dynamic nature of air pollution and the way it is affected by multiple factors means that concentrations at some sites can go up while the overall trend across the city is improving. Factors that can influence local trends include changes in traffic volumes, the variable response of exhaust abatement in different road conditions as well as temporary changes issues like construction activity, weather, local road layouts etc.

In addition they reflect all pollution sources experienced at a monitoring site and not just locally emitted pollution or road-based pollution specifically. While the vast majority of roads in London met the PM_{10} EU annual mean limit value of 40 µg m^{-3} in 2013, the majority still exceeded the NO_2 EU annual mean limit value of 40 µg m^{-3} by a large margin.

Variability at individual air quality monitoring sites

Given this overall trend, it is of interest to examine trends at individual air quality monitoring sites – to see the extent to which they follow the overall trend for all sites, or deviate from it – either positively or negatively. Some degree of variability is to be expected, as individual sites will reflect individual circumstances. By using statistical techniques to normalise trends across sites and to isolate the locally-generated component of emissions at roadside sites, it is possible to look specifically at the difference or 'increment' between the roadside air quality

measurements and those at equivalent background sites to quantify the air pollution from traffic as distinct from other regional and urban sources.

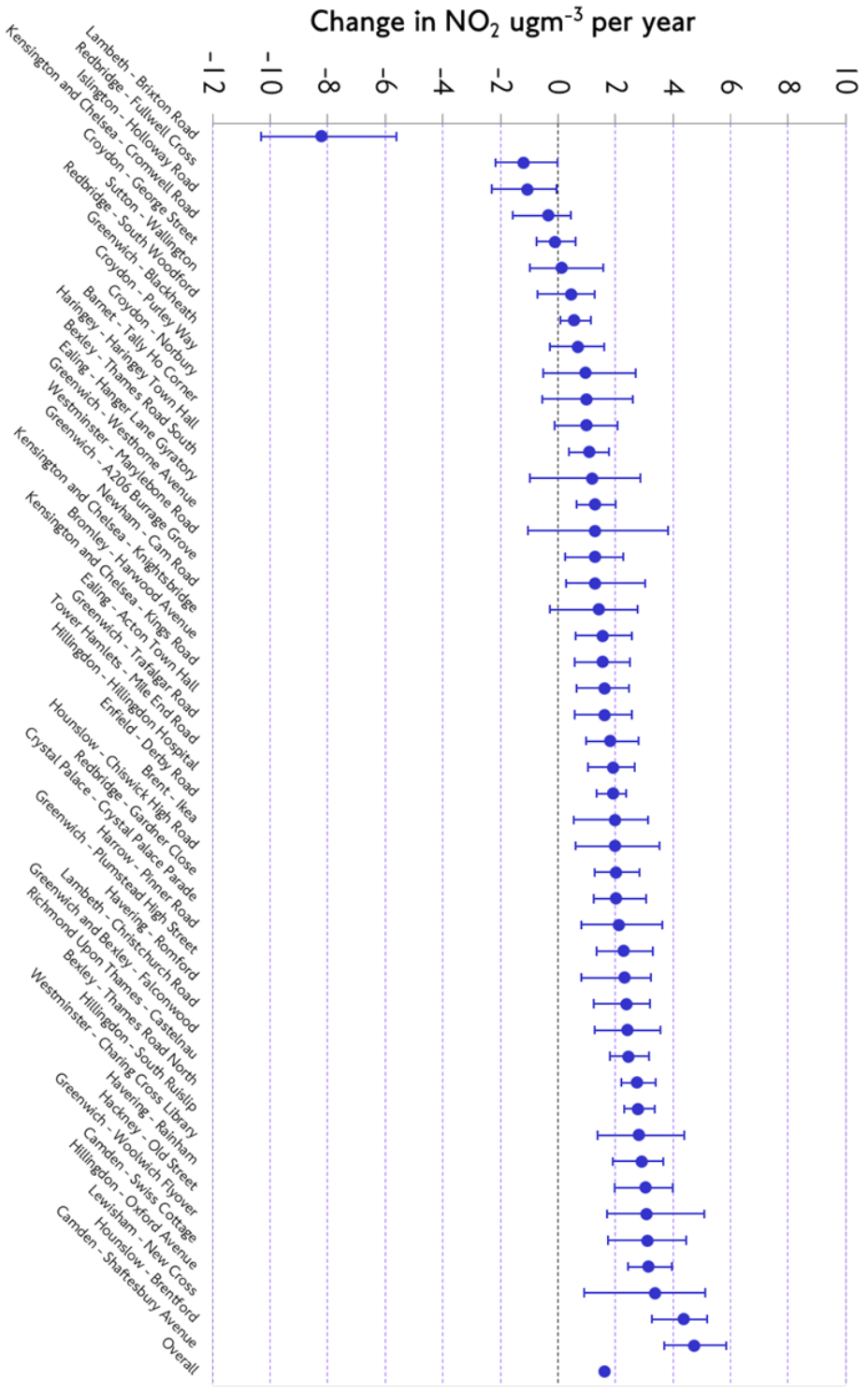
Research by King's College London on behalf of TfL (see: http://www.londonair.org.uk/london/asp/news.asp?NewsId=Tfltravelreport2016&StartIndex=11 and also http://www.sciencedirect.com/science/article/pii/S0269749116305966) has looked specifically at this increment and the rate at which it has changed over time.

It is clear from this analysis that the traffic contribution to pollution concentrations at some sites is reducing much faster than at others. For example, ambient concentrations of NO_2 and PM_{10} measured at Marylebone Road have reduced over the last four years but this tendency has not been replicated so clearly across other London roadside sites.

It is also clear from the overall average trend data that there has been a difference in overall trends over the last ten years – with NO_2 tending to increase overall between 2005 and 2009 and decrease from 2010 onwards.

Figure 8.18 shows changes in the roadside increment of NO_2 between 2005 and 2009 at individual sites, relative to the position in 2005 (centre dotted line) and the average for all included sites (point at the very bottom of the graphic). The large majority of sites show an increase in the roadside increment of NO_2, of up to 5 ugm^{-3} per year, with an average across all sites of +1.63 ugm^{-3} per year. Only 4 (of 47 sites) showed a decrease over this period, most notably at Brixton Road (Lambeth).

Figure 8.18 Trends in NO_2 in London – 2005 to 2009.



Source: the London Air Quality Network and analysis by King's College London.

Looking at trends in PM_{10} between 2005 and 2009 (figure 8.19), the picture is more evenly distributed, with similar numbers of sites recording increases and decreases, with an overall average across sites of a small decrease in the roadside increment of -0.19 µg m^{-3} per year.

Figure 8.19 Trends in PM_{10} in London – 2005 to 2009.

Source: the London Air Quality Network and analysis by King's College London.

A different picture emerged between 2010 and 2015. Figure 8.20, for NO_2, shows that, within the overall picture of a small average reduction to the roadside increment of -1.65 ugm-^{3} per year, approximately two-thirds of sites showed a reduction, but the remaining third showed an increase.

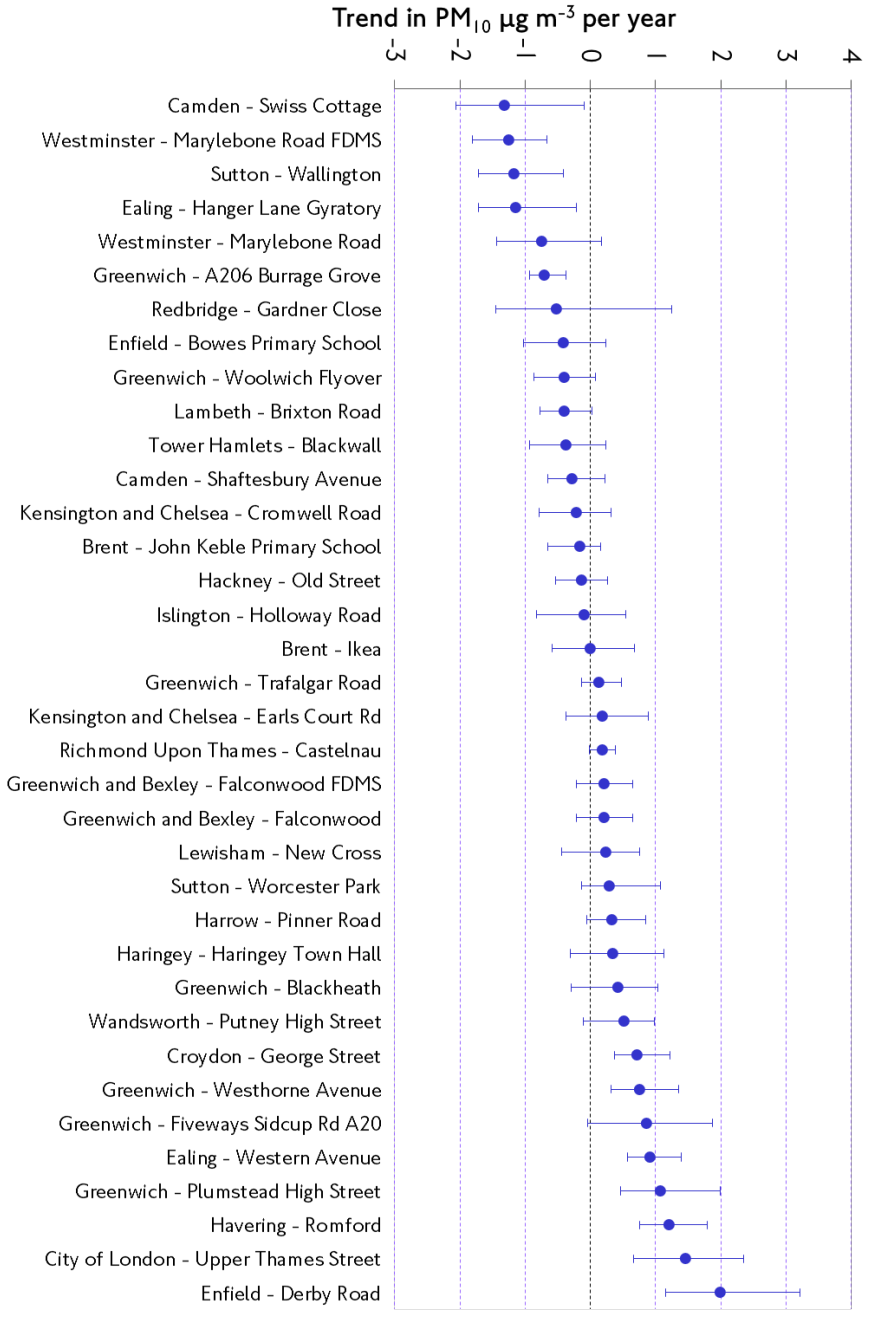
Figure 8.20 Trends in NO_2 in London – 2010 to 2015.

Source: the London Air Quality Network and analysis by King's College London.

All of the sites that have shown large reductions – notably Brixton Road and Putney High Street, have benefitted in particular from action to reduce emissions from buses – previously identified as major contributors to NO_2 concentrations at these sites. However, it is not immediately apparent what has led to the increase in NO_2 at a substantial number of sites over this period – especially given the progressive turnover of the general vehicle fleet, reflecting progressively tighter Euro emissions standards and other policy initiatives to improve air quality.

The picture was again more mixed for PM_{10} (figure 8.21) between 2010 and 2015 and the average trend for the sites considered was fairly stable (a very small increase of +0.07 µg m^{-3} per year) to the roadside increment.

Figure 8.21 Trends in PM_{10} in London – 2010 to 2015.



Source: the London Air Quality Network and analysis by King's College London.

Again, the fact that many sites saw increased PM_{10} roadside increment concentrations over this period, albeit of relatively small magnitude, is of interest, given the general effort to reduce PM_{10} emissions London wide.

Comparison of trends 2005 to 2009 with trends 2010 to 2014

Most of the monitored roads in London showed a reduction in concentrations of NO_2 during 2010 to 2015 while between 2005 and 2009 NO_2 increased overall. However, some sites showed an upward trend in both periods, for example Old Street (Hackney), Town Hall (Haringey) and Rainham (Havering). On the other hand, Brixton Road (Lambeth) showed consistent reductions in both periods, at a faster rate during the second period than during the first.

For PM_{10}, the majority of sites close to the city centre (<10km) showed a downward trend in the PM_{10} roadside increment during 2010 to 2014. The sites that showed an upward trend in the period 2010 to 2014 were mostly those further away from the centre, and some of these showed a downward trend in the first period. Many of these roads also had increased HGV traffic.

Summary

Despite the general trends at roadside sites in London there was clear intra-city variability in trends. This might be explained by two causes. First, different policies might have been applied locally or traffic conditions may have changed – for example an increase in congestion. Second, due to different composition of the local vehicle fleet, air pollution trends might respond differently to fleet technology changes (eg introduction of Euro-classes, alternative-fuelled vehicles, etc), the introduction of emission abatement technologies to diesel heavy-vehicles or to behavioural changes with people and businesses changing their use of specific vehicle types (eg relative increase of the fleet age during the recent economic downturn). Understanding these differences will provide evidence on the types of policies and actions that can help reduce pollution across London as a whole and most effectively.

8.6 Insight: The relationships between local air quality, deprivation and walkability

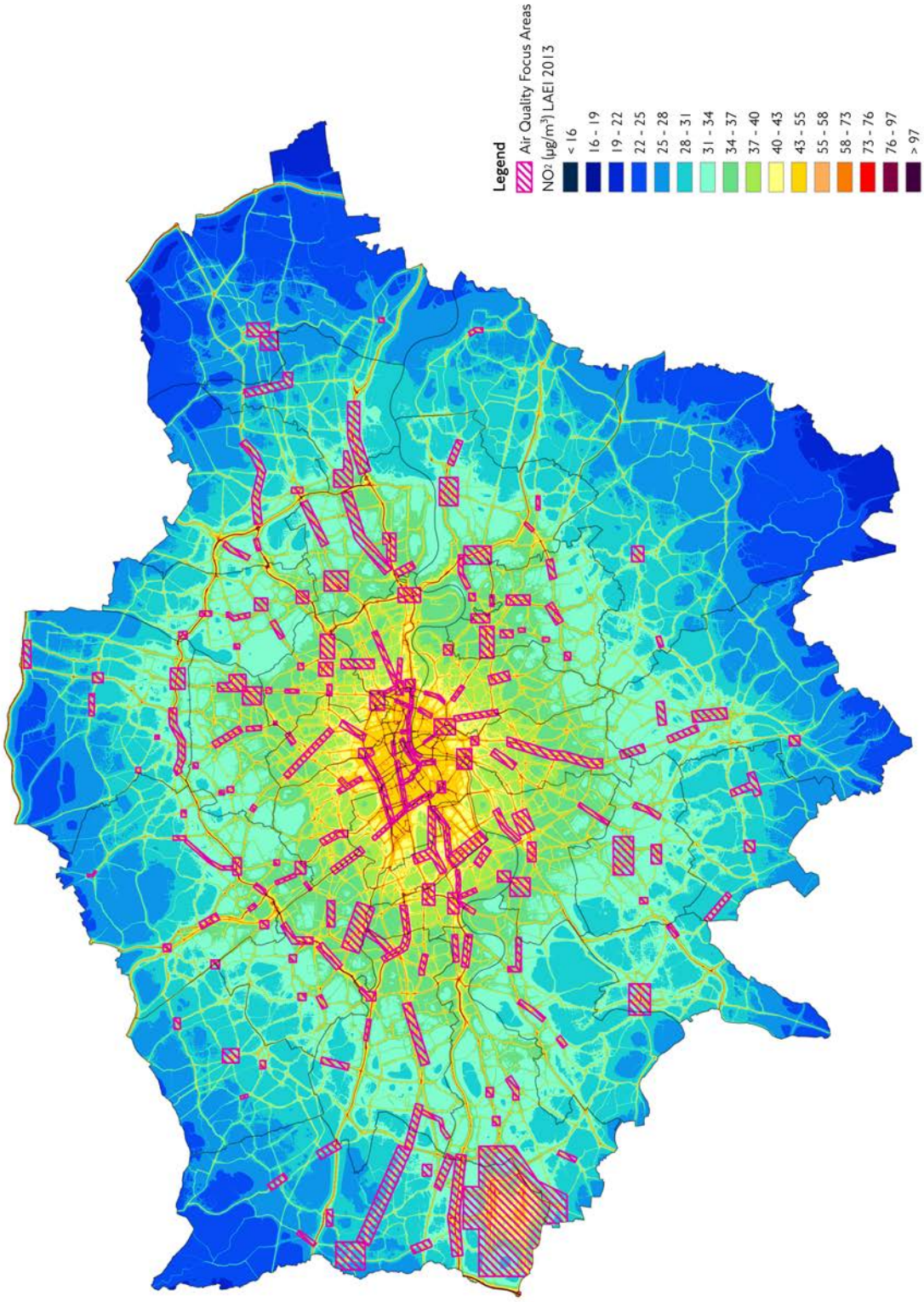
Introduction and content

The air quality concentration maps, for 2013, shown in figures 8.10 and 8.11, give a geographically continuous and disaggregate representation of concentrations across London, at a grid resolution of 20 square metres. They can be used to highlight specific locations in London where particular action to address air quality locally is warranted, either due to particularly high concentrations or high levels of human exposure, and can be overlaid with a range of other, similarly disaggregate datasets and used to examine how air quality relates to other aspects of urban life. This section illustrates the use of such mapping techniques and how they are used to inform air quality policy in London.

Defining air quality 'Focus Areas'

Air quality Focus Areas are a tool to help ensure that measures to reduce pollution are directed and scaled most appropriately to areas of greatest need – either in terms of particularly high concentrations or high levels of human exposure.

Figure 8.22 Air quality 'Focus Areas', based on 2013 LAEI.



The previously-published Focus Areas have been redefined on the basis of the outputs from the latest update to the LAEI. They are not an exhaustive definition of air quality 'hotspots', but give a good overview of the locations of greatest need. The revised Focus Areas are shown on figure 8.22. A technical description of how Focus Areas are defined can be found at: https://data.london.gov.uk/dataset/air-quality-focus-areas.

Air quality and deprivation

As an example of the relationship between air quality and social factors, figure 8.23 shows the top 20 per cent of the most deprived Output Areas (based on indices of multiple deprivation (see: https://www.gov.uk/government/statistics/english-indices-of-deprivation-2015) overlaid on the 2013 concentration map for NO_2.

Bearing in mind the relatively low level of residential population in central London, it can be seen from the map that deprived areas are clustered in inner-east London, and that these areas experience (in 2013) concentrations of NO_2 that generally exceed the limit values.

Air quality and walkability

In the context of initiatives designed to encourage more walking described elsewhere in this report, it is of interest to examine the relationship between 'walkability' and pollutant concentrations. Figure 8.24 shows the top 20 per cent of London's 'most walkable' areas overlaid on the NO_2 concentrations map for 2013. Walkability is a measure of how friendly an area is for walking.

From this map it is possible to immediately see the coincidence of high levels of walkability across central London with the highest concentrations of NO_2.

Figure 8.23 Relationship between air quality and indices of multiple deprivation.

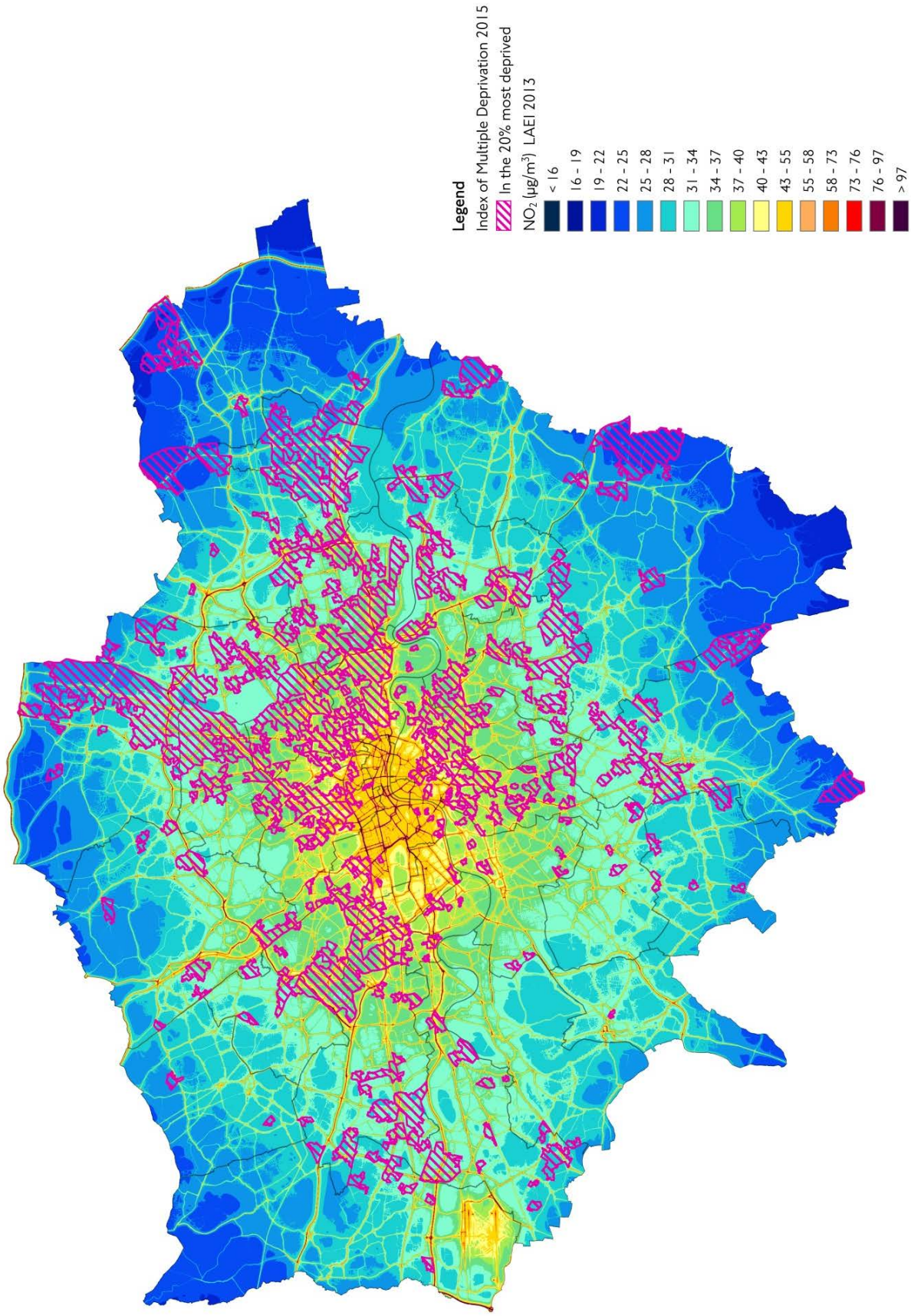
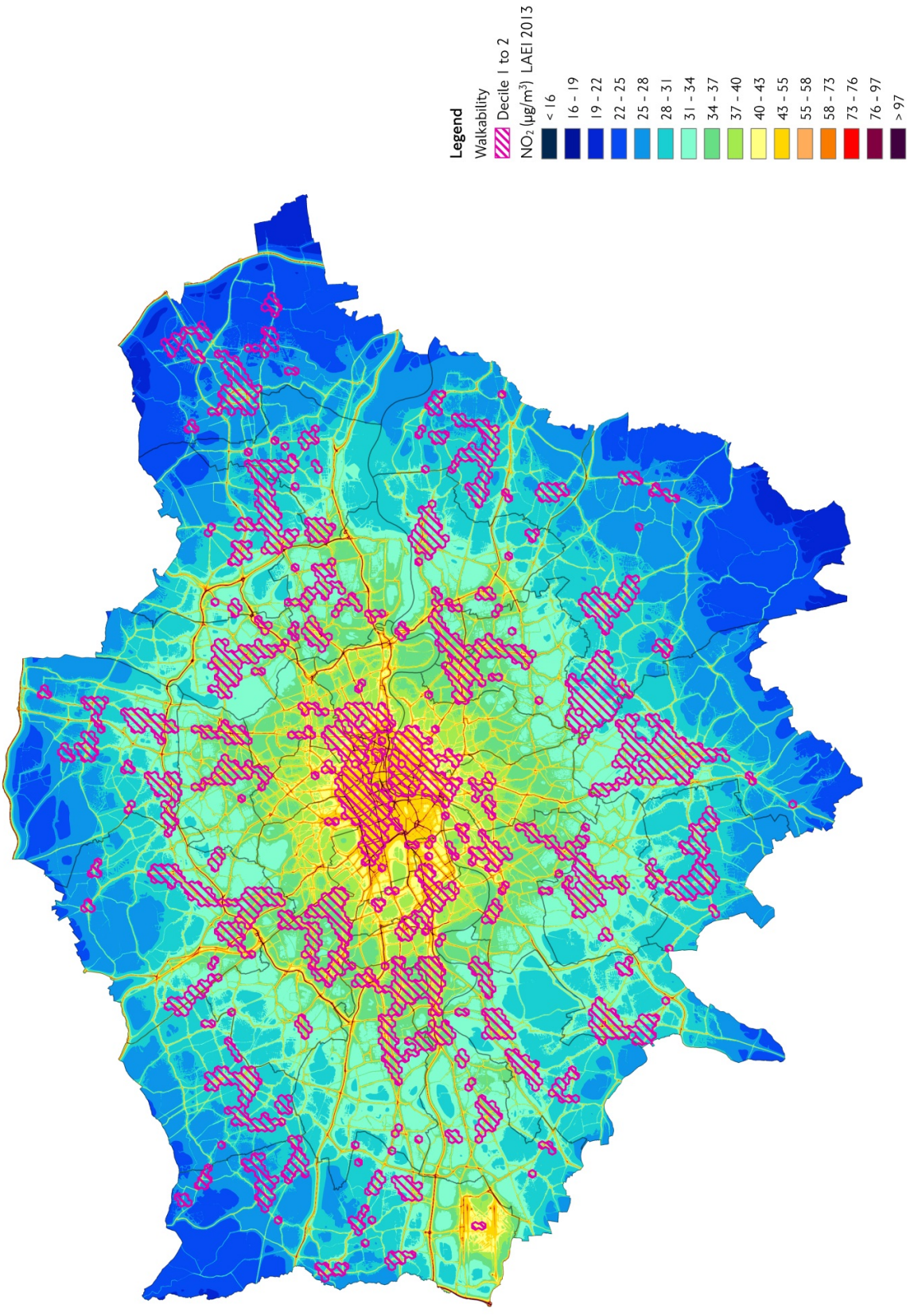


Figure 8.24 Relationship between air quality and local 'walkability'



8.7 Insight: Developing new vehicle emissions factors for London

Background

Emission factors are the mathematical functions used in air quality modelling to represent the relative emissions of various pollutants from vehicles of particular body types (eg car, van, HGV, bus etc) and differing technology types (eg petrol, diesel, gas) and emissions performance (eg Euro standard of the vehicle). Thus air quality modellers must use a wide range of these factors to represent the multiplicity of vehicles on the roads.

This section summarises on-gong work by TfL to refine the emissions factors used for modelling in London to better reflect real-world driving conditions. The work is is aimed at a future update to the London atmospheric emissions inventory.

How emissions factors are applied

Emissions factors (stated in grams per kilometre) are applied to calculations of vehicle emissions recorded in emissions inventories, such as the LAEI. The emissions factors for each vehicle type are combined with assumptions for the number and distances driven by each of those types, to produce an estimate for total annual emissions for that vehicle type. An emissions factor will exist for each pollutant of interest. Currently these include carbon dioxide, oxides of nitrogen, particulate matter, hydrocarbons and carbon monoxide, although factors can be derived for any pollutant, assuming that underlying data exists to support this.

What is currently used?

Emissions factors are different to other forms of quantification of emissions performance such as the emissions limits prescribed in European directives (the Euro standards) or the 'official' carbon dioxide emissions declared by vehicle manufacturers in marketing of new vehicles and for vehicle taxation purposes. Emissions factors are developed to represent the emissions performance under the broadest possible range of 'real-world' operating conditions. However, since it is impossible to capture each and every operating circumstance, there is inevitably a degree of averaging involved in the definition of emissions factors.

The most prevalent source of emissions factors in use in Europe is COPERT 4, the latest version being version 11. COPERT is a software tool used to generate the factors. While COPERT 4 is good at representing emissions under a broad set of conditions, it does have some limitations. For instance, it does not produce emissions factors for vehicles moving at very low speeds and is not necessarily well tuned to congested urban driving conditions. Both of these are significant issues in central London.

TfL London drive cycles

TfL developed a hypothesis that emissions in urban driving conditions could be better represented by data collected from bespoke drive cycles. To test this hypothesis, a set of 9 drive cycles representing three types of road; urban, suburban and arterial, and 3 traffic conditions; free flow, AM peak and inter-peak, were developed. These drive cycles have been used to conduct emissions tests on a range of cars, vans and HGVs under laboratory conditions using a chassis dynamometer (rolling road).

This testing programme, which is described elsewhere in TfL published reports, revealed some variance from the levels of emissions predicted by the COPERT emissions factors. For the most part, when considering emissions of oxides of nitrogen (NO_x), petrol cars performed better than the COPERT 4 emissions factors might suggest, but diesel cars tended to perform less well than indicated in the factors. To test this variance further, new emissions factors have been developed, based upon the TfL laboratory test data.

Creating new factors

During the laboratory emissions test, the exhaust flow from the vehicle is sampled and analysed on a second-by-second (1hz) basis. This means that for each second that the vehicle was operated over the drive cycle, there will be an emissions value in grams for each pollutant of interest. The emissions are then grouped together into increments of speed in a process known as 'speed binning'. This allows for the calculation of average emissions at each 1 km/h speed increment over the drive cycle.

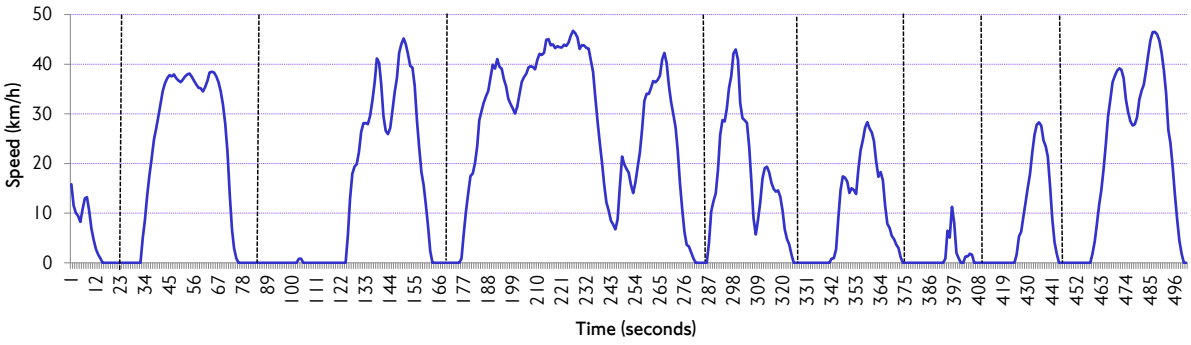
The occurrence of each 1km/h speed increment, and the rate of acceleration or deceleration that the vehicle experiences while moving through those speed increments, is defined by the level of transience of the drive cycle. Hence the need for the drive cycles to closely match the on-road vehicle behaviour.

Micro-trips

A further refinement of the speed binning process was developed using 'micro-trips'. This is a process whereby the drive cycle speed trace is broken up into shorter 'micro-trips' representing the path of a vehicle from a stationary position to becoming stationary again after a period of driving. Rules were applied that stipulated that a micro-trip must exceed 5 km/h and be at least 20 metres long, otherwise it is disregarded. 'Stationary' is defined as an instance when the vehicle speed falls below 1 km/h. At the end of a micro-trip the last 3 seconds of idling time (stationary) are attributed to that trip, before the next one is started.

Some micro-trips are little more than 20 metres in length while others cover a full road link. When drive-cycles are split into sections between stationary periods, then each subdivision contains acceleration and respective deceleration phases, plus possibly periods of cruising. This 'micro-trip' analysis approach balances acceleration and deceleration phases thereby reducing the spread of emission rates for a given speed. It also calculates emission rates for higher speed driving over longer sections. Conversely for lower speeds, averages are established from shorter segments. This naturally matches the characteristics of traffic flow network data typically applied in emissions inventories, with higher speed links typically being longer eg motorway links; and lower speed sections representing shorter sections of road between junctions and crossings in central urban areas.

Figure 8.25 An illustrative extract of the London Drive Cycle time series with micro-trip start points annotated (vertical-dashed lines).



Source: TfL Planning Strategic Analysis.

Carbon dioxide (CO_2) emissions are directly linked to fuel usage, which is a function of the load placed on the vehicle. This means that there is good correlation between the speed (and importantly, acceleration) of the vehicle in the emissions of carbon dioxide. For oxides of nitrogen (NO_x) emissions there is no direct relationship between engine load and NO_x production because other factors such as the operation of exhaust after treatment systems come in to play. This means that there is a high degree of scatter when plotting NO_x emissions, but the scatter is reduced when the micro-trips process is applied.

Filling the gaps in laboratory data

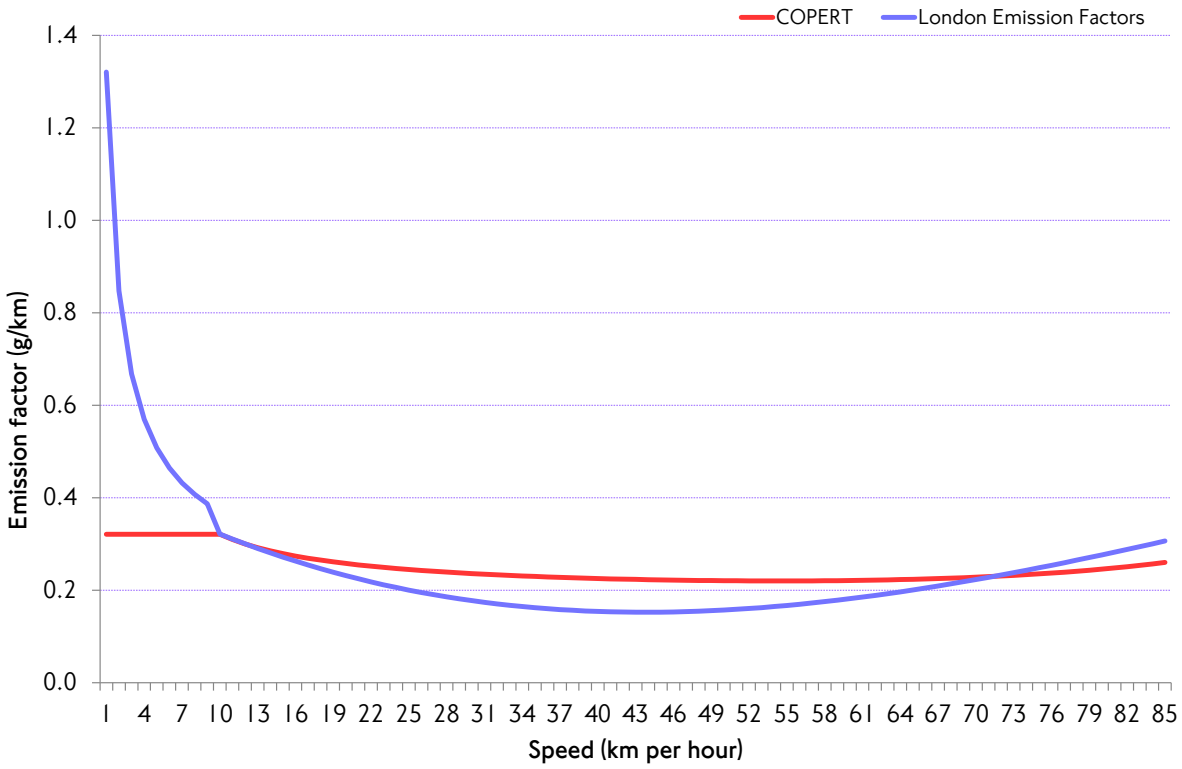
Since it is not possible to conduct laboratory testing on every model of car or commercial vehicle on the roads, it is necessary to test a representative sample and then to use a model to fill in the gaps in the range of test data. For this purpose, the PHEM model, developed by the University of Graz, Austria was selected. The leading European Instantaneous Emission Model, PHEM, has been configured to predict emissions for the whole fleet of passenger cars, taxis, light commercial vehicles (vans), city buses and HGVs over their corresponding 'real-world' drive cycle. PHEM simulates engine power demands and predicts tail-pipe emissions of NO_x, NO_2, HCs, Particulate Mass (PM_{10}), Particle Number (PN), Carbon Monoxide (CO) and Hydrocarbons (HC). The model is considered to robustly replicate both the dynamic and aggregate vehicle emission performance (emission factors) of all types and ages.

The PHEM model uses average values in a broad range of parameters to capture rolling resistance, aerodynamic drag and many other constituents. TfL test data from a sample of Euro 4, 5 and 6 vehicles, along with speed/time plotting points from on-road data logging were used to adapt the PHEM model more closely to London driving conditions. TfL 'iBus' data which provides real-time speed/time data from the London bus fleet was also incorporated. Once adapted for London, the PHEM model could be used to calculate emissions factors for earlier Euro standards and vehicle configurations not captured in the TfL test project. There is a very strong correlation between NO_x emissions factors estimated using the updated PHEM model and those measured under laboratory conditions, particularly in the case of diesel vehicles.

New factors compared with COPERT

Figure 8.26 shows the close correlation, but also the variance between the newly derived TfL emissions factors and the COPERT 4 factors for the same vehicle type. In this case the chart represents the NO_x emissions from a light goods vehicle of less than 3.5 tonnes gross vehicle weight, with Euro 6 diesel engine. Similar curves exist for each vehicle and fuel type. Because the test data existed to support it, the TfL factors extend below 12km/h, unlike COPERT factors. This is significant in congested urban driving, where speeds below 5km/h are frequently seen. Consequently the COPERT factors 'flatline' below 12km/h.

Figure 8.26 Comparison of London-specific emissions factors with COPERT equivalent – Euro 6 diesel light goods vehicle.



Source: TfL Planning Strategic Analysis.

In this case, at road speeds from approximately 20km/h to 65km/h, the London Emission Factors suggest lower emissions of NO_x than the COPERT 4 factors. Below 12km/h, the London Emissions Factors tend towards infinity as the vehicle speed approaches zero, while the COPERT 4 factors appear flat as they do not actively represent emissions at those low speeds.

Next steps

TfL is carrying out a programme of sensitivity testing using the new emissions factors described here. It remains to be seen to what extent they may be implemented in future versions of emissions inventories.

The UK Emission Factor Toolkit (EFT) and associated COPERT vehicle emission model has some limitations when predicting CO_2, NO_x and PM emissions in 'real' London driving conditions. Uncertainties with EFT are greater at lower road speeds, with the average-speed emission curves systematically under-predicting the fuel

consumption and the rate at which emissions of air quality pollutants are generated for all vehicle types. This has been identified by comparing predicted emission rates with those measured in a laboratory over a real speed profile (or drive cycle).

European average-speed emission models have developed and evolved over many years, through several projects and initiatives, involving several organisations right across Europe. Perhaps because of this there is a lack of clarity about the data and methods used to establish the average-speed emission functions.