



Assessing transport connectivity in London

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I Introduction

At Transport for London (TfL) we are responsible for planning and operating London's transport system. To continuously improve transport in the Capital, we analyse the quality of London's transport infrastructure and services. One important type of analysis we use is connectivity assessment.

The word 'connectivity' describes how well different places are connected to each other using the transport system. If trains, buses and highways work more efficiently then the level of connectivity improves. Some people use the word 'accessibility' instead. In TfL we use 'accessibility' when referring specifically to public transport that is step-free and suitable for people with different needs. Step-free access is one aspect of good connectivity, but an assessment of connectivity to a specific place also includes other factors about the quality of transport links. An assessment of connectivity could also refer to any mode of transport.

Both TfL and our partners use the assessment of connectivity for different purposes:

- To identify places that may benefit from transport improvements
- To understand the likely impacts of plans for new routes, stations or roads
- To identify for the most suitable locations for medical and other services, so that people can reach them easily
- To understand what parts of London are suitable for developing more houses and offices
- To recommend whether different locations need more or less car parking

This document explains how we measure transport connectivity in London. We describe here the different tools used for connectivity assessment and the techniques they are based on. We present three main types of connectivity assessment, which can be undertaken either for London today or for future scenarios, once London's population and transport networks have changed.

The three types are:

- The PTAL measure (Public Transport Access Level), which rates a selected place based on how close it is to public transport and how frequent services are in the area
- Travel time mapping, presenting graphically how long it takes to travel from a selected place to other places, or how far you can travel in a given amount of time
- Catchment analysis, describing how many workplaces, or different types of services, exist within a certain travel time from a selected place

The document contains various examples of studies where we have used each type. We also explain the background to the information that is available on our new web-based Connectivity Assessment Toolkit, WebCAT.

Please note that the large number of maps included here do not necessarily contain TfL's latest data, and are primarily presented to illustrate the assessment approach. At the end of the document we have included a short glossary, summarising the definitions of some of the technical terms we use.



2 Public Transport Access Level (PTAL)

2.1 This chapter

In this chapter we introduce the PTAL measure. We explain what PTAL is, bring various examples for its role in the planning process, and also explain where PTAL values can be found. For readers who are interested in the full process used to calculate PTAL values, the chapter also includes a description of the calculation method.

2.2 What is PTAL?

PTAL is a measure of connectivity by public transport, which has been used in various planning processes in London for many years. For any selected place, PTAL suggests how well the place is connected to public transport services. It does not cover trips by car.

PTAL values are simple. They range from zero to six, where the highest value represents the best connectivity. For historical reasons, the

PTAL value of one is split into two categories (1a and 1b) and the PTAL value of six is split into two categories (6a and 6b). All together there are nine possible values of PTAL: 0, 1a, 1b, 2, 3, 4, 5, 6a and 6b. We often present PTAL values in maps, where a preset set of colours represent the different values. This is described later, in table 2.2.

A location will have a higher PTAL if:

- It is at a short walking distance to the nearest stations or stops
- Waiting times at the nearest stations or stops are short
- More services pass at the nearest stations or stops
- There are major rail stations nearby
- Any combination of all the above.

Setting	Public Transport Accessibility Level (PTAL)		
	0 to 1	2 to 3	4 to 6
Suburban	150-200 hr/ha	150-250 hr/ha	200-350 hr/ha
3.8-4.6 hr/unit	35-55 u/ha	35-65 u/ha	45-90 u/ha
3.1-3.7 hr/unit	40-65 u/ha	40-80 u/ha	55-115 u/ha
2.7-3.0 hr/unit	50-75 u/ha	50-95 u/ha	70-130 u/ha
Urban	150-250 hr/ha	200-450 hr/ha	200-700 hr/ha
3.8-4.6 hr/unit	35-65 u/ha	45-120 u/ha	45-185 u/ha
3.1-3.7 hr/unit	40-80 u/ha	55-145 u/ha	55-225 u/ha
2.7-3.0 hr/unit	50-95 u/ha	70-170 u/ha	70-260 u/ha
Central	150-300 hr/ha	300-650 hr/ha	650-1100 hr/ha
3.8-4.6 hr/unit	35-80 u/ha	65-170 u/ha	140-290 u/ha
3.1-3.7 hr/unit	40-100 u/ha	80-210 u/ha	175-355 u/ha
2.7-3.0 hr/unit	50-110 u/ha	100-240 u/ha	215-405 u/ha

Figure 2.1: Recommended housing densities in the London Plan

hr = habitable rooms
u = a dwelling unit, i.e. a flat or a house
ha = hectare

So PTAL can be seen as a measure of the density of the public transport network. PTAL does not take into account the destinations you can travel to from each location or the ease of interchange. PTAL also does not reflect levels of crowding on buses or trains.

2.3 Where PTAL is used

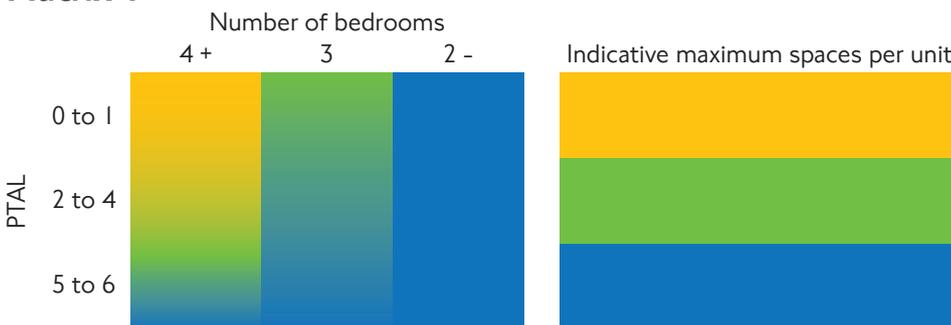
PTAL was originally introduced by the London Borough of Hammersmith & Fulham, and was later adopted across London to support various planning processes. The use of PTAL is now deeply embedded in strategic and local planning. A key example for such use is in the London Plan, which is the overall strategic plan for London, that sets out economic, social and environmental goals for the period until 2031.

The London Plan uses PTAL as one of the key factors in determining the density of housing that is desired in different parts of London. This is based on the idea that areas with good public transport service are more suitable for intense development. This is demonstrated in figure 2.1, which is taken from the London Plan.

PTAL is also used in the London Plan to recommend how much parking should be provided for residential developments across London. To encourage the use of public transport, the general principle is to provide less parking in places with good public transport. Places that are less well-connected to public transport get more parking spaces.

The London Plan's Housing Supplementary

Matrix 1



Matrix 2

	PTAL 0 to 1		PTAL 2 to 4		PTAL 5 to 6	
	Suburban	Parking provision	Urban	Parking provision	Central	Parking provision
3.8-4.6 hr/unit	150-200 hr/ha	35-55 u/ha	150-250 hr/ha	45-90 u/ha	200-350 hr/ha	Up to 2 spaces per unit
3.1-3.7 hr/unit	40-65 u/ha	Up to 2 spaces per unit	200-450 hr/ha	55-115 u/ha	200-700 hr/ha	Up to 1.5 spaces per unit
2.7-3.0 hr/unit	50-75 u/ha	Up to 1.5 spaces per unit	45-120 u/ha	70-130 u/ha	200-700 hr/ha	Up to one space per unit
3.8-4.6 hr/unit	150-250 hr/ha	35-65 u/ha	300-650 hr/ha	55-145 u/ha	650-1100 hr/ha	Up to 1.5 spaces per unit
3.1-3.7 hr/unit	40-80 u/ha	Up to 1.5 spaces per unit	65-170 u/ha	70-170 u/ha	140-290 u/ha	Up to one space per unit
2.7-3.0 hr/unit	50-95 u/ha	Up to one space per unit	80-210 u/ha	175-355 u/ha	175-355 u/ha	Up to one space per unit
3.8-4.6 hr/unit	150-300 hr/ha	35-80 u/ha	300-650 hr/ha	100-240 u/ha	650-1100 hr/ha	Up to one space per unit
3.1-3.7 hr/unit	40-100 u/ha	Up to 1.5 spaces per unit	65-170 u/ha	80-210 u/ha	175-355 u/ha	Up to one space per unit
2.7-3.0 hr/unit	50-110 u/ha	Up to one space per unit	100-240 u/ha	100-240 u/ha	215-405 u/ha	Up to one space per unit

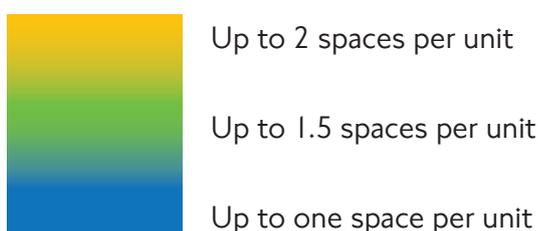


Figure 2.2: PTAL and the amount of parking in the London Plan

Planning Guidance report includes 'Matrix 1', which links between the PTAL, the number of bedrooms and the number of parking spaces; and 'Matrix 2', which is a more refined approach. These are presented in figure 2.2. The plan clarifies that the guidance in the tables should be used together with a broader discussion of local circumstances.

As part of the policy to designate certain areas for high-intensity land use, the London Plan also monitors the proportion of business and commercial activities which are in areas with PTAL five or above. The plan includes a key performance indicator to maintain a high proportion of workplaces in areas of high PTAL.

PTAL is regularly used in strategic studies

focusing on more specific areas. Figure 2.3 shows an example from the Upper Lee Valley Opportunity Area Planning Framework. The two maps show the levels of connectivity at the time of the study and in a future forecast, reflecting the likely impacts of the transport interventions proposed in that study, such as new bus routes and increased rail frequencies.

Figure 2.4 shows another PTAL comparison from the study of the Vauxhall, Nine Elms and Battersea (VNEB) Opportunity Area. The base year is presented on the left and a future scenario on the right. The planned extension of the Northern line to this area, as well as improvements to walking routes around

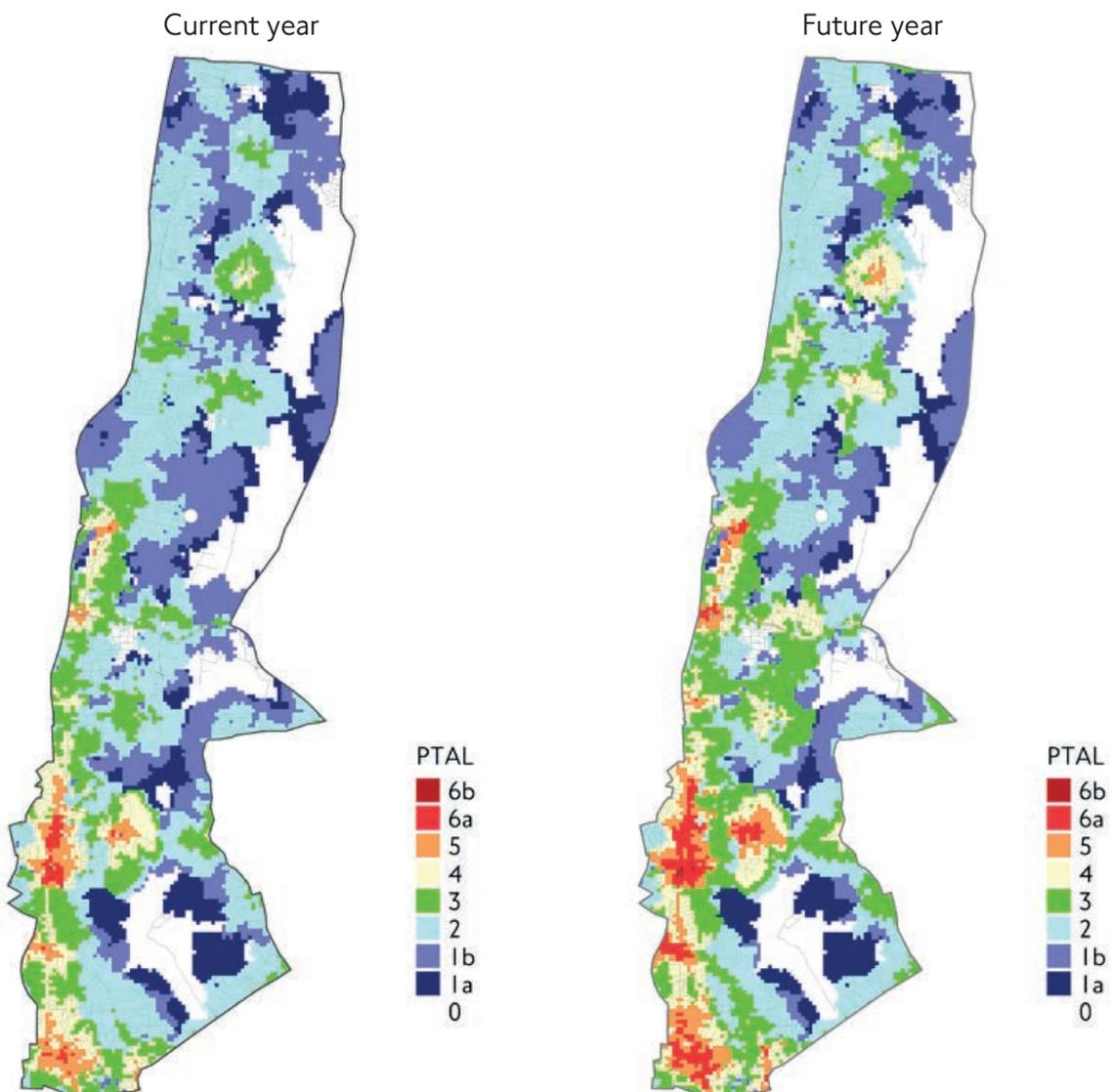


Figure 2.3: PTAL maps for the current year and a future year, from the Upper Lee Valley Opportunity Area Planning Framework

the Battersea Power Station, lead to a PTAL increase from three to six in some locations.

PTAL is often used for studies at the geographical level of a single borough. A PTAL map for the Royal Borough of Greenwich is presented in figure 2.5. A London-wide PTAL map can also be produced, as shown in figure 2.6.

These examples demonstrate the strengths of PTAL as a highly informative, yet simple, measure of connectivity. Like all measures of connectivity, however, there are some limitations to the PTAL methodology.

For example, the measure differentiates between the nine PTAL categories, but not within each

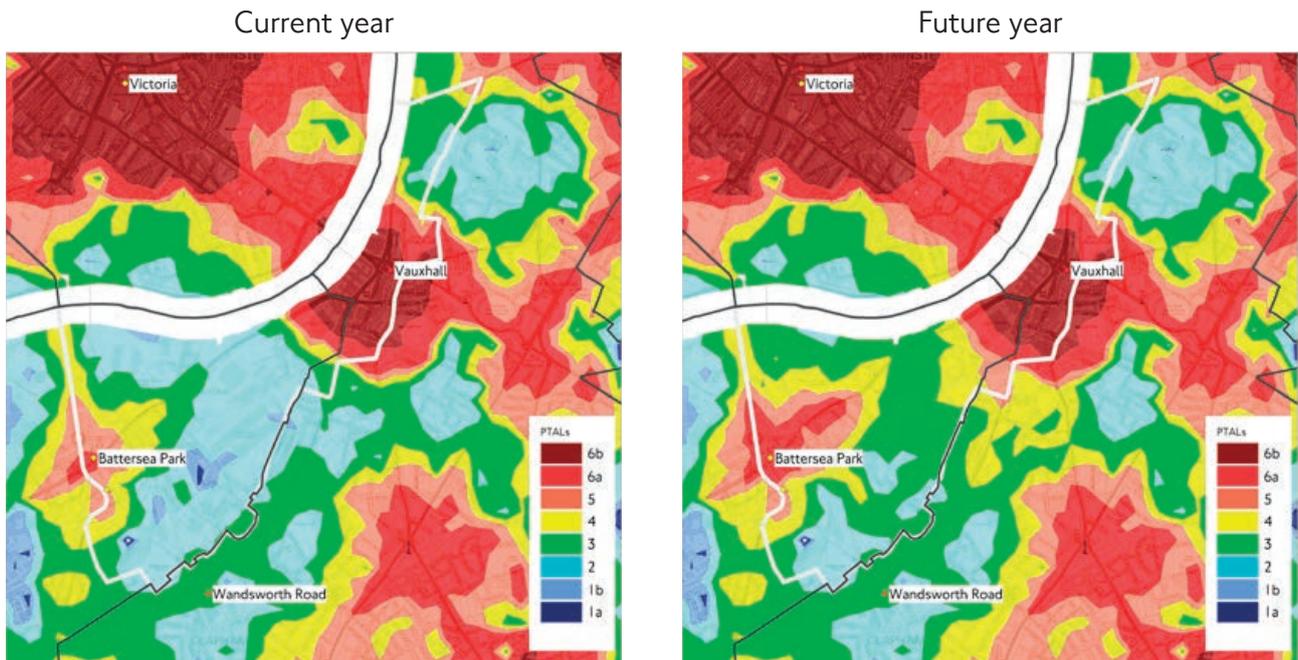


Figure 2.4: PTAL maps from the Northern line extension study in the Battersea area

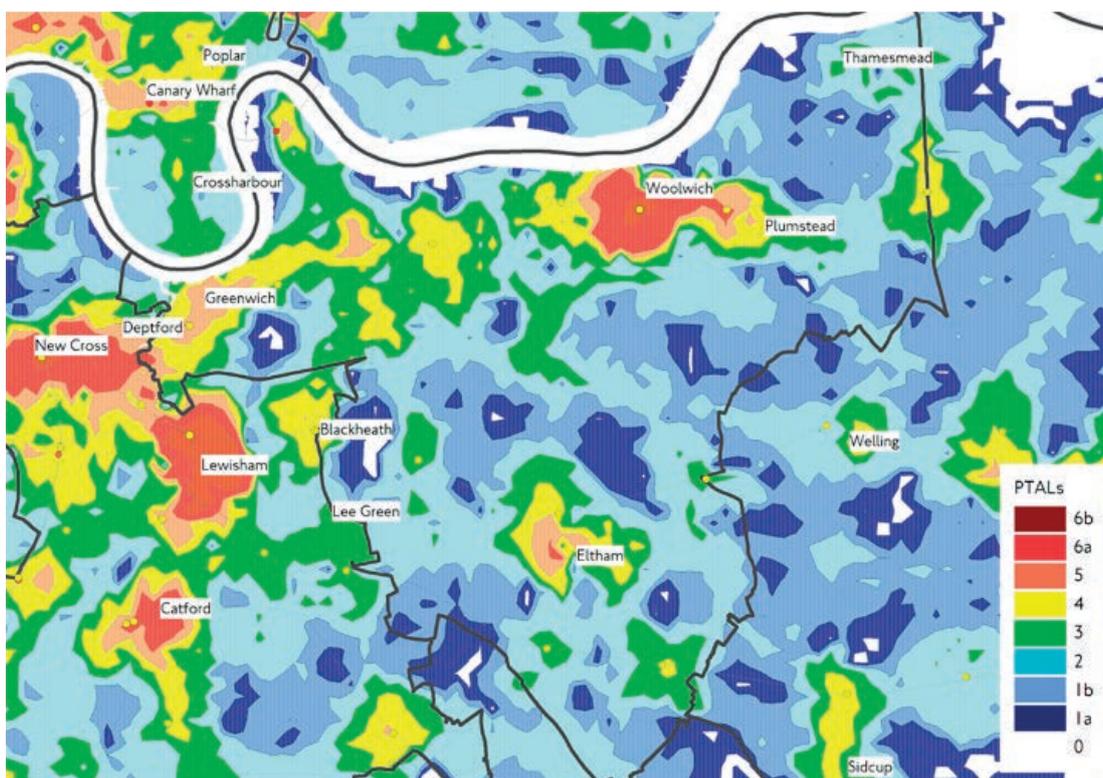


Figure 2.5: A PTAL map for a single borough

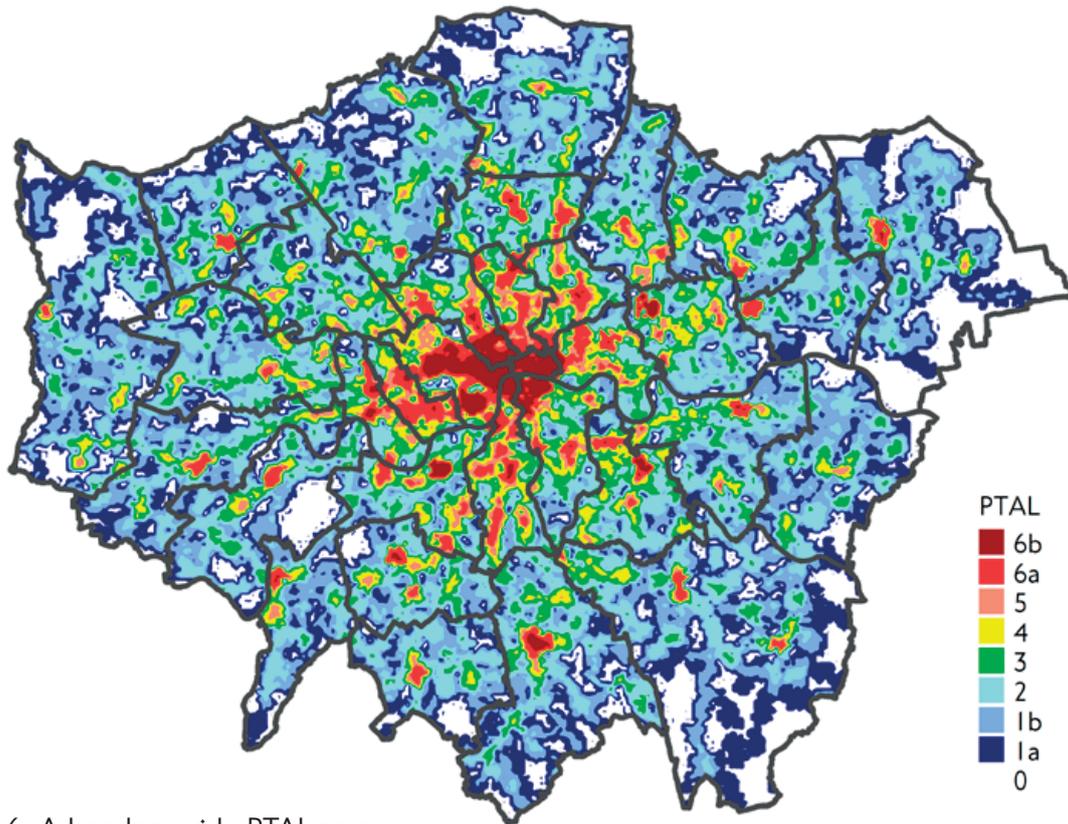


Figure 2.6: A London-wide PTAL map

category, where there can be some significant differences. It highlights changes that occur near the stops and stations rather than people affected in other places. It is used for measuring overall public transport connectivity, and cannot be used for individual public transport modes. When applied to future year scenarios, PTAL is influenced by assumptions made on future service levels, which for buses can be harder to estimate.

PTAL values are based on the frequency of services during the morning weekday peak, which is useful in indicating the overall level of service. In some cases, for example around a shopping centre, it may be helpful to look at the level of connectivity at other times of the day or during the weekend. Issues such as station and train capacity, reliability, services to new destinations and step-free access are not part of the PTAL measure, but they remain important issues for the broader assessment.

It is therefore important to use professional judgement when analysing PTAL outputs and to interpret any result in the relevant context. It may also be helpful to supplement PTAL

analysis with travel time mapping, as described in the next chapter. Support in this process is available from our team. Contact details are provided later in this document.

2.4 Checking PTAL values

During 2015, we introduce a new service named WebCAT, a web-based Connectivity Assessment Toolkit. The key tool on WebCAT allows users to search for a specific location and view a PTAL map for the area around that location.

In WebCAT, a zoom into a relatively small area presents a map where PTAL values are shown as a grid of squares. The colour of each square indicates the PTAL value and the background shows a grey-scale street map. The side of each square is 100 meters, and the PTAL value shown is for the point in the centre of the square. There are almost 160,000 such squares in the map that covers Greater London. The PTAL map window on WebCAT shows PTAL values for all the squares in view. This is illustrated in figure 2.7.

When using WebCAT to zoom out and present a larger area, the grid is replaced with a 'heat

map', showing broad areas with different PTAL values. This is illustrated in figure 2.8.

PTAL values can be checked on WebCAT either for a network similar to the one in operation now (which we refer to as the 2011 base year), or for a future scenario. Scenarios based on our forecasts for the years 2021 and 2031 are currently available. The future scenarios allow checking how PTAL values are likely to change when new services, such as Crossrail, are introduced.

An older service is the WebPTALs calculator, www.webptals.org.uk. A screenshot from this website can be seen in figure 2.9. The calculator allows users to select a location anywhere in London and view the PTAL value for this location only.

The method used to calculate PTAL is the same in the old and new websites. The full method is described later in this chapter. The use of the

100-meter squares in WebCAT is a minor change to the way you select the point where PTAL is calculated, compared to the old website. We chose this approach for two reasons:

1. It enables us to show a map of PTAL values surrounding the selected point instead of a single value. This provides useful context to the PTAL value of a development site in a quick and user friendly way.
2. With the walking speeds used to calculate PTAL, the distance between any point and the centre of the nearest square is never more than a one minute walk. Since some people walk slower or faster, and some people use shortcuts which are not currently included in maps, one minute was assumed to be a reasonable limit of accuracy.

Figure 2.10 shows PTAL outputs for the same place using the old and new websites.

WebCAT

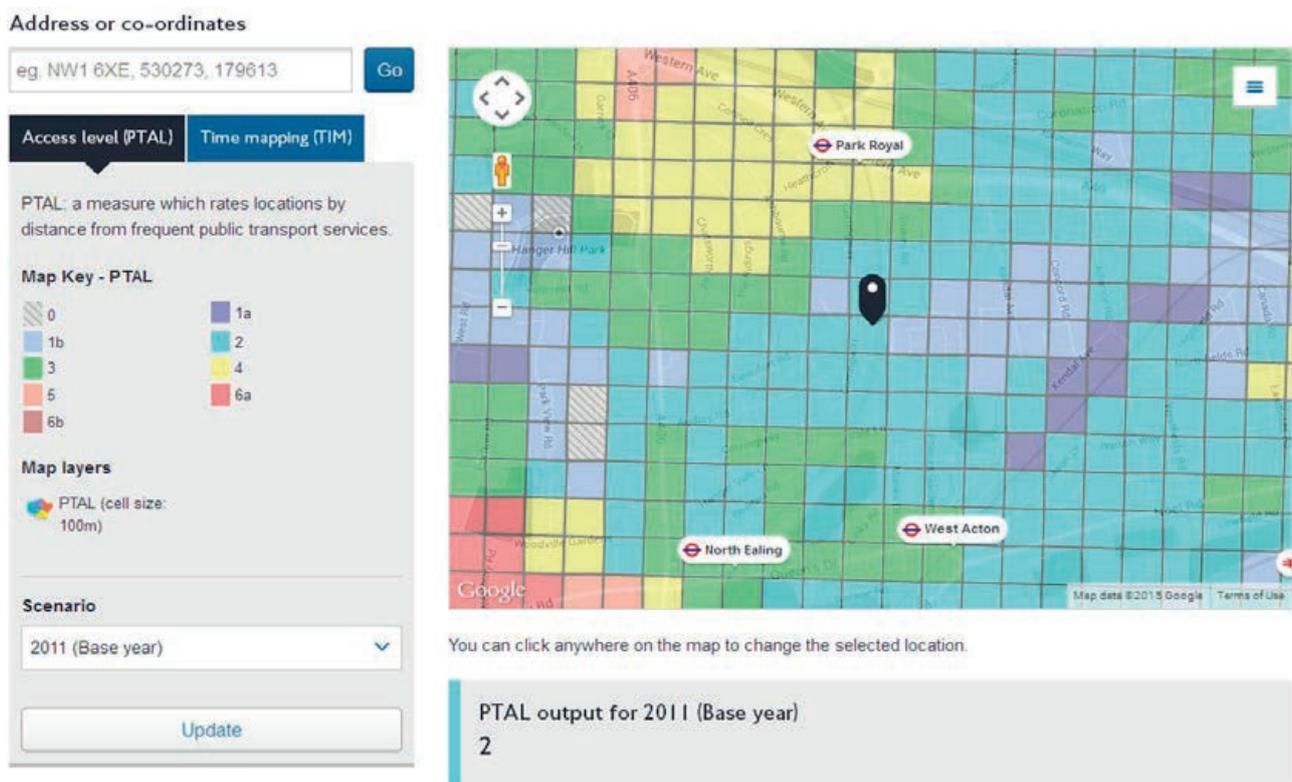


Figure 2.7: A grid of PTAL values on WebCAT

WebCAT

Address or co-ordinates

eg. NW1 6XE, 530273, 179613

Access level (PTAL) **Time mapping (TIM)**

PTAL: a measure which rates locations by distance from frequent public transport services.

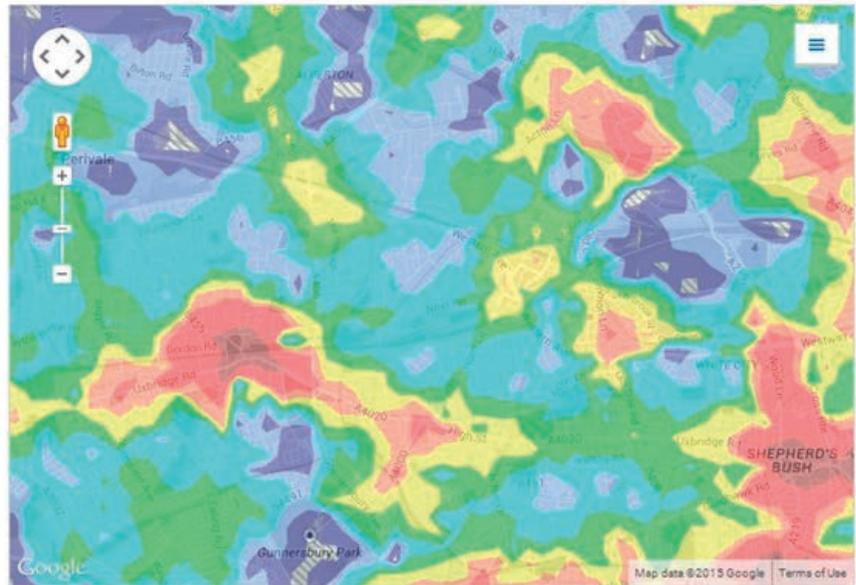
Map Key - PTAL

Map layers

PTAL (cell size: 100m)

Scenario

2011 (Base year)



You can click anywhere on the map to change the selected location.

Figure 2.8 A PTAL 'heat map' on WebCAT

TfL Planning Information Database

Username:

Password:

Search

Easting Northing

Postcode

Street

Station

PTAL Report

Map Layers

- Base mapping
- Infrastructure
- Other

Documents

Feedback

[Decrease map size](#)

Figure 2.9: The old PTAL web calculator

Old – web calculator



New – WebCAT

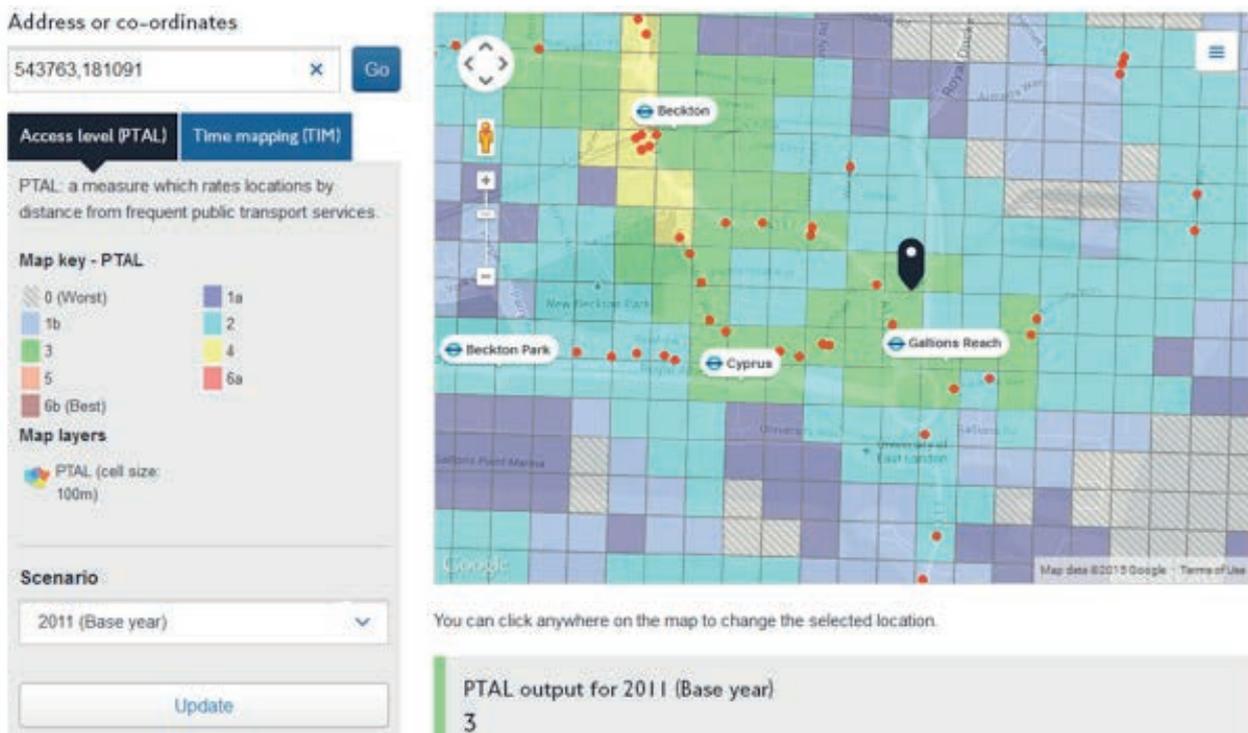


Figure 2.10: The same location in the old and new websites

Figure 2.11 demonstrates two cases of a PTAL query on WebCAT for a selected location. Example A shows a PTAL map around a site in an area where PTAL is quite uniform. The fact that the exact point of interest may be up to a minute walk from the middle of the nearest square is unlikely to make a difference. Many queries are expected to be similar to this example.

Example B shows a specific case where the point of interest is very close to where PTAL squares change colour. In such cases, wherever the exact point falls, places with a different PTAL are less than a one minute walk away. It is worth being aware that the point of interest is very close to the boundary between PTAL values.

Example A



Example B



Figure 2.1 I: Two cases of PTAL queries on WebCAT

If in a specific query the impact of a one minute walk could be significant, we recommend contacting us using the contact details provided at the end of this document.

very similar to the report produced by the old web calculator. An example is shown in figure 2.12. The detailed calculation is explained later in this chapter.

A report showing how each PTAL value was calculated is available on WebCAT. This is

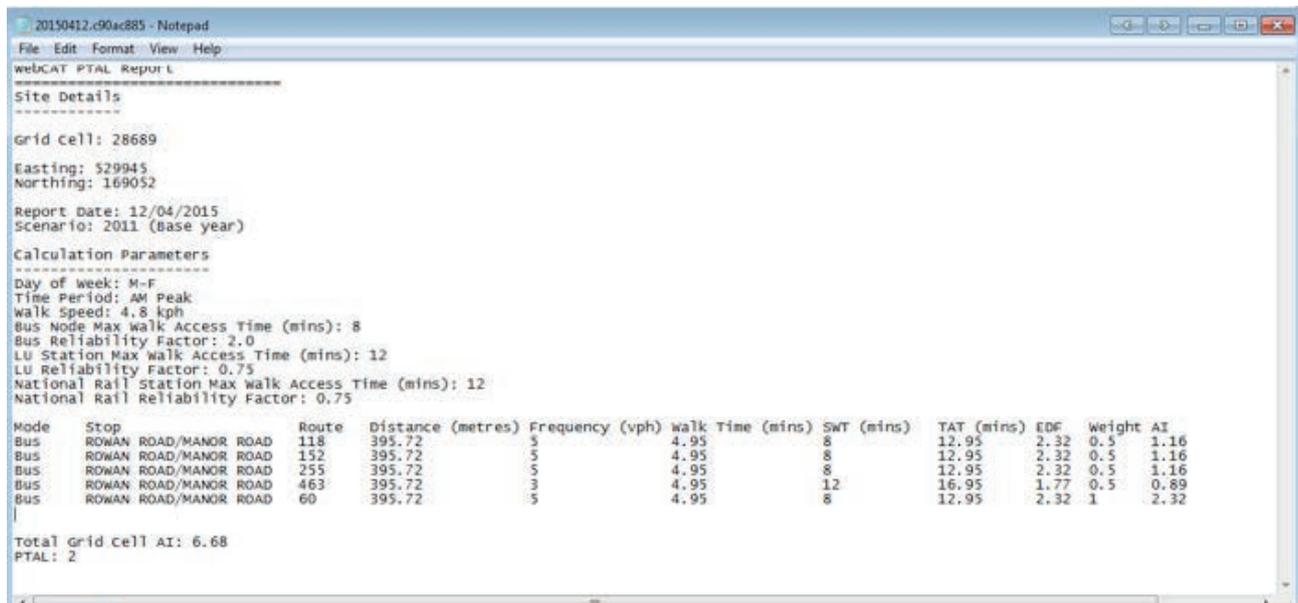


Figure 2.12: A report explaining the PTAL calculation



BUS STOP

Westminster
Station 

towards Waterloo
or Lambeth North

 24 hour

148

211

Buy tickets before
boarding on all routes





2.5 The calculation of PTAL

Checking PTAL values on WebCAT would be suitable for most applications. This section describes in more detail how PTAL values are calculated, either for those wishing to fully understand this process, or for those who want to undertake the calculation by themselves.

To calculate PTAL values, we use four sets of data:

1. The list of places that we want PTAL values for, which could represent houses, offices, shops and so on.
2. Data on the location of all public transport stations and stops in London. We refer to them as service access points (SAPs).
3. London's walk network, describing all the streets and paths that can be used for walking. This is used to calculate the walk time from the origin of people's journeys (the first bullet above) to the public transport network (the second bullet above).
4. Data on all public transport routes in London, the SAPs that each one of them serves, and their frequencies. This could be either current services or expected future services, depending on what type of PTAL we want to calculate.

The full calculation method for a single location is described in table 2.1. This needs to be repeated when PTAL is calculated for multiple points. The table is presented here for technical readers and can be skipped by others.

PTAL for an individual point is always calculated using the same method, but we have several different ways of combining multiple PTAL values to create a map. These different ways are explained in table 2.3. An example of a spreadsheet calculation of PTAL is presented in figure 2.15.

Table 2.2 explains how the Access Index is converted into PTAL and presented in maps.

Step	Key facts
<p>Calculate walk times to service access points (SAPs)</p>	<ul style="list-style-type: none"> • There are about 13,000 SAPs in Greater London. Not every bus stop is a separate SAP. If several stops are very close to each other then they are coded as a group • A walking speed of 4.8 kph is assumed in the calculation • The walk network is created from the Integrated Transport Network (ITN) published by Ordnance Survey, which includes all of London's roads. Motorways and major trunk roads have been removed as they are not suitable for walking. Rail bridges, footpaths and local short cuts have been added • The calculation assumes that people will walk up to 640 metres (approximately eight minutes) to a bus service and up to 960 metres (12 minutes) to a rail or Tube service. Services available at a longer distance do not affect the PTAL of a selected location. The walk access distance is measured using software such as RouteFinder, an application of the MapInfo package • Information on bus stops and routes is taken from TfL's BusNet data • Rail, Tube and tram station locations and frequencies are derived from our strategic public transport model, Railplan. A separate publication on our website describes the Railplan tool
<p>Calculate scheduled waiting time (SWT) for each route at each SAP</p>	<ul style="list-style-type: none"> • The standard PTAL calculation is based on service frequencies in the period between 08:15 and 09:15 on a weekday • Passengers are assumed to arrive at the station point at random, without adjusting their arrival to the bus timescale, as is common with frequent urban services • The SWT (in minutes) is estimated as half the time interval between arrivals of the service at the SAP, i.e. $SWT = 0.5 * (60/frequency)$ • For example, a bus service with a frequency of six buses per hour will have an interval of 10 minutes and a SWT of five minutes, which is the average amount of time a passenger who arrives randomly will have to wait • If a single route has several stops in the area we look at, only the nearest is considered • PTAL considers directions in a simplified way. If a service runs in both directions, the most frequent direction is used in the calculation • For rail services, only those with at least two stops within London are considered. So the PTAL near major stations does not consider services that do not stop elsewhere in London
<p>Calculate average waiting times (AWT) for each route at each SAP</p>	<ul style="list-style-type: none"> • The AWT (in minutes) equals the SWT plus a reliability factor. The reliability factor varies by mode of transport. It reflects the fact that actual wait times can be longer because services do not arrive in an entirely regular manner • A reliability factor of two minutes is used for buses and a factor of 0.75 minutes is used for rail, Tube or tram services

Step	Key facts
Calculate total access time (TAT) for each route at each SAP	<ul style="list-style-type: none"> The TAT (in minutes) combines the walk time to the SAP with the AWT at the SAP, i.e. $TAT = \text{walk time} + AWT$
Calculate equivalent doorstep frequency (EDF) for each route at each SAP	<ul style="list-style-type: none"> The EDF (in minutes) converts the TAT back into units of frequency, i.e. $EDF = 0.5 * (60 / TAT)$. It is a measure of what the service frequency would be like if the service was available without any walk time
Calculate Access Index (AI)	<ul style="list-style-type: none"> It is common that for each mode of transport available for a certain journey, a specific route from a specific nearby stop or station is the most suitable. The PTAL method simplifies this by giving a higher weight to the single service with the highest EDF for each mode, and a lower weight to other services within the same mode The AI is therefore based on summarising the EDFs of all routes at all SAPs (within the acceptable walking distance), but giving a weight of one to the highest EDF per mode and a weight of 0.5 to all other EDFs. The calculation of the AI for each specific mode is $AI = \text{Largest EDF} + 0.5 * \sum(\text{all other EDFs})$ A separate AI is initially calculated this way for buses, rail, Tube (including Docklands Light Railway) and tram A total AI is then calculated for the selected location, as the sum of the AIs across all modes, i.e. $AI_{\text{total}} = \sum(AI_{\text{bus}} + AI_{\text{rail}} + AI_{\text{Tube}} + AI_{\text{tram}})$
Convert to PTAL	<ul style="list-style-type: none"> The AI is converted to PTAL using the bands specified in table 2.2

Table 2.1: The method used to calculate PTAL for a single location

PTAL	Access Index range	Map colour
0 (worst)	0	
1a	0.01 – 2.50	
1b	2.51 – 5.0	
2	5.01 – 10.0	
3	10.01 – 15.0	
4	15.01 – 20.0	
5	20.01 – 25.0	
6a	25.01 – 40.0	
6b (best)	40.01+	

Table 2.2: Conversion of the Access Index to PTAL

Approach	When we use it	Things to note
<p>Presenting PTAL for individual points selected manually</p>	<ul style="list-style-type: none"> • In a study that focuses on specific sites • When we want the walk distances to be calculated as accurately as possible for a well-defined point 	<ul style="list-style-type: none"> • Focusing on specific points gives more accurate results only if the walk network, bus stop locations etc. are coded very accurately. For future scenarios this is often not possible • PTAL is sensitive to walk distances and can vary between different entries of a large site. In such cases, show the range of PTAL values rather than the lowest or highest
<p>Showing PTAL for a grid of points covering an area (illustrated in figure 2.13)</p>	<ul style="list-style-type: none"> • To create the data we publish on WebCAT • To map PTAL over a relatively large area 	<ul style="list-style-type: none"> • The London-wide grid in WebCAT has a point every 100 metres, and about 150,000 points overall • When the study area is not too large, we sometimes use a grid with a point every 50 metres • The plotted PTAL values can have a sudden jump from high to low around the place with the maximum walk distance from the nearest stop
<p>Presenting only the boundaries (contours) between areas with different PTAL</p>	<ul style="list-style-type: none"> • To map PTAL over a very large area • To create a more aesthetic map without jumps between low and high PTAL values 	<ul style="list-style-type: none"> • When a map of boundaries is created from grid values, it can smooth the jumps between low and high PTAL • This smoothing is not fully consistent with the PTAL calculation but it is still realistic, because the maximum walking distance that creates this jump is only an estimate
<p>Calculating average PTAL per zone (illustrated in figure 2.14)</p>	<ul style="list-style-type: none"> • When we want to attach a single PTAL value to preset zones, for example when we do analysis using Census zones 	<ul style="list-style-type: none"> • To create such maps, we calculate an average Access Index for all locations within the same zone • Compare figures 2.6 and 2.14 to see the impact of averaging. The impact is larger in zones where there is a range of walking distances to public transport

Table 2.3: Different ways of creating a PTAL map

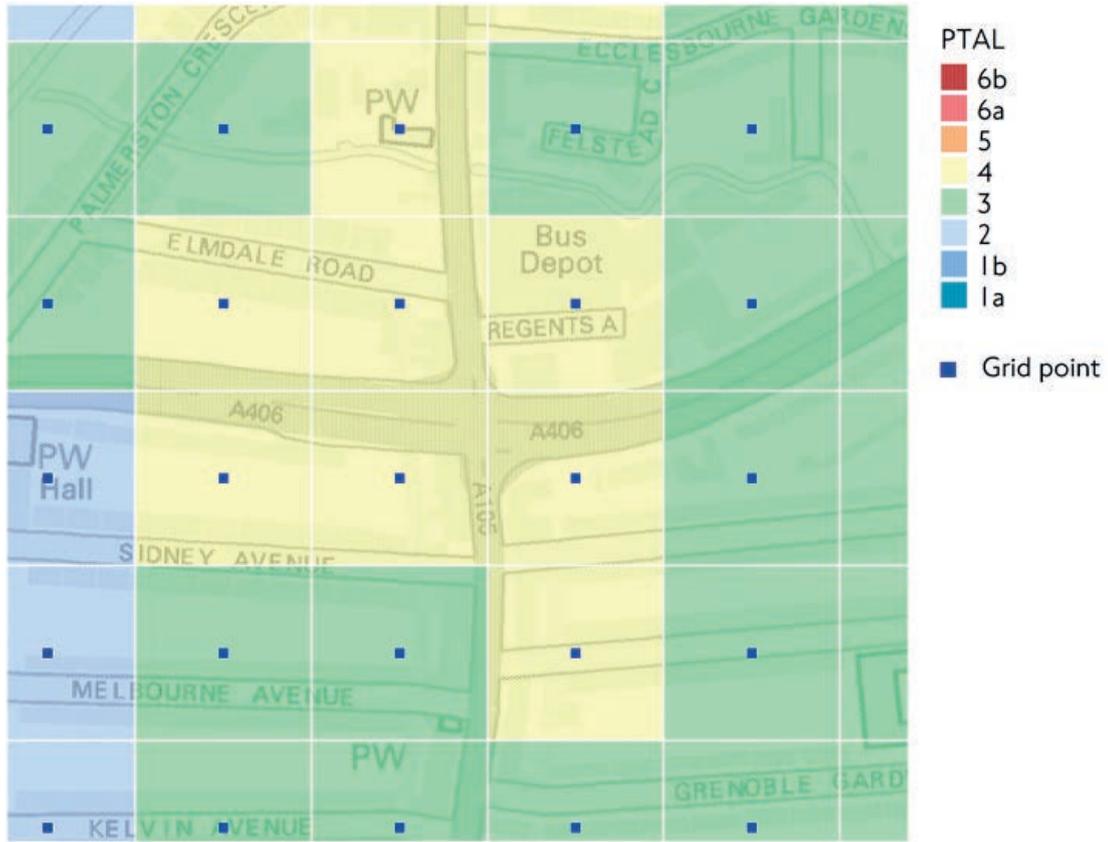


Figure 2.13: PTAL map for a grid of points

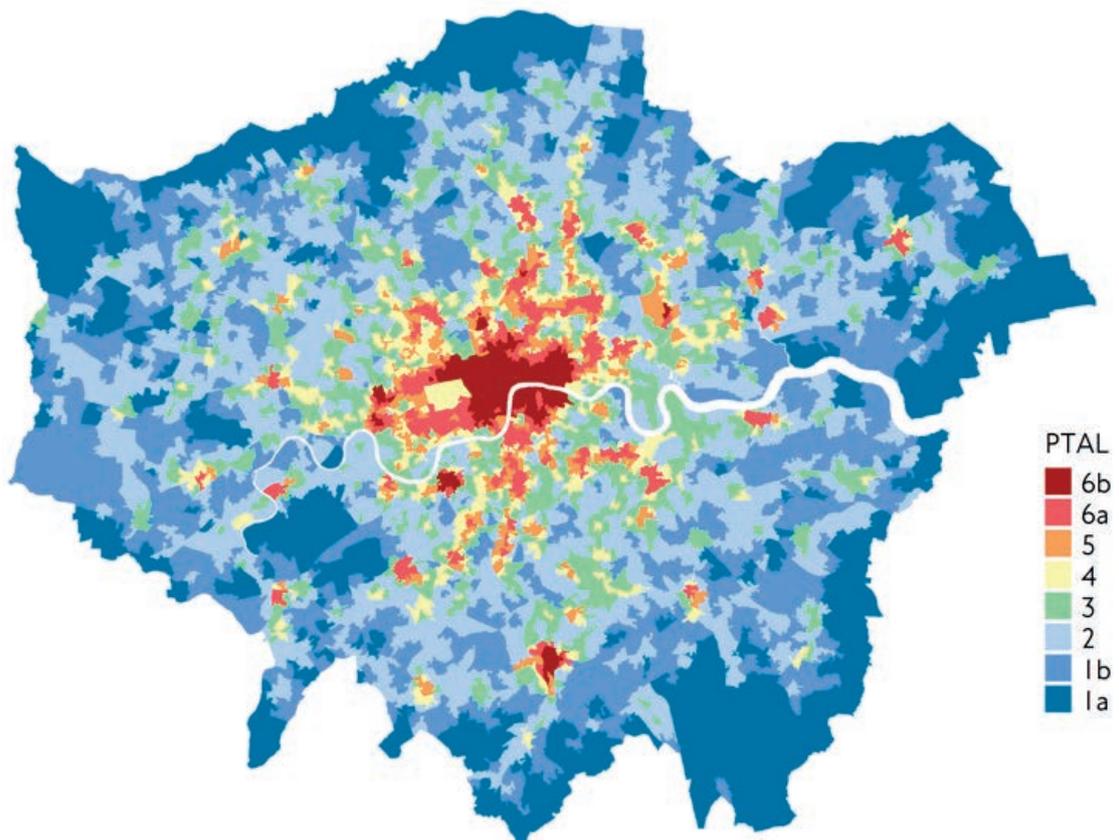


Figure 2.14: A London-wide PTAL map created using one value per zone

PTAL Report

Site Details

Description: **Site Name**
 Easting: **535,587.64**
 Northing: **175,587.64**
 Date: **08/02/2010**

Calculation Parameters

Day of Week: **M-F**
 Time Period: **AM Peak**
 Walk Speed: **4.8**
 Bus Max. Walk Access Time (mins): **8**
 Bus Reliability Factor: **2**
 LU Max. Walk Access Time (mins): **12**
 LU Reliability Factor: **0.75**
 Rail Max. Walk Access Time (mins): **12**
 Rail Max. Reliability Factor: **0.75**

Data			Calculations							
Mode	Stop	Route	Distance (metres)	Frequency (vph)	Walk Time (mins)	AWT (mins)	TAT (mins)	EDF	Weight	AI
Bus	Stop3	34	200	3	2.50	12.00	14.50	2.07	0.5	1.03
Bus	Stop 1	a2	200	10	2.50	5.00	7.50	4.00	1	4.00
Bus	Stop 1	a3	200	7	2.50	6.29	8.79	3.41	0.5	1.71
Bus	Stop 2	a4	400	3	5.00	12.00	17.00	1.76	0.5	0.88
Bus	Stop 2	a5	400	4	5.00	9.50	14.50	2.07	0.5	1.03
Bus	Stop 2	a6	400	7	5.00	6.29	11.29	2.66	0.5	1.33
LU	Stn 1	Route1	746	8	9.33	4.50	13.83	2.17	1	2.17
LU	Stn 1	Route2	746	8	9.33	4.50	13.83	2.17	0.5	1.08
Rail	Stn 1	Route1	900	3	11.25	10.75	22.00	1.36	1	1.36
Rail	Stn 1	Route2	900	2	11.25	15.75	27.00	1.11	0.5	0.56
Sum of AI's										15.16

Figure 2.15: Spreadsheet calculation of PTAL



3 Travel time mapping

3.1 This chapter

In this chapter we present several techniques we use to describe levels of connectivity using travel time maps. We first explain the concept of travel time mapping and give various examples for studies where this has been used. Then we focus in more detail on our two different approaches for creating travel time maps, TIM (time mapping) and CAPITAL (Calculator of Public Transport Access in London). Towards the end of the chapter we present an additional connectivity measure, ATOS (Access To Opportunities and Services), which is created using the other travel time measures.

3.2 What is travel time mapping?

The previous chapter focused on the PTAL measure which rates different locations by their level of connectivity to the public transport network. The method used to calculate PTAL allows us to present it in a very simple way, based on nine preset levels. PTAL is therefore very commonly used, but it also has some limitations, which we listed in the previous chapter. It is often useful to look at more than one measure, to get a richer picture of the levels of connectivity in our study area.

Travel time maps provide additional assessment of connectivity, either by all public transport modes, or a specific public transport mode, or by car. The concept of time mapping is simple, and is based on using different colours to show on a map how long it takes to travel between one selected place and all other places.

We have much data about traffic and travel times in London, but the data does not cover each possible trip from every place to every other place. For this reason, the travel times we use for connectivity assessment are calculated using our strategic transport models. We use the Railplan

model to estimate travel times by all public transport modes, and a set of models called Highway Assignment Models (HAMs) to estimate travel times on London's roads. There is a series of other publications on our website, explaining how these models work in more detail.

The models we use include a simplified representation of London's streets, public transport services, and the people who use them. The models split the area of London into a few thousand zones which represent all the places that people travel to and from. Each zone normally contains a few hundred houses and buildings; we use smaller zones in areas that are more densely populated. A map of zones covering London is illustrated in figure 3.1.

The models we use estimate the routes that people are likely to take when travelling from zone to zone, either by car or by public transport. Based on these routes, they give us an estimated travel time from each zone to each zone. Since we use a map with a few thousand zones, and each zone can be either the origin or the destination of people's journeys, there are many millions of possible origin-destination pairs. Journeys that start or finish outside London are also taken into account.

Most of the time people spend travelling in the real world is picked up by the calculation of the travel time from one modelled zone to another. This includes the time in the car, bus or train, and for public transport it also includes some waiting and walking time. But this zone-to-zone calculation is quite simplified in the way it deals with people's local movements inside each zone. This is because the calculation of the walking time to a public transport stop, or driving time within a neighbourhood, may require more local detail than the models have. In many studies this simplification is not

considered a problem, but in some studies we prefer to make an additional effort to refine the calculation. For this reason we have two

different approaches for calculating travel times, CAPITAL and TIM. Both approaches are explained later in this chapter.



Figure 3.1: The zones that represent people's origins and destinations in our models

3.3 Where travel time mapping is used

Similar to PTAL, travel time mapping is often used to describe the level of connectivity at an area where some transport improvements are

considered. Figure 3.2 shows a travel time map from anywhere in London to Bank Tube station, during the morning peak, by all modes of public transport.

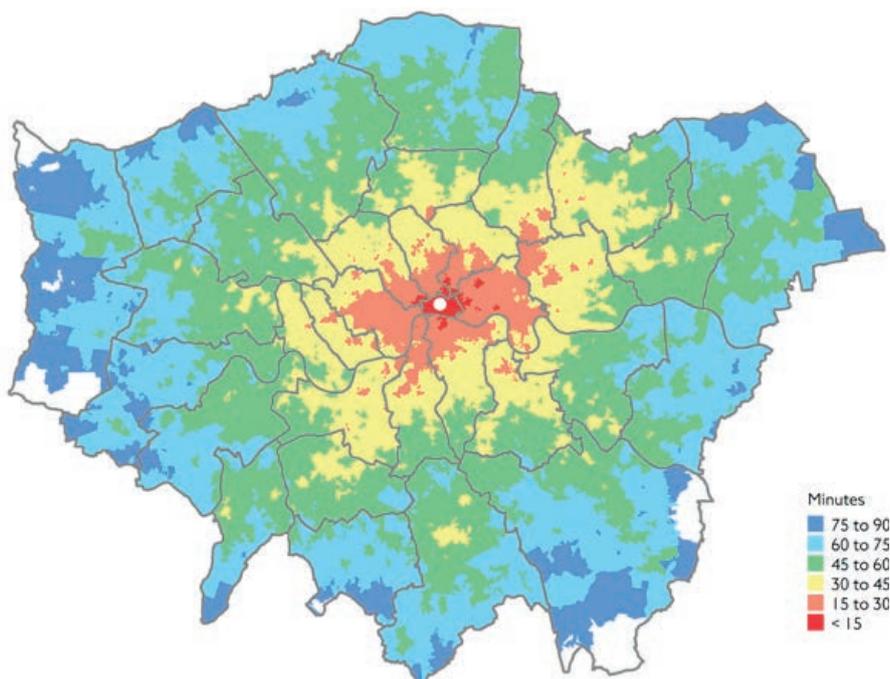


Figure 3.2: Morning peak travel times to Bank station by public transport

Figure 3.3 provides a similar plot where the focus is on Erith in southeast London. It is easy

to observe the difference between these two locations in terms of the level of connectivity.

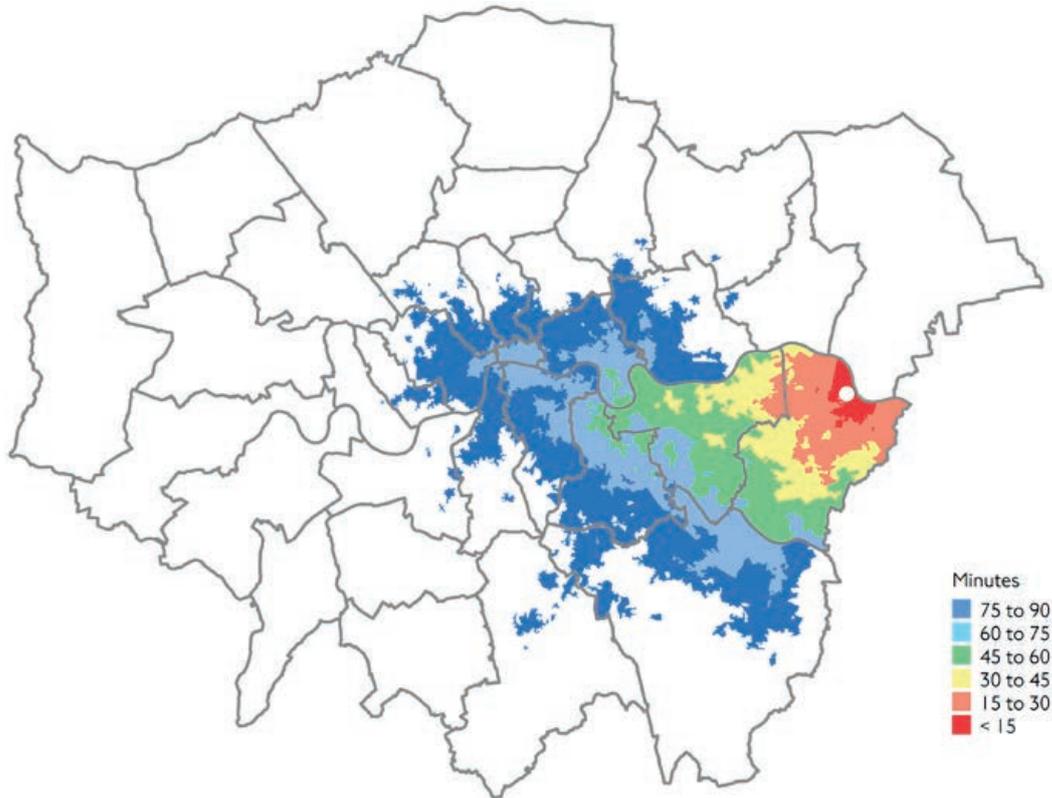


Figure 3.3: Morning peak travel times to Erith by public transport

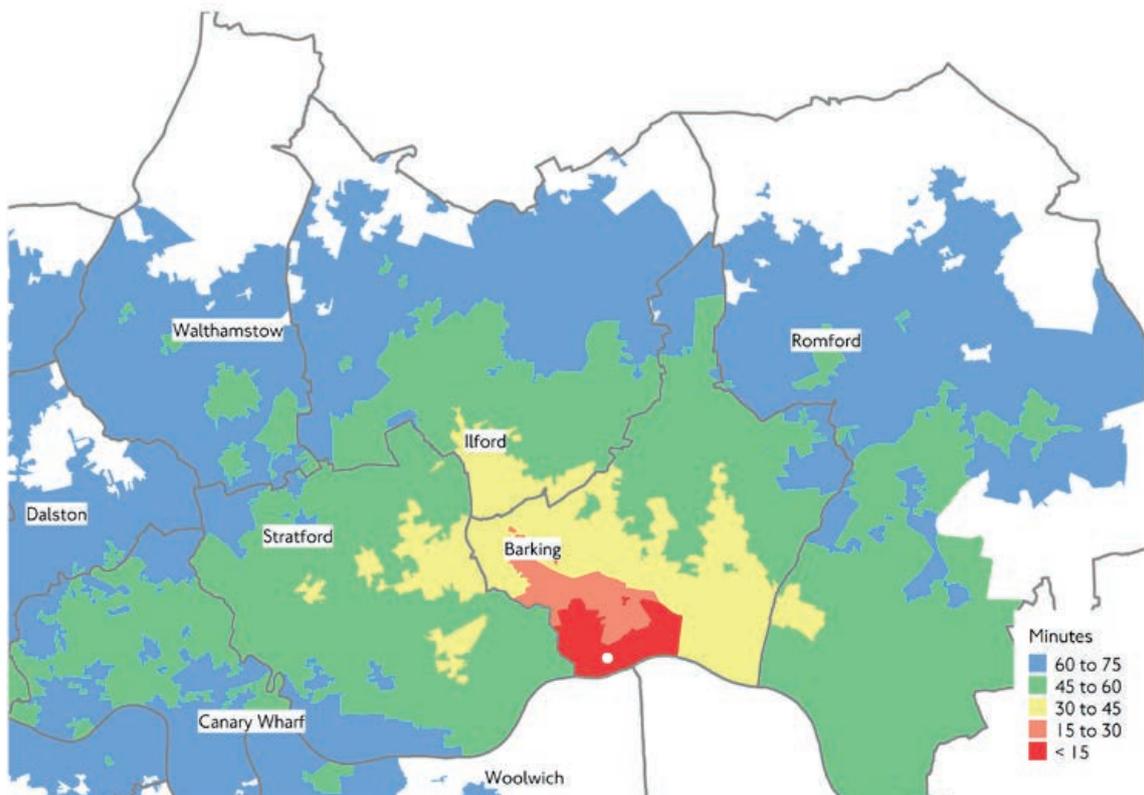
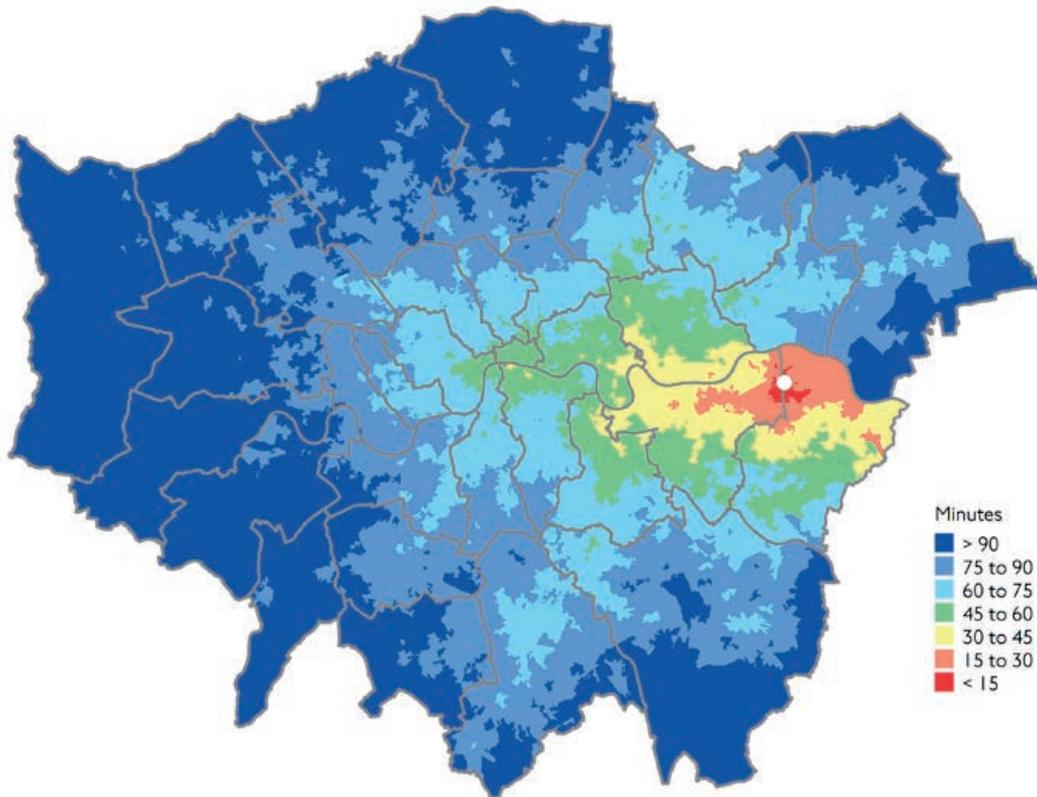
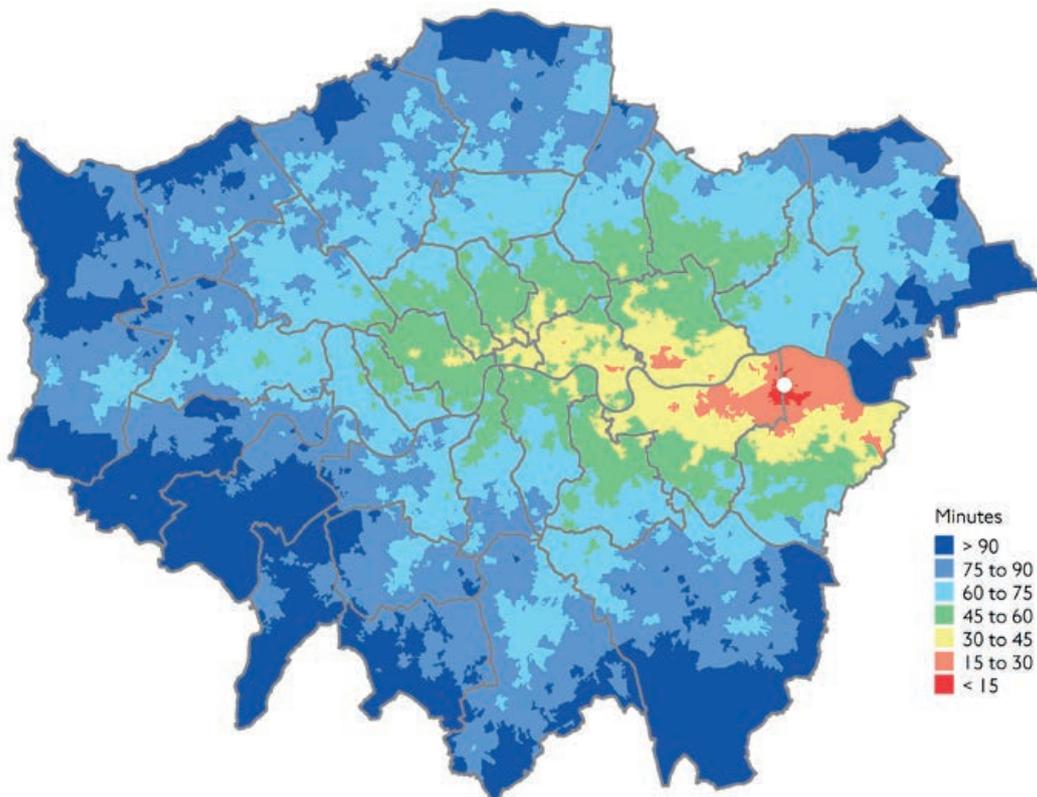


Figure 3.4: Travel times today to the development area at Barking Riverside



Figures 3.5: Travel times by public transport to Abbey Wood without Crossrail



Figures 3.6: Travel times by public transport to Abbey Wood with Crossrail

Travel time mapping is also often presented for an area where a significant development is considered, for example a new residential quarter on former industrial land. In such cases, the connectivity assessment feeds into the discussion about the type of transport improvements that will be required to serve the new development. This is illustrated in figure 3.4, focusing on the Barking Riverside area, where significant development of new housing is planned. The figure shows the current travel times before any intervention. Similar maps are then prepared for various options proposed for improved connectivity.

Travel time maps help understand the expected London-wide impacts of major transport investments such as Crossrail. Figures 3.5 and 3.6 demonstrate expected travel times by public transport to Abbey Wood with and without the Crossrail route.

It is sometimes difficult to understand the change between two travel time maps only by eye. We therefore create maps that show the difference in travel time between two different scenarios. As an example, figure 3.7 shows the expected difference in public transport travel times to the Abbey Wood area, before and after the introduction of Crossrail, ie the difference between the two maps presented earlier.

Areas shown in white in figure 3.7 will not see a significant change. Areas with a strong colour are those that will benefit from the largest improvement in connectivity to Abbey Wood. It can be seen that the improvement is not limited to the areas along the Crossrail corridor, since the new route will also offer improved connectivity to other destinations by transferring to other routes at one of the Crossrail stations. This also illustrates a type of improvement that is difficult to show when using PTAL only.

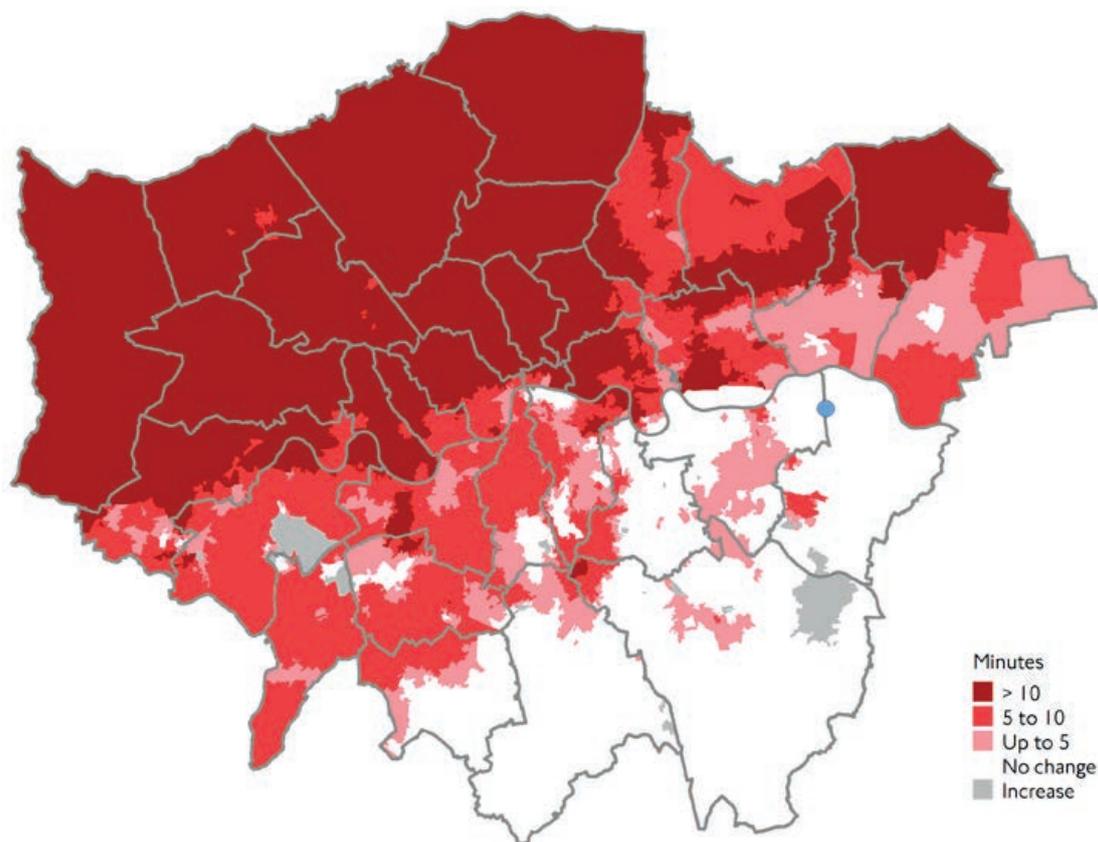


Figure 3.7: Expected differences in public transport travel times to Abbey Wood with and without Crossrail

Our work often focuses on improving public transport services, but a certain level of connectivity by car needs to be provided as well. We therefore produce travel time maps in a similar format, showing how long it takes to travel by car between one selected place and all other parts of London. This is illustrated in figure 3.8, taken from a study that focused on Ilford town centre.

Another use of time mapping is to analyse the level of connectivity offered to different types of users. This is illustrated in figures 3.9 to 3.12. This set of four figures examines connectivity to Hounslow. Figure 3.9 shows travel times for those who can use any public transport service. Figure 3.10 presents travel times for those who require step-free access; they can use most bus services and only some rail and Tube services. Figure 3.11 demonstrates travel times

for those who use buses only, for example due to the lower fares.

Figure 3.12 summarises the three preceding maps. The figure focuses on places from which you can travel to Hounslow in 60 minutes. The areas with the light shading allow travelling to Hounslow by 60 minutes, even by those who require step-free access or use buses only. From the areas with the slightly darker shading you can make the trip to Hounslow within 60 minutes, even with step-free restrictions, but other modes except the bus are needed. In the areas with the darkest shading you can reach Hounslow in less than 60 minutes only without mode or step-free restrictions. This analysis can be used when discussing what improvements to the service should be prioritised in this part of London.

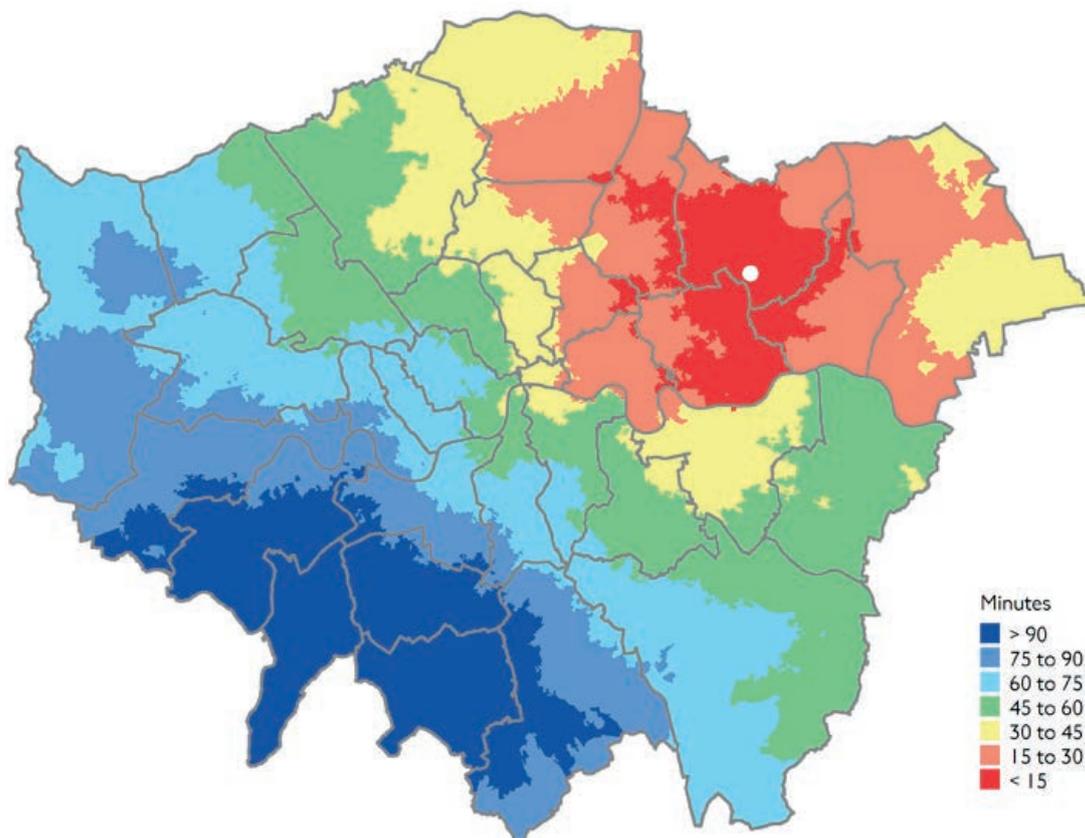


Figure 3.8: Highway travel time maps to Ilford town centre

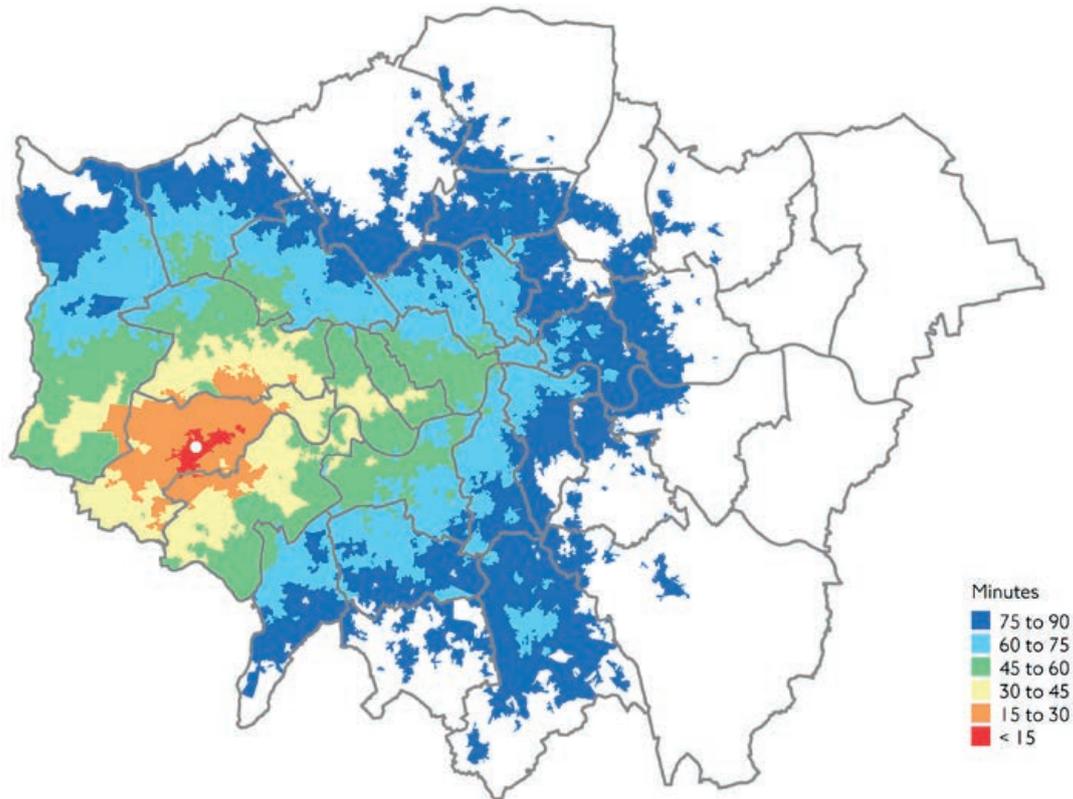


Figure 3.9: Travel times to Hounslow for those using any public transport service

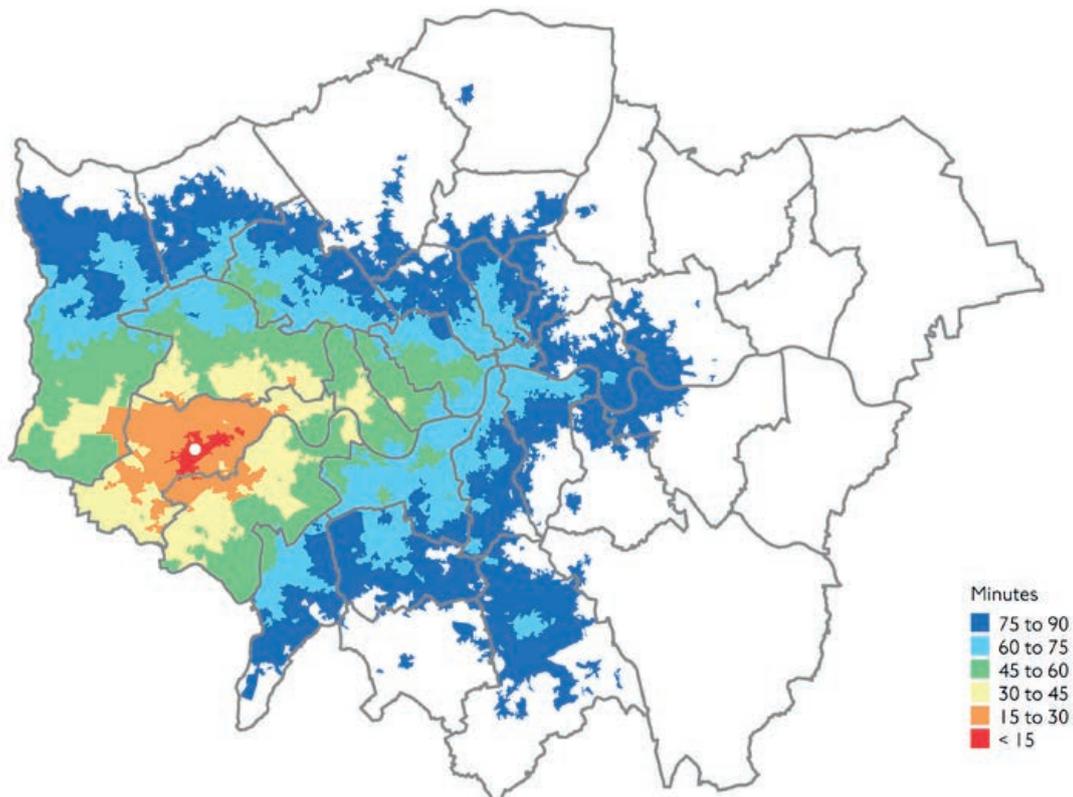


Figure 3.10: Travel times to Hounslow for those requiring step-free public transport

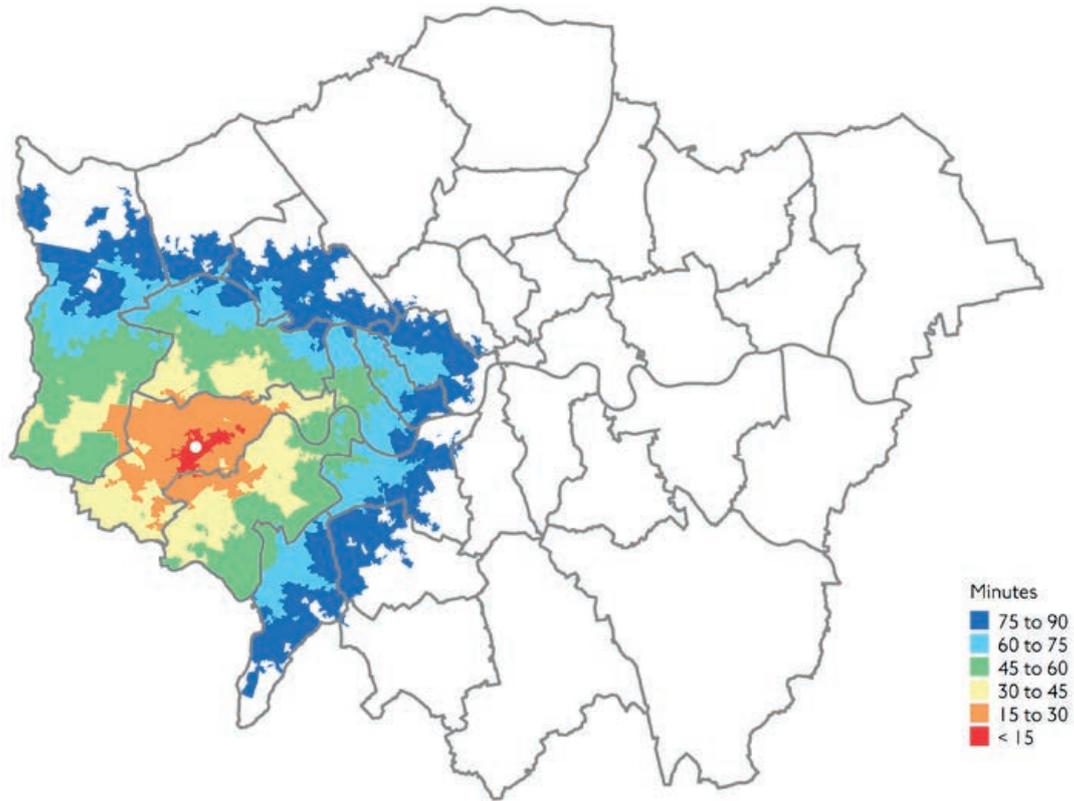


Figure 3.1.1: Travel times to Hounslow for those using buses only

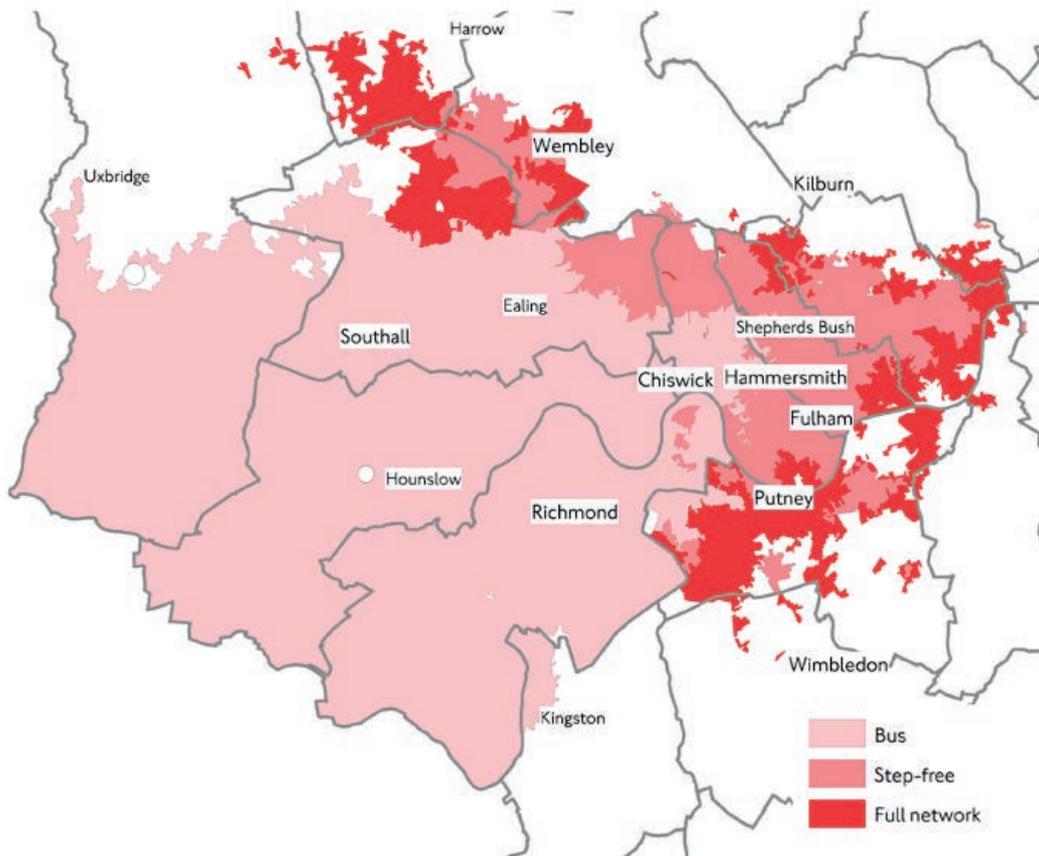


Figure 3.1.2: Differences in connectivity to Hounslow between different user groups

3.4 The TIM measure

TIM is an acronym for time mapping. This is the type of travel time mapping which is available on WebCAT, our new web-based Connectivity Assessment Toolkit.

TIM outputs contain only the travel time between the zones described at the beginning of this chapter. This normally covers most of the journey time and is considered appropriate

for strategic planning purposes. Travel times within each zone are included in TIM in a relatively simplified way.

WebCAT users can make TIM queries and view travel time maps based on a few parameters, as described in table 3.1.

Figures 3.13 and 3.14 show typical screenshots of a TIM query in WebCAT.

Criteria	What data is available
Year	Data is available for a network similar to the one that is operated in London today, which we refer to as the base year. The base year is normally a recent year, for which we have sufficient data. Our current base year is 2011. Alternatively, there are estimated travel times for two future years, 2021 and 2031.
Time of day	For a typical workday in the selected year, there are TIM outputs for either the morning peak, the evening peak, or the daytime between the peaks.
Mode	For the base year, WebCAT users can view travel times either by all public transport modes, or by step-free services, or by bus only. For future years, currently only travel times by all public transport modes are available. Travel times by car or bike are currently not available on WebCAT.
Direction	Users can select whether the map presents travel times from their selected location to other places, or from other places to their selected location, or an average of the two.

Table 3.1: Travel time data available on WebCAT



WebCAT

Address or co-ordinates

eg. NW1 6XE, 530273, 179613

Access level (PTAL) **Time mapping (TIM)**

TIM: a new measure, looking at how far you can travel in a given journey time.

Map Key - Travel Time

< 15 minutes	15 - 30 minutes
30 - 45 minutes	45 - 60 minutes
60 - 75 minutes	> 75 minutes

Map layers

Travel Times Borough Boundaries

Scenario

2011 (Base year)

Mode

All public transport modes

Time of Day

AM peak

Direction

Average



You can click anywhere on the map to change the selected location.

TIM output for 2011 (Base year)
Mode: All public transport modes, Time of day: AM peak, Direction: Average

Easting: 519153, Northing: 181862
A representation of all public transport modes in London available
National Rail, London Overground, London Underground, DLR, Tram, Buses.

Figures 3.I.3: Time mapping (TIM) in the Connectivity Assessment Toolkit (WebCAT)

WebCAT

Address or co-ordinates

eg. NW1 6XE, 530273, 179613

Access level (PTAL) **Time mapping (TIM)**

TIM: a new measure, looking at how far you can travel in a given journey time.

Map Key - Travel Time

< 15 minutes	15 - 30 minutes
30 - 45 minutes	45 - 60 minutes
60 - 75 minutes	> 75 minutes

Map layers

Travel Times Borough Boundaries

Scenario

2011 (Base year)

Mode

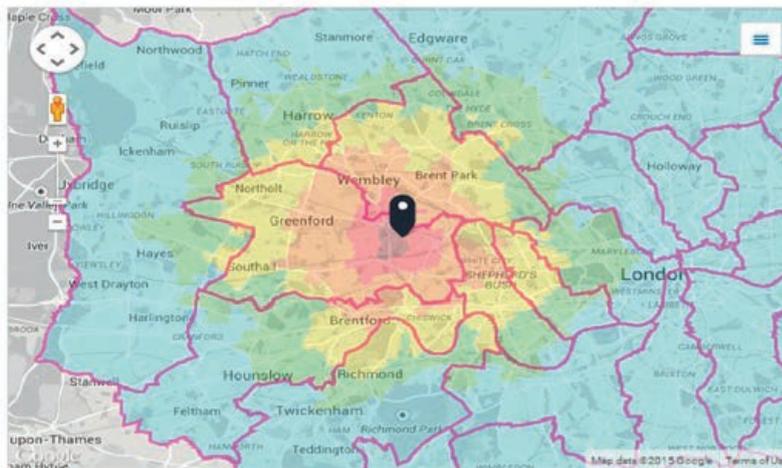
Bus only

Time of Day

AM peak

Direction

Average



You can click anywhere on the map to change the selected location.

TIM output for 2011 (Base year)
Mode: Bus only, Time of day: AM peak, Direction: Average

Easting: 519153, Northing: 181862
A representation of all public transport modes in London available
National Rail, London Overground, London Underground, DLR, Tram, Buses.

Figures 3.I.4: Time mapping (TIM) in the Connectivity Assessment Toolkit (WebCAT)

3.5 The CAPITAL measure

CAPITAL is an acronym for Calculator of Public Transport Access in London. CAPITAL acquired its name when it was originally developed to look at public transport connectivity only, although we now use the CAPITAL approach also to map travel times by car.

Similar to TIM, we use CAPITAL to show how long it takes to travel from a selected place to all other places. Unlike TIM, CAPITAL covers not only the travel time from zone to zone in the zone-based model we use for the calculation, but also the time it takes to access the transport network within the origin and the destination zone. In other words, CAPITAL gives some additional attention to the detail of where exactly the journey origin is within the zone that represents that area in the model. It also does the same for the destination.

Because CAPITAL does more calculations looking at the streets near the origin and the destination of each journey, it takes longer to calculate than TIM. CAPITAL is therefore not suitable for online calculation in our WebCAT page, but it can be calculated using the models held in TfL Planning.

The difference between TIM and CAPITAL is demonstrated in figures 3.15 and 3.16. Both figures look at public transport travel times from the Greenwich Peninsula to central London. But figure 3.15 is based on TIM whereas figure 3.16 is based on CAPITAL. The white lines in both figures represent the boundaries between zones in the model.

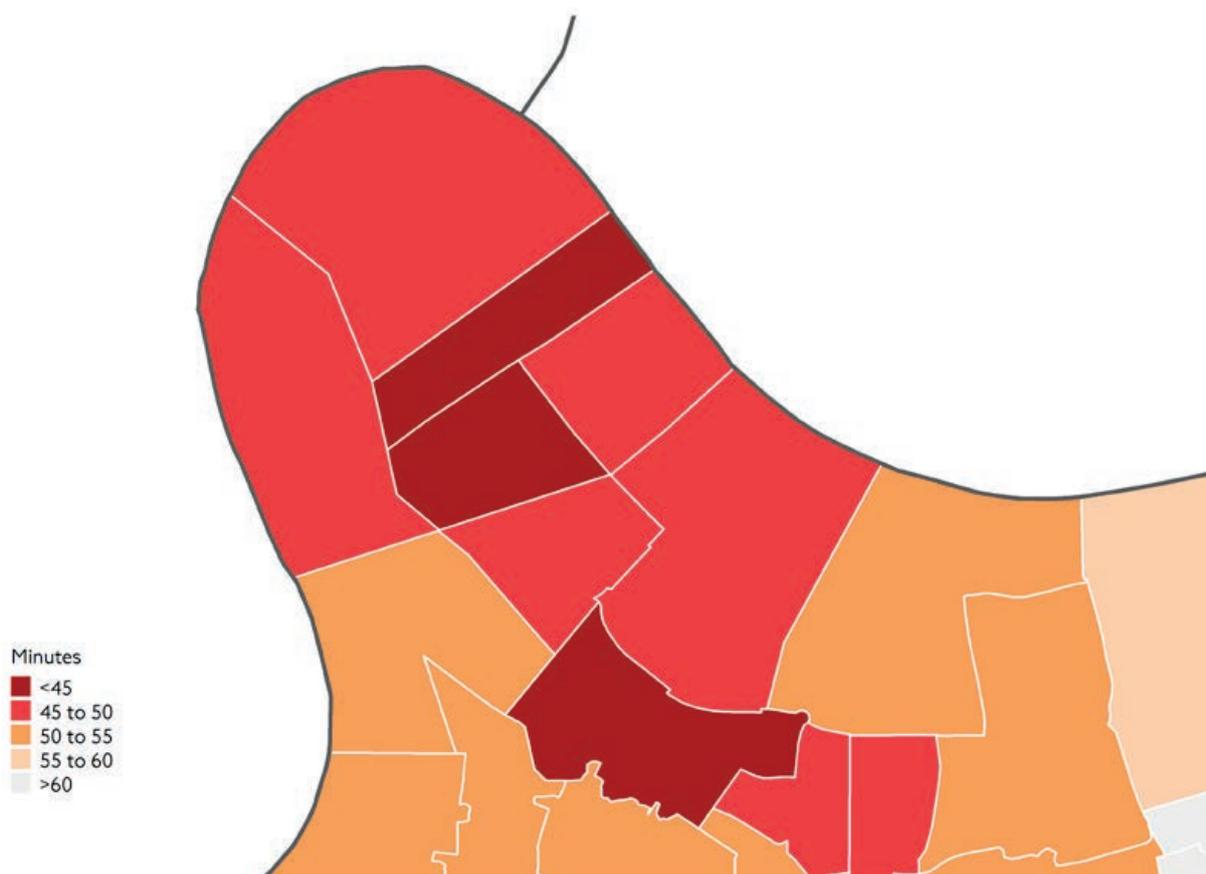


Figure 3.15: TIM output from the Greenwich Peninsula to central London

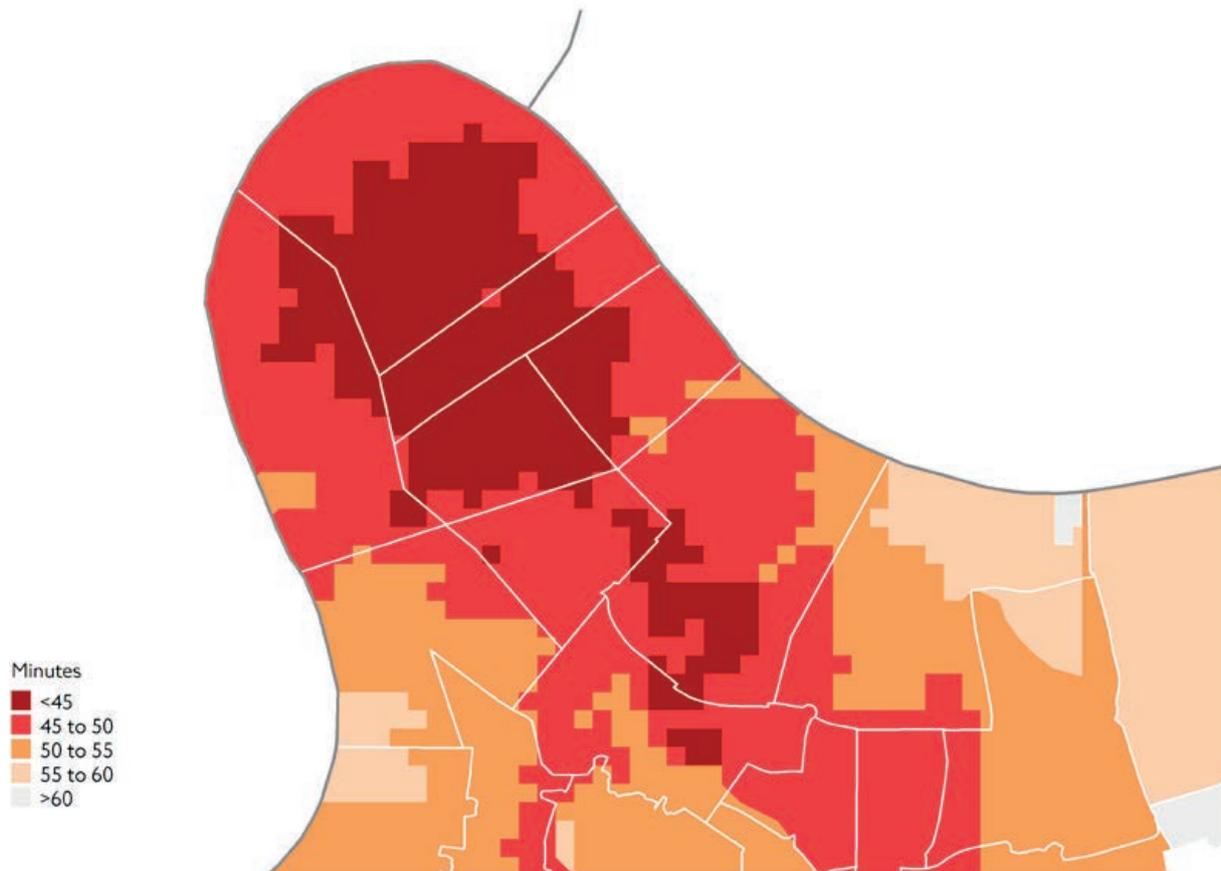


Figure 3.16: CAPITAL output from the Greenwich Peninsula to central London

In figure 3.15, the locations where the colour changes are not necessarily the exact locations where we would expect travel times to become shorter or longer. Each zone in the model only gets one colour in TIM outputs, because travel times are only calculated from the centre of each zone. Since the map focuses on a relatively small area, which only includes a small number of zones, the location of the boundaries between zones becomes quite visible. These locations are not so visible in maps covering large areas, like those presented earlier. So in figure 3.15 it may seem as if there is a step change in travel times where the boundaries between zones lie, although in reality the change will be more gradual. The advantage of the TIM approach is that it relies on fewer calculations, and it is therefore suitable for a webpage like WebCAT.

Figure 3.16 is created with the CAPITAL measure, which also allows for variation of

the travel time within each modelled zone. The calculated travel time to Central London is adjusted for different locations within the presented area, and therefore more variation can be seen, which often takes the shape of the local street network. The presentation is therefore richer, but the calculation is more complex and time-consuming.

For many types of studies, the less detailed calculation of TIM would be sufficient, especially if the study focuses on an area and not on a specific site. The additional effort required when using CAPITAL is justified when it is important to define the very specific location from which travel times are calculated.

The method used to calculate CAPITAL travel times is described in table 3.2. The table is presented here for technical readers and can be skipped by others.

Step	Key facts
Define a scenario	<ul style="list-style-type: none"> • CAPITAL uses TfL’s strategic transport models, Railplan or the HAMs, which are described in a separate publication on our website • CAPITAL can be calculated for any scenario that model runs have been prepared for. This could be for example London’s current transport network, or a future network with a new bridge introduced on the Thames, or a scenario with a new station added, and so on • The modelling scenario is always specified for a certain year. Most scenarios in our library are for 2011 (base year), 2021 (forecast) or 2031 (forecast) • Models are run for a specific time of day; either the morning peak, the evening peak, or the daytime between the peaks • CAPITAL can be calculated for all public transport modes, or for step-free services, or for bus only, or for the car. A similar tool for cycling is currently being developed but is not yet available
Define origins and destinations	<ul style="list-style-type: none"> • CAPITAL accepts user-defined origins and destinations, that the travel times are calculated for (unlike TIM, where origins and destinations are always the centres of the modelled zones) • The calculation is done between a single point (origin or destination) and all others • This single point is often selected as a town centre, a station or a development site • For the other points (ie the destinations, if the single point is the origin) we often select a grid that covers a large area. A very dense grid takes longer to calculate but gives finer results. The destination can also be London’s 25,000 ‘census output areas’, or the 4,800 ‘census super output areas’, or London’s 650 wards
Define service access points (SAPs) and service egress points (SEPs)	<ul style="list-style-type: none"> • SAPs and SEPs are the points where the transport network can be accessed • A public transport journey includes a relatively short walk from the origin to the SAP, then a public transport journey from the SAP to the SEP, and then another short walk from the SEP to the destination. Only the public transport journey is covered by the model, and the two walks at the start and the end fill in a short gap which is not modelled • A car journey includes a relatively short drive from the origin to the SAP, then the main drive from the SAP to the SEP, and then another short drive from the SEP to the destination. In the real world these are normally a single trip, but since only the middle section is modelled, the short sections at the start and the end fill in a short gap which is not modelled

Step	Key facts
Calculate access times	<ul style="list-style-type: none"> • MapInfo's RouteFinder application is used to calculate the access time from each origin and each destination to some neighbouring points that are represented in the model • A walking speed of 4.8 kph is assumed in the access time calculation for public transport journeys • The walk network is created from the Integrated Transport Network (ITN) published by Ordnance Survey, which includes all of London's roads. Motorways and major trunk roads have been removed as they are not suitable for walking. Rail bridges, footpaths and local short cuts have been added • Figure 3.17 illustrates the process of identifying the access route from the origin to several nearby SAPs, or the access route to the destination from several nearby SEPs. The blue point represents the origin or destination. The yellow points represent SAPs and SEPs in the area. The green lines are the possible routes identified for each access point. Walking or local driving times are calculated for these routes
Extract travel times from the SAP to the SEP from the model	<ul style="list-style-type: none"> • The models used are Railplan for all types public transport journeys and the HAMs for car journeys. Separate documents are available, describing these models in more detail
Construct combined journeys	<ul style="list-style-type: none"> • The three different elements of each journey (origin to SAP, SAP to SEP, SEP to destination) are added using MS-Access • For many journeys there is a choice between various SAPs and SEPs when travelling from the origin to the destination. Therefore, at this stage a single SAP-SEP route is selected for each combination of origin and destination. In most cases the route that minimises the total travel time is selected
Convert the result to a CAPITAL map	<ul style="list-style-type: none"> • Any standard Geographical Information System can be used for this

Table 3.2: The method used to calculate CAPITAL

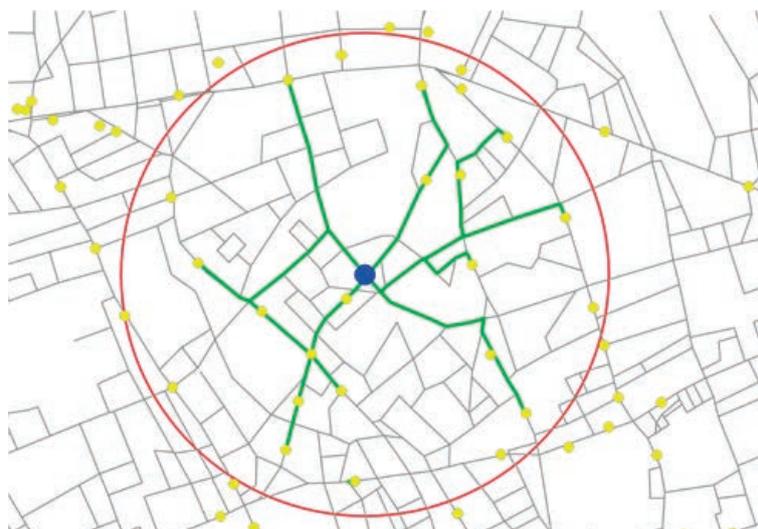


Figure 3.17: The part of the journey, near the origin or the destination, that CAPITAL looks at in detail

3.6 The ATOS measure

Access to Opportunities and Services (ATOS) is a measure that indicates how easy it is to access essential key services and employment locations, using public transport or by foot. ATOS scores range between A and E, where A indicates the best level of connectivity.

ATOS values for a selected location depend on CAPITAL travel times for that location. But unlike CAPITAL which looks generally at travel times to all other parts of London, ATOS is based on travel times to a basket of destinations. The way these destinations are selected is described in table 3.3. We specify a different ATOS for each type of service rather than one ATOS for the whole basket.

Services or opportunities	Assumed mode of transport	Selection criteria	Data source
Employment	Public transport or walking	The nearest 10,000 low-qualified (blue collar) and high-qualified (white collar) jobs	Employment data from the Greater London Authority (GLA)
Education	Public transport or walking	The nearest three primary schools, secondary schools and further education (FE) colleges	The EduBase register, which includes primary schools, secondary schools and FE colleges
Health	Public transport or walking	The nearest three GP surgeries	NHS Direct data
Food shopping	Public transport or walking	The nearest town centre or large supermarket	Supermarkets of more than 15,000 square feet were included
Open spaces	Walking	The nearest publicly accessible open space	The GIGL dataset (Greenspace Information for Greater London)

Table 3.3: The destinations included in the ATOS measure

For all services or opportunities described in table 3.3, the data we use to calculate ATOS includes locations outside London, since these may be used by those living in Outer London. The use of 'nearest three' is a simplified way of capturing individual preferences and the capacity of medical services and schools, which cannot be explicitly considered in the calculation.

The method used to calculate ATOS is described in table 3.4. The method uses the process described earlier to calculate travel times using the CAPITAL measure. Figure 3.18 shows, as an example, ATOS for secondary schools across London.

Step	Key facts
Define a scenario	ATOS can be calculated for any scenario that CAPITAL outputs are available for. This can represent London's transport networks and services either now or in a hypothetical future situation
Identify 10 nearest destinations of each type	The types of service listed in table 3.3 are treated here as the destinations of people's journeys. For every possible point of origin in the study area, the 10 nearest destinations of each type are identified using the RouteFinder application. The list of 10 represents a choice set which will be further refined at a later step
Calculate travel times	We now obtain CAPITAL travel times by public transport for all combinations of origin and destinations identified above. The CAPITAL travel times include detailed walking times
Select nearest destinations	Based on the calculated CAPITAL travel times, we select the nearest destination (for food shopping and open spaces) or the three nearest (for health and education)
Calculate travel time statistics	For each type of service, the average travel time and the standard deviation of travel times are calculated across all origins
Calculate ATOS scores	<p>Each type of service gets an ATOS score, ranging from A to E, at each location. The score at any location is based on how travel times to nearest relevant destinations (for the specific type of service) compare to the average travel time across all locations.</p> <p>Score A: Travel times to relevant destinations are more than one standard deviation below the average</p> <p>Score B: Below the average, but by not more than one standard deviation</p> <p>Score C: Average or above, but by not more than one standard deviation</p> <p>Score D: Between one and two standard deviations above the average</p> <p>Score E: More than two standard deviations above the average</p>

Table 3.4: The method used to calculate ATOS

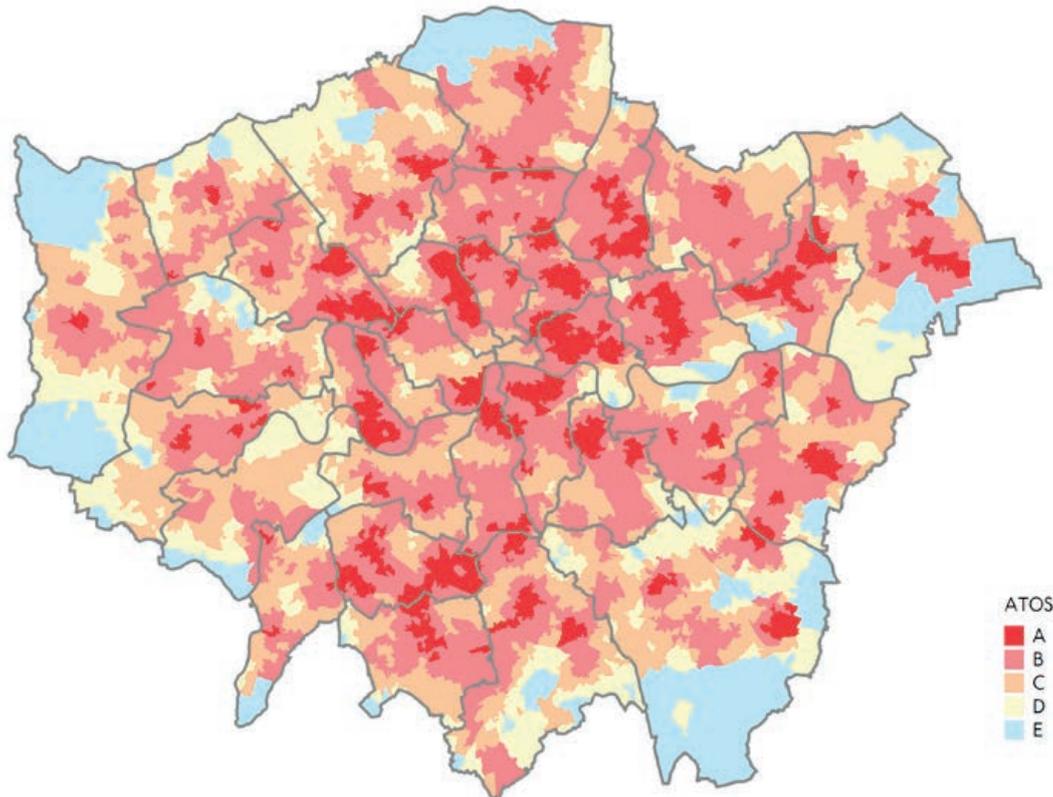


Figure 3.18: ATOS scores for secondary schools

The ATOS measure is useful when considering which places in London require connectivity improvements. It is also particularly helpful when making decisions about the best places to introduce new services, such as health or education, aiming to locate them in places with a high level of connectivity. However, some limitations of ATOS are acknowledged:

1. The same ATOS score would have a different meaning for different types of service. For example, ATOS score A for GP surgeries indicates a travel time of up to seven minutes, whereas ATOS score A for further education colleges represents a travel time of up to 22 minutes. This is because there are GP surgeries in many more locations than further education colleges.
2. Since different services are spread around London at different densities, it is difficult to create a meaningful combined score across various types of services and opportunities.
3. There is only a partial match between areas with low ATOS scores and areas where access to services has been identified as lacking. In some cases, even with an ATOS score E, an area is generally seen as well-connected.
4. The methodology does not consider the quality, the capacity and specific areas of expertise of different services such as schools and clinics.
5. In many cases, the ATOS scores mainly show that some parts of London are denser than others. This may not always easily lead to conclusions about transport services.

As with other measures, it is recommended to look at multiple measures of connectivity and to interpret any findings in the relevant context. A powerful way to assess the level of connectivity to specific types of services is through catchment analysis. We describe this type of analysis in the next chapter.



4 Catchment analysis

4.1 This chapter

In this chapter we describe the analysis we do to identify the area that is influenced by the level of connectivity in a specific place. We show some examples here for analysis done in various studies, and we explain how they differ from each other.

4.2 What is catchment analysis?

The catchment area of a place includes all the locations that are easy to reach from that place. If the place provides a service, like a shop, school or hospital, then most of the customers, students or patients will come from the catchment area. If the place is a house, the catchment area is where residents are most likely to work. We use the catchment area as an indicator for connectivity, because better transport makes the catchment area larger.

For any specific place of interest, we identify the catchment area by plotting the area that you can travel to by up to a certain travel time. Then we can check how this plotted area changes if we introduce new transport routes, stations, bridges and so on. We also plot catchment areas when helping partner organisations to decide where to locate new businesses or services.

There are several different types of catchment analysis we do regularly. They are described in table 4.1.

4.3 Where catchment analysis is used

In many studies we use a maximum travel time of 45 minutes to define the catchment area, since many people see this as an acceptable travel time for different types of journeys. A 60-minute catchment area is sometimes used as the maximum travel time people will consider as a local journey.

Figures 4.1, 4.2 and 4.3 are examples of catchment maps where only the catchment area is presented. Figure 4.1 is from a study in the Shepherd's Bush area, where we looked at the difference between the area that can be reached by bus only and by all public transport modes. Figure 4.2 shows how the extension of the Jubilee line changed the 60-minute catchment area of North Greenwich. Figure 4.3, taken from a study of metropolitan town centres in London, shows for different parts of London the nearest centre they can travel to in not more than 45 minutes.

Figures 4.4 to 4.9 are examples of maps where socio-economic information is presented for different parts of London to explain the difference in their catchment areas. Figure 4.4 presents the number of jobs that were available by public transport, in a maximum of 45 minutes, in 2011. Figure 4.5 shows how the same information is expected to change with the transport network London will have in 2031. Similar maps are used, for different years, in our Travel in London report and in the Mayor's Transport Strategy. Such maps of employment catchments are mainly interesting when studying the level of connectivity in residential locations.

Note that although figure 4.5 is based on expected travel times for 2031, it still uses the same employment data used for 2011. This is done so that we can look at the connectivity impacts of the different transport network alone, without the impact of the expected change in employment locations. It is possible to undertake the same analysis using forecast employment numbers for the future. When this is done, the catchment analysis illustrates the impact of more than one factor simultaneously.

Type of catchment analysis	Key facts
Presenting only the catchment area	<ul style="list-style-type: none"> • This is the simplest type of catchment analysis. This shows the catchment area and its boundaries on a map • See examples in figures 4.1 to 4.3
Presenting socio-economic information for the catchment area.	<ul style="list-style-type: none"> • We often show the total number of workplaces in the catchment area. There is better connectivity if more workplaces can be reached within a given travel time • Other employment-related statistics we often present for the catchment area are the number of businesses, number of white collar (highly-skilled) workplaces or blue collar (low-skilled) workplaces, as published by the Office for National Statistics • Alternatively we present population-related statistics, including the total population in the area, the number of households, or the population in specific age groups • See examples in figures 4.4 to 4.9
Presenting the number of services of a specific type for the catchment area.	<ul style="list-style-type: none"> • We sometimes show the number of town centres in the catchment area, since town centres provide a range of services close to each other. We are also able to analyse town centre catchment for specific categories, such as metropolitan or district town centres, as defined by the GLA • There is often interest in the number of schools, colleges, or other categories of educational services, within a given travel time. The same applies to different types of health services • See examples in figures 4.10 to 4.14
Presenting travel times within the catchment area.	<ul style="list-style-type: none"> • Travel time maps were described in the previous chapter. In the context of catchment analysis we sometimes present the travel times within the catchment area, to show that there are different levels of connectivity even within this area • See examples in figure 4.15
Presenting the difference in the catchment area between different scenarios or different types of users.	<ul style="list-style-type: none"> • For any of the types of analysis listed above, mapping the catchment difference between different situations helps to better understand strengths and weakness of the transport system • See examples in figures 4.1, 4.2, 4.8, 4.9 and 4.12

Table 4.1: Common types of catchment analysis

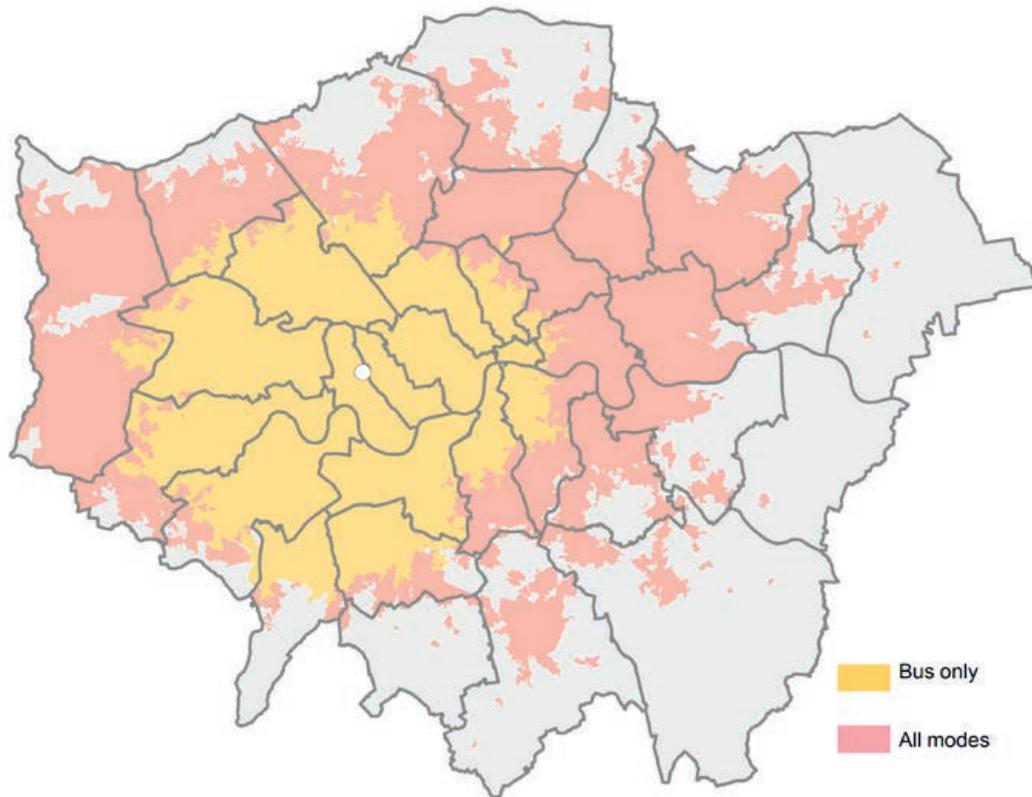


Figure 4.1: The 60-minute catchment to Shepherd's Bush by bus or by all public transport modes

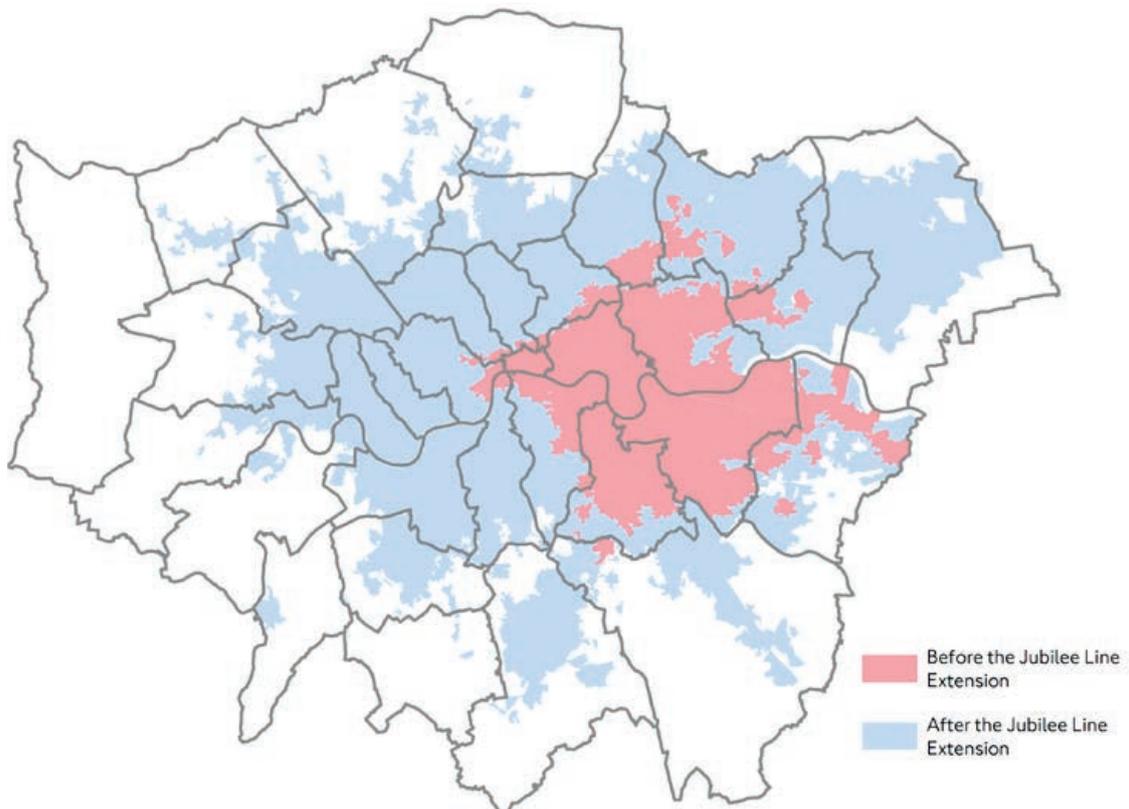


Figure 4.2: The 60-minute catchment to North Greenwich

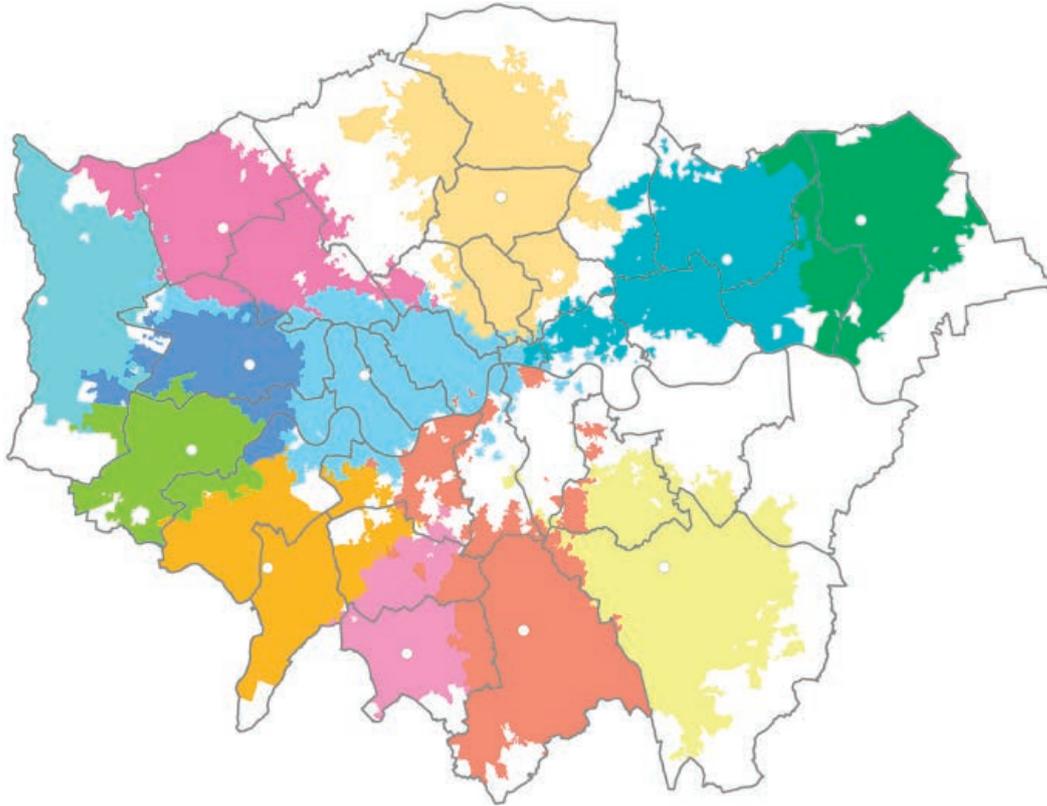
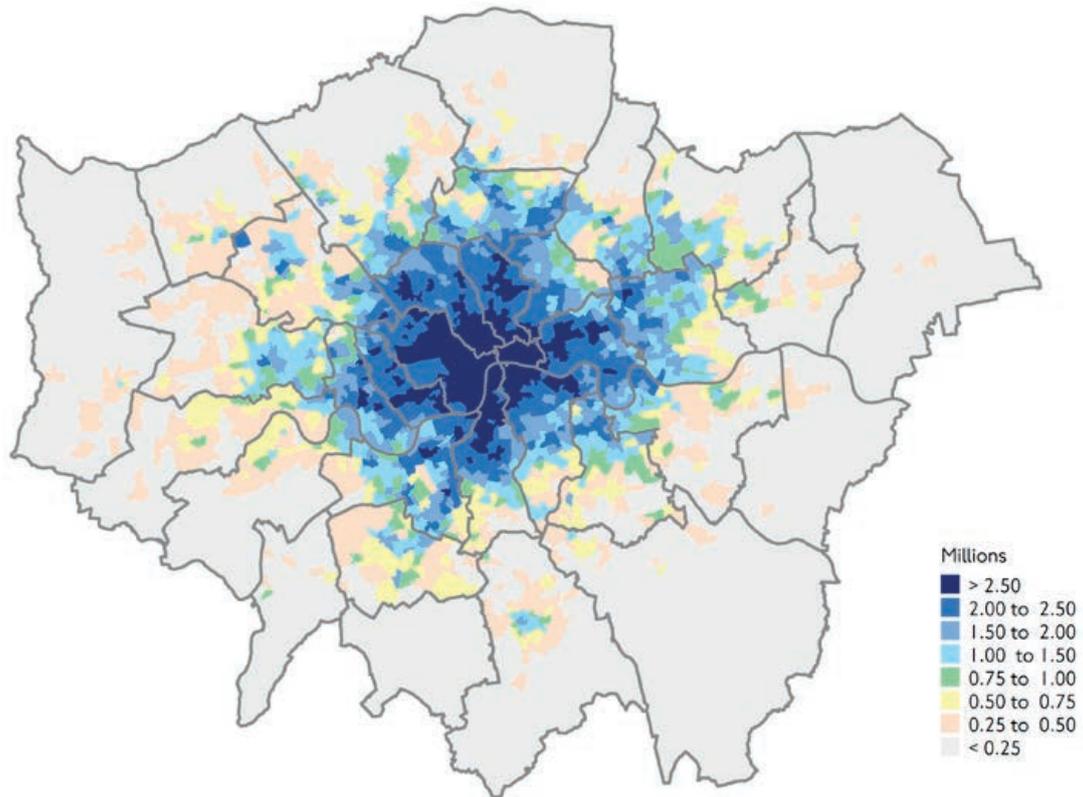
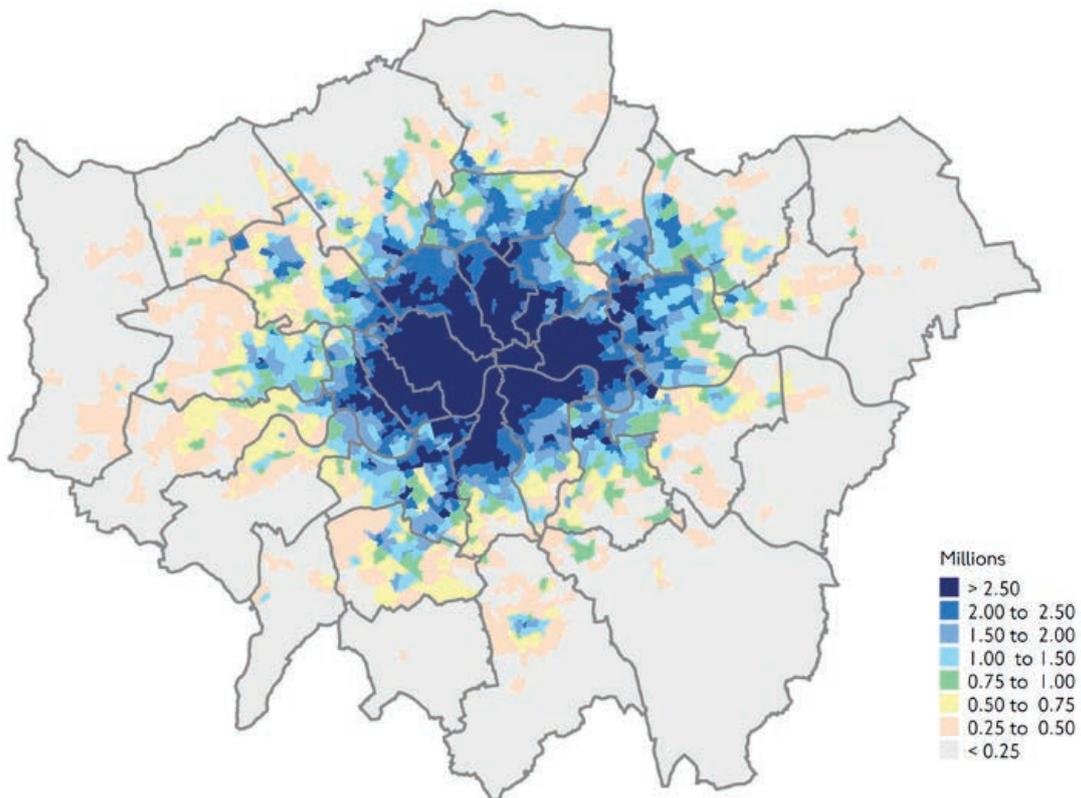


Figure 4.3: The 45-minute catchment area of London's metropolitan town centres

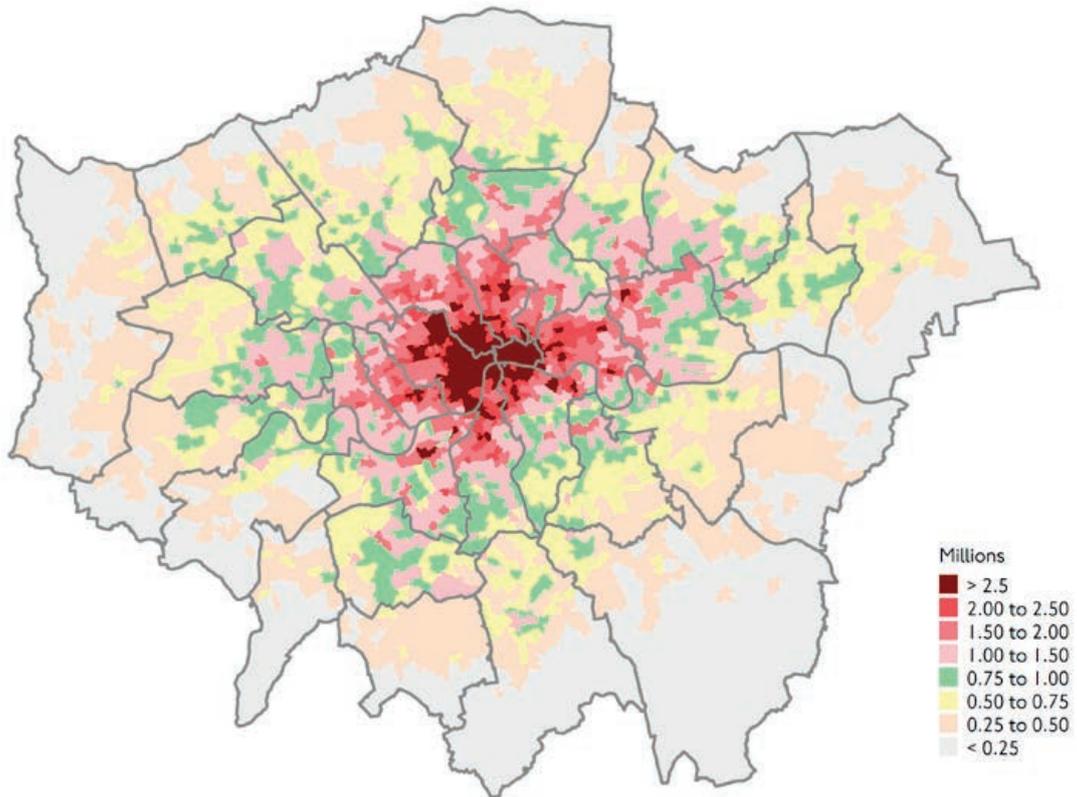




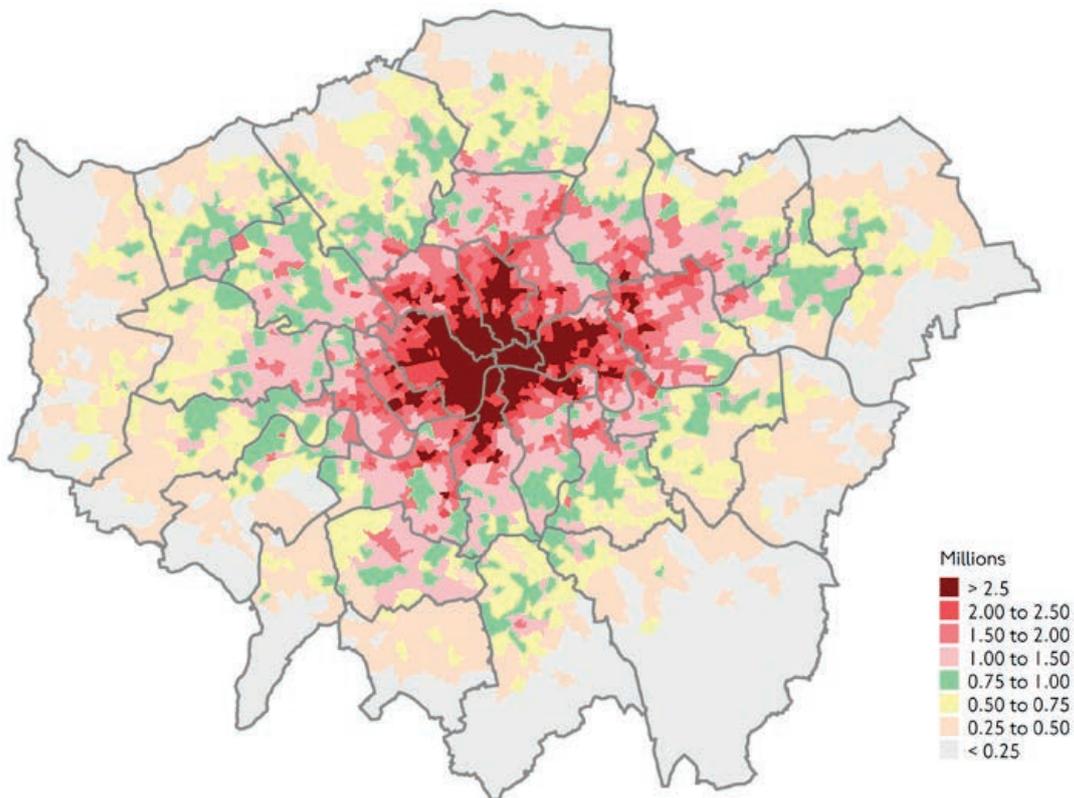
Figures 4.4: The number of jobs within 45 minutes from different parts of London in 2011



Figures 4.5: The number of jobs within 45 minutes from different parts of London in 2031



Figures 4.6: The total population within 45 minutes from different parts of London in 2011



Figures 4.7: The total population within 45 minutes from different parts of London in 2031

Figures 4.6 and 4.7 show the total population that exists within the 45-minute catchment areas of different parts of London. Again, this is a comparison of the 2011 transport networks to the expected 2031 network, whereas the population statistics used for both maps are from 2011, so that the comparison focuses on the impact of transport in isolation. Such maps of population catchments are particularly interesting when studying the level of connectivity in locations where employment and commercial developments are considered.

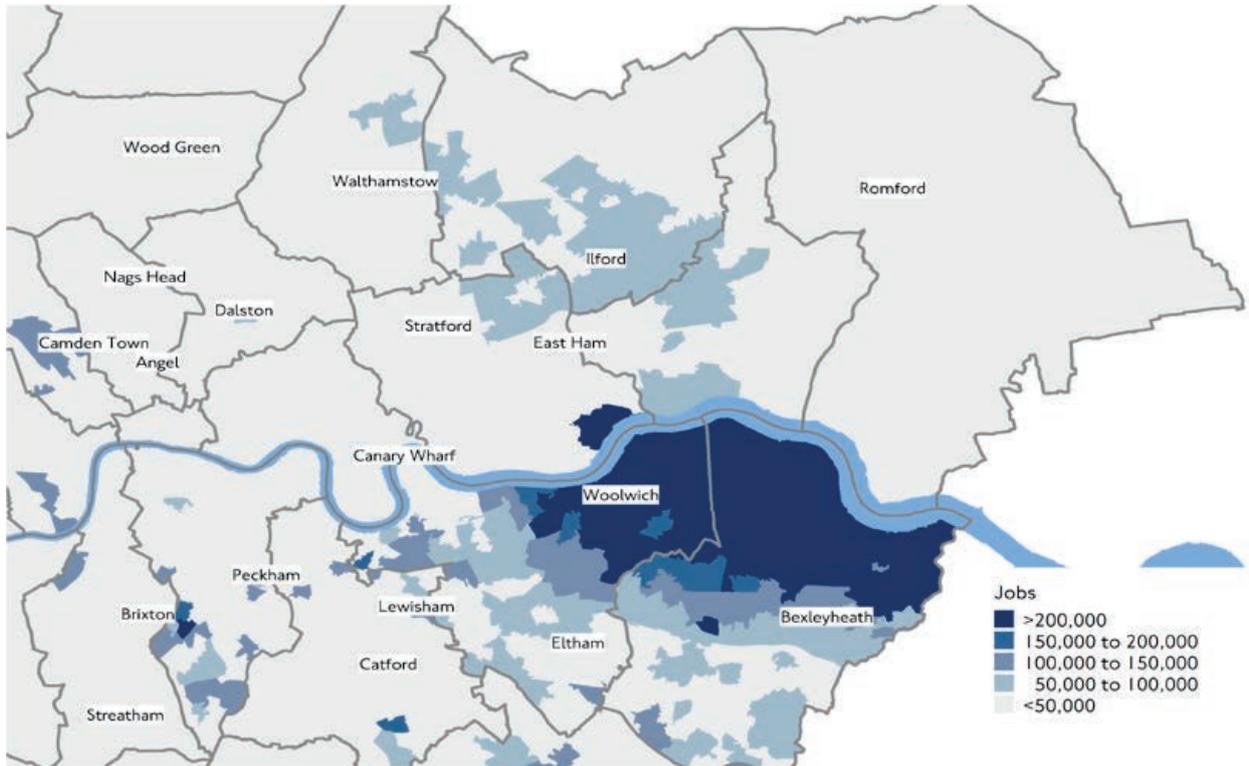
Catchment analysis using socio-economic data is often used to demonstrate the benefits from investing in transport infrastructure in specific places. Figures 4.8 and 4.9 are taken from a study of possible new bridges, tunnels or ferries crossing the Thames in east London. This time the catchment area is specified based on travel times by car.

The two figures focus on the impact of a possible bridge at Gallions Reach, which is one of the alternatives considered in this study. The figures show the difference between socio-economic statistics calculated with and without the bridge. Figure 4.8 looks at the

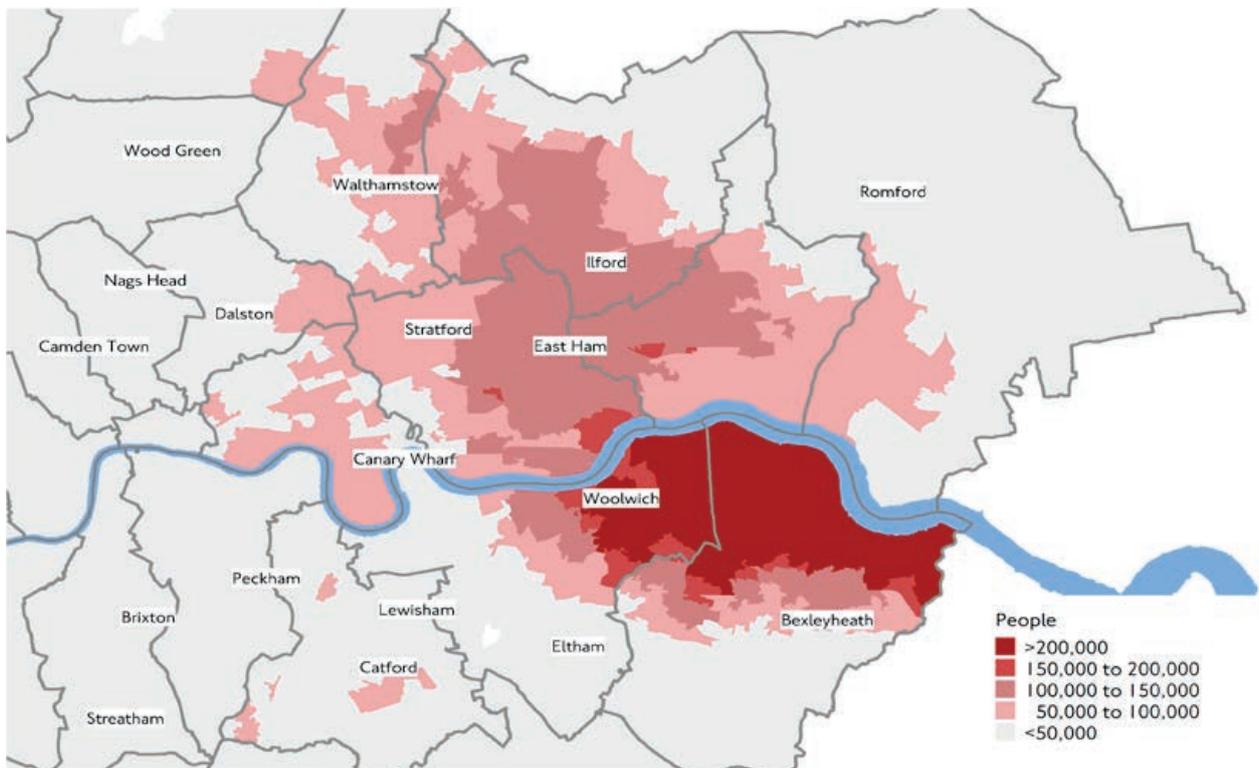
change in the number of jobs and figure 4.9 looks at the change in the total population at a working age. For both figures, the catchment area was defined by a 37-minute drive, as this is the average driving time to work in the area.

Figures 4.10 to 4.14 demonstrate the type of analysis where we count the number of services of a specific type within the catchment area. Figures 4.10 and 4.11 show the number of further education colleges that can be reached from different parts of London within 45 minutes; the first figure allows using any public transport service while the second allows using step-free services only. Comparisons like this, for various types of services, are used when investment in step-free infrastructure is assessed. This is done, for example, in the Accessibility Implementation Plan that accompanies the Mayor's Transport Strategy.

The example in figure 4.12 is also based on connectivity to further education colleges. This map is taken from the feasibility study of the Crossrail2 route, showing how the route is expected to change the number of colleges that residents along the line can access.



Figures 4.8: Additional jobs within a 37-minute drive in 2021 if Gallions Bridge is built



Figures 4.9: Change in economically active population within a 37-minute drive in 2021 if Gallions Bridge is built

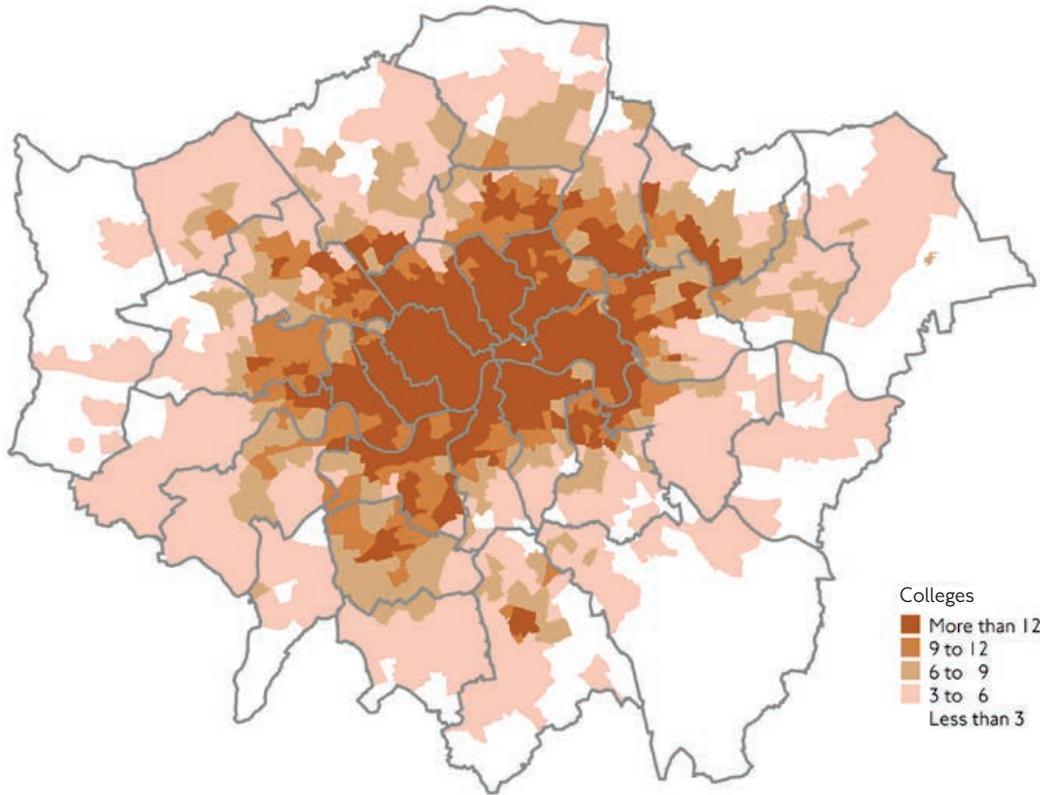


Figure 4.10: Connectivity to further education colleges with the full public transport network

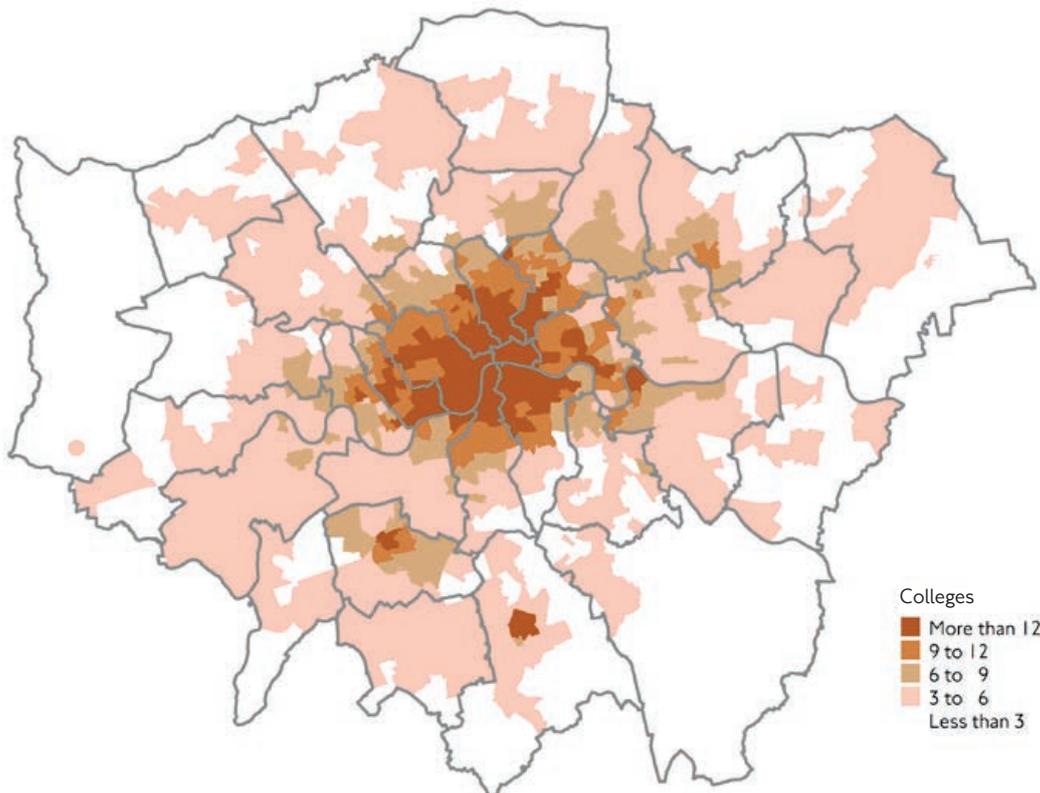


Figure 4.11: Connectivity to further education colleges with step-free services

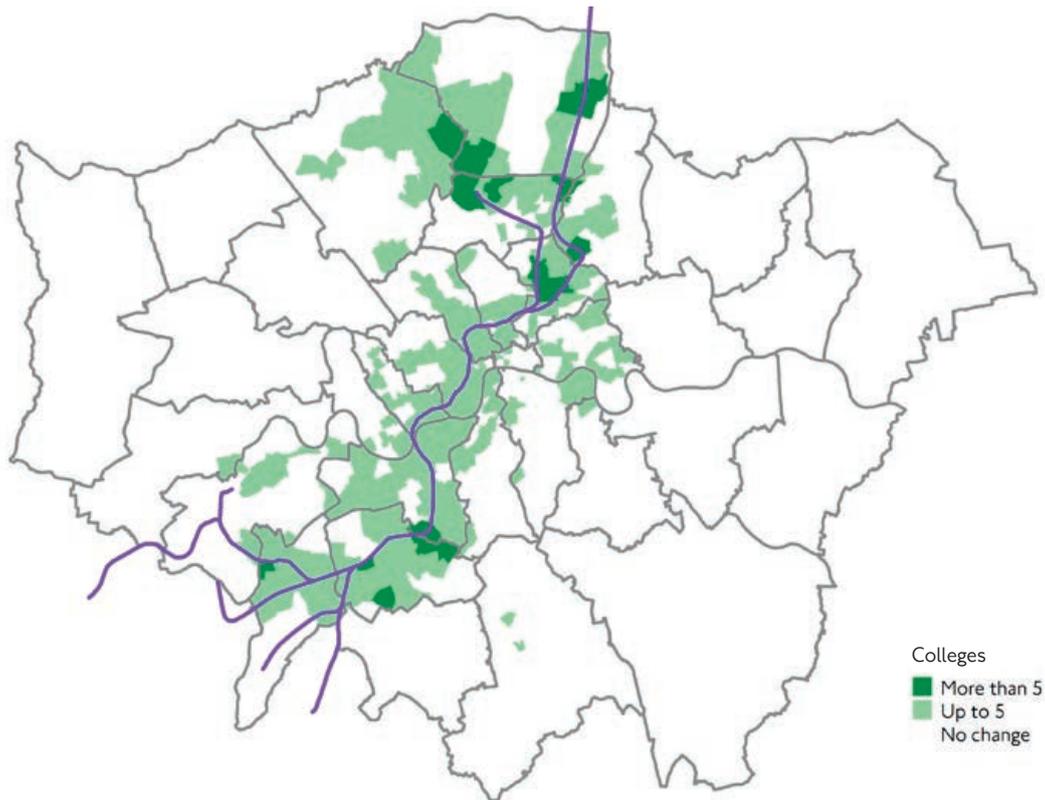


Figure 4.12: The impact of Crossrail2 on connectivity to further education colleges

In figures 4.13 and 4.14, the measure presented is the number of town centres that can be accessed by a 30-minute public transport journey. The two maps show estimates for 2007 and 2031, respectively.

Travel time maps were introduced in the previous chapter, but the following is a specific example where such maps form a type of catchment analysis.

Figure 4.15 shows the travel time to the nearest local town centre from anywhere in London. When getting further away from one town centre, travel times gradually increase but only until you approach another town centre. By presenting the travel time to the nearest centre, the shape of the catchment area of each centre becomes visible.

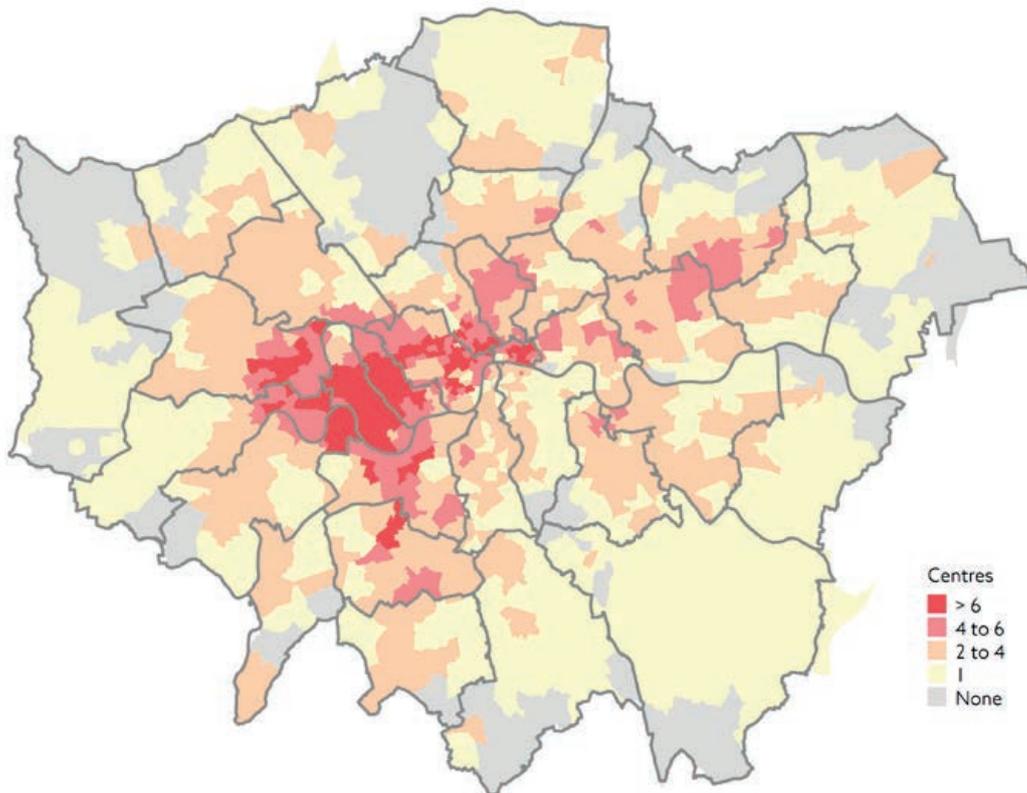


Figure 4.13: The number of town centres that can be reached in 30 minutes by public transport, 2007

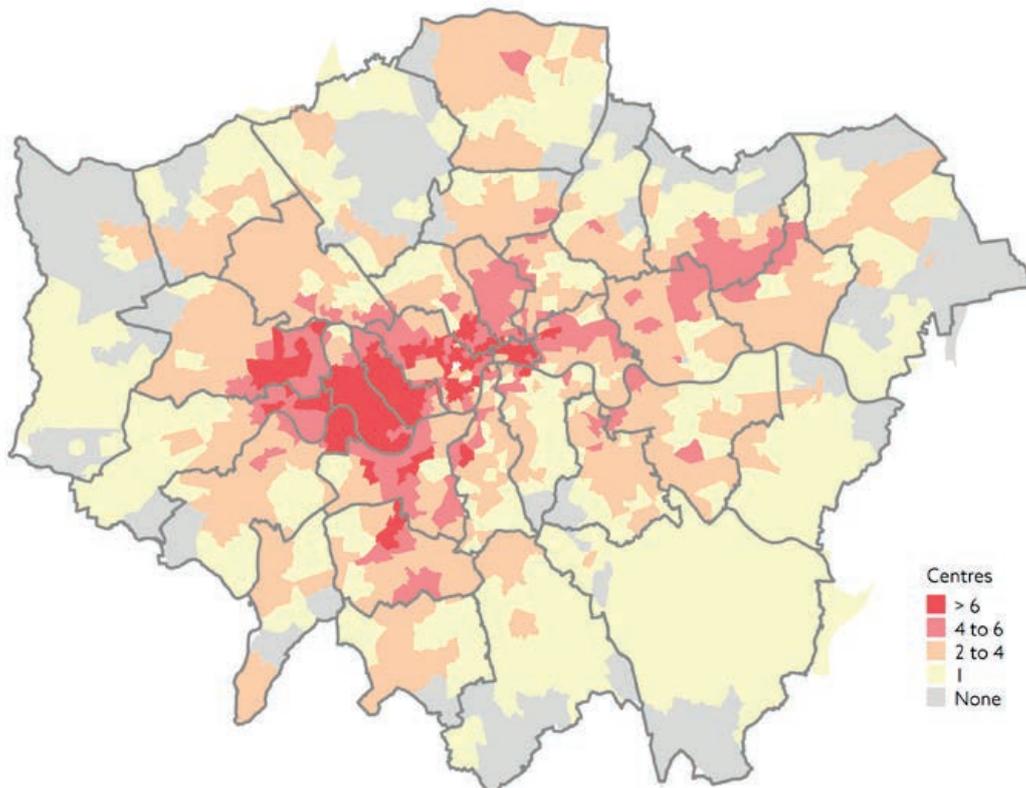


Figure 4.14: The number of town centres that can be reached in 30 minutes by public transport, 2031

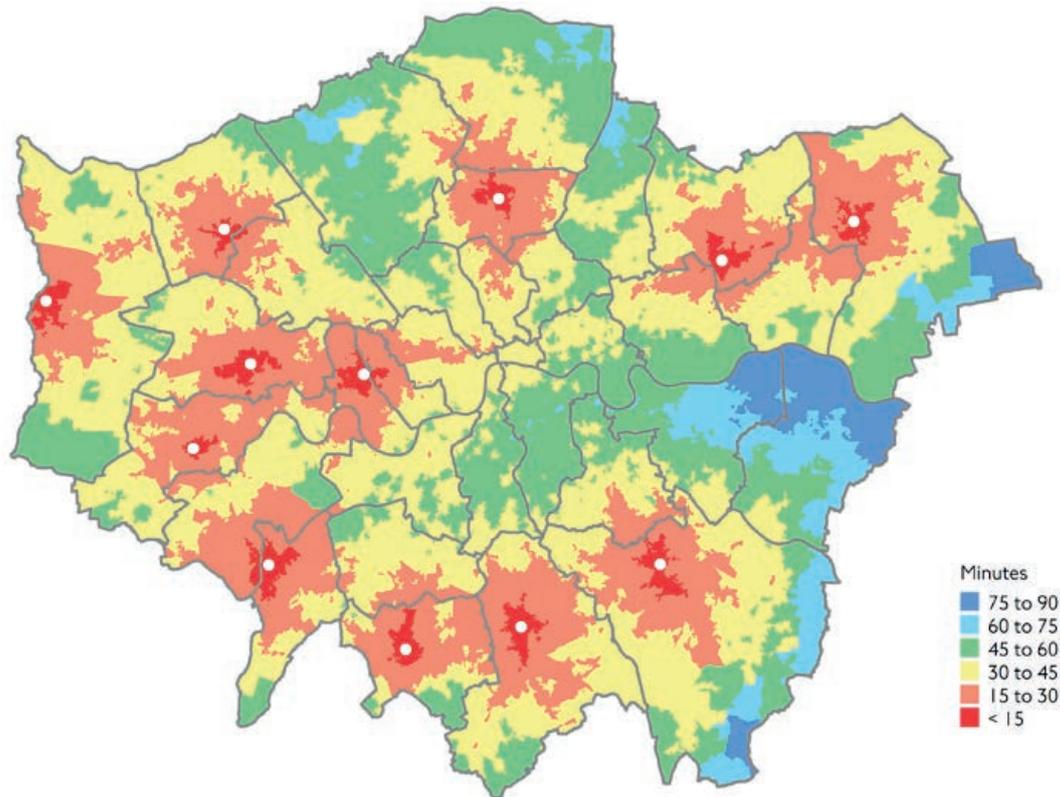


Figure 4.15: Travel time to the nearest metropolitan town centre

4.4 Calculating catchment statistics

The inputs to the preparation of catchment maps, and calculation of relevant statistics, include the following:

- Modelled travel time from all relevant origins to all relevant destinations in the study area. The travel times can follow either the TIM approach or the CAPITAL approach, presented in the previous chapter
- Information for each zone about the statistics we want to present: number of workplaces (figure 4.8), population (figure 4.6), colleges (figure 4.12), town centres (figure 4.15) and so on
- Specifying a specific location the map may focus on, which we consider as the origin or the destination of a journey, such as North Greenwich in figure 4.2

- Specifying the journey time threshold that specifies the boundary of the catchment area, for example a maximum of 45 minutes in figure 4.1

If we examine connectivity to a location, the value to plot in each zone on the map would be the total of the statistic of interest (for example population), added up across all zones from which travel time is below the selected threshold. If we examine connectivity from a location, the value to plot in each zone would be the total of the statistic of interest (for example workplaces), added up across all zones to which travel time is below the selected threshold.

5 Supporting your connectivity assessment

Our new Connectivity Assessment Toolkit, WebCAT, should be the primary toolkit to use for your connectivity assessment. It currently allows making PTAL and TIM queries. Catchment analysis features will be introduced to WebCAT later in 2015.

For advice on using WebCAT, or for help with studies of connectivity, please contact WebCAT@tfl.gov.uk

For advice regarding our strategic transport models, please contact StrategicModelling@tfl.gov.uk



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6 Glossary

Accessibility: A station or a service is accessible if it is suitable for people with a range of needs, such as wheelchair users or people with heavy shopping. In some places, the term accessibility is used to describe more generally how good transport is in different areas; at TfL we use the term **Connectivity** for this to avoid confusion.

ATOS: Access to Opportunities and Services. This is a measure that gives a score to different places based on how well they are connected to education, health and other types of services.

CAPITAL: Calculator of Public Transport Access in London. This is one of our methods for showing levels of connectivity using travel time mapping.

Catchment: The catchment area of a place includes all the locations that are easy to reach from that place. The catchment area of a service includes the locations where people are likely to use this service.

Connectivity: If it is easy to travel to or from a place then it has a good level of connectivity. We have different measures of connectivity, described in this document.

Frequency: The number of public transport journeys per hour on one specific route, or at one specific place.

Grid: A series of points with fixed distances between them. We sometimes cover a map with a grid of points and make different calculations for each point in the grid, so that we have these calculations for everywhere on the map.

HAMs: Highway Assignment Models. These are **models** that help us understand travel times by car between different parts of London. A separate document on the TfL website describes these tools.

Integrated Transport Network (ITN): A digital representation of all the streets, roads and junctions in Great Britain, which we use to create the maps described in this document.

London Plan: A document published by the Greater London Authority which contains the overall strategic plan for London for the period until 2031, including economic, environmental, transport and social topics.

Mayor's Transport Strategy: A vision which sets out how TfL and our partners will develop transport in London over the coming 20 years.

Mode: Buses, cars, the Underground, bikes and so on are all different modes of transport.

Model: Models (or transport models) are computer tools that help us estimate how the transport system will work, and how people will travel, in future situations. We have a range of transport models which are described in another publication on our website.

PTAL: Public Transport Access Level. This is a measure of connectivity to the public transport network, which is described in detail in this document.

Railplan: A **model** that help us understand travel times by all modes of public transport between different parts of London. A separate document on our website describes this tool.

SAP: Service access point. This is a term we use for the place that people walk to from the origin of their journey in order to start a trip by another mode. This could be a bus stop or station entrance.

Scenario: A version of the transport system which may or may not happen. London's transport system, with all the streets and routes that exist today, is one scenario. London's transport system in the year 2021, including the Crossrail route, is another possible scenario. For transport planning we often define different scenarios and do separate connectivity assessment for each one.

SEP: Service egress point. This is a term we use for the place that people reach by any mode of transport and then walk to the destination of their journey. This could be a bus stop or station entrance.

Step-free services: Public transport services that can be used also by people with limited mobility, such as wheelchair users.

TIM: Time mapping. This is one possible way of examining connectivity, which is described in this document.

WebCAT: Web-based Connectivity Assessment Toolkit. This is a new webpage, introduced by TfL in 2015, for the use of professional planners.

Zone: When we do analysis using **models**, we split the area of London into zones, and calculate travel times from each zone to each zone. One zone typically contains a few hundred buildings.





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