Changes in motor traffic inside London's LTNs and on boundary roads

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Abstract

This report is a systematic review and meta-analysis of traffic data presented in monitoring reports from 46 LTN schemes in 11 London boroughs which were introduced between May 2020 and May 2021. The analysis covers internal and boundary roads, looking at both actual changes in motor traffic, and what changes might have been expected based on background trends in London's three 'functional zones' (Central, Inner, and Outer). Both median and mean averages are presented. Medians give the middle value (a picture of what is 'typical'), whereas means are averages taken across all count sites, so incorporate the size of all increases or falls in traffic and give more of an aggregated picture.

All metrics show substantial declines in motor traffic on internal roads. 304 (74%, or three-quarters) of 413 internal road count sites saw a fall in motor traffic. At baseline, 59% (242 of 413) were carrying over 1,000 motor vehicles per day, but only 34% (140) did so post intervention. The typical (median) internal road went from carrying 1,226 motor vehicles per day before LTN implementation to carrying 666 motor vehicles per day following LTN implementation. Based on background trends one might have expected typical traffic to have fallen very slightly to a median 1,202 motor vehicles per day. A mean 'pre-LTN' traffic volume of 1,816 dropped to 964 'post-LTN'. Background trends would have predicted a small decline to 1,779.

By contrast, LTNs are on average only marginally associated with change in traffic volume on boundary roads. 82 (47%) saw a fall in motor traffic, and 92 (53%) saw an increase. Individual count points vary substantially, perhaps because of external factors such as high levels of development near to a specific count site between baseline and follow-up. In terms of averages, the median boundary road has similar before

and post-intervention actual counts (10,999 rising to 11,040, against an expected value of 10,523). Mean averages fell slightly, from 11,679 to 11,487 (expected value 11,405). This represents a 1.3% (+140 vehicles per day) median increase in actual traffic volume, which is 4.5% (+288) higher than what might have been expected (based on background trends). For mean averages, a 1.6% fall in actual volume (-192 vehicles per day) is 0.7% (+82) greater than the expected value.

Hence, LTN impacts on internal roads seem systematic and substantial. Boundary road averages changed little, although with substantial variation around these averages in either direction, much of which may be linked to non-LTN site-specific factors. Not all boroughs produced monitoring reports containing tabular data that we could use. More should do so, and there should be more public sharing of pan-London traffic count data to facilitate studies of LTN and other interventions.

Executive summary

This document is a systematic review and meta-analysis of local authority data on changes in motor traffic inside and on boundary roads of 46 Low Traffic Neighbourhood schemes (LTNs) introduced between May 2020 and May 2021 in 11 London boroughs. It seeks to establish impacts of these LTNs on motor traffic. It presents actual measured changes and compares these to background changes in traffic levels across the three London functional zones (Central Activities Zone, Inner, and Outer London). Mean and median averages and distributional plots are presented.

There has been much debate over LTN impacts on motor traffic, but so far, analysis has largely covered individual schemes or at most a small number of schemes. However, local factors such as roadworks, major schemes, building or utility works may substantially impact traffic changes in individual scheme areas or even boroughs, within typical monitoring timeframes. These other influences could skew reporting for any single LTN or group of LTNs close together. Aggregating data across London lets us 'average out' such skewing, so we can generalise about typical or overall impacts of schemes. Any scheme with qualifying data is included, as per the criteria below, increasing confidence in the results.

Our database of LTN schemes suggested that (excluding schemes in Redbridge and Wandsworth, removed soon after introduction) 96 were introduced between March 2020 and May 2021, and hence might have been expected to have monitoring data available. However, some schemes did not (yet) have monitoring reports published, and several boroughs had at the time of data collation (May-June 2022) published no traffic data for their schemes that we were able to use. To include a scheme in the meta-analysis, we needed spatially located traffic count data for at least one count point, for a specific 'pre' intervention month (January

2017 onwards) and at least one specific 'post' intervention month. For instance, we could not include schemes where baseline data was given as annual averages. Within reports that we were able to use, we excluded individual count points that had these kinds of data issues.

The resultant main analysis includes 587 count points with comparable 'pre' and 'post' intervention data, of which 174 were on boundary roads and 413 were on internal roads. Using the latest available 'post' intervention data, our analysis covers changes in actual count figures, and compares this to the change that might have been expected based on background monthly traffic changes. TfL provided us with data on estimated changes in average daily motor traffic volumes between January 2017 and June 2022, in relation to March 2019, for London's three functional zones. We used this to create a background change factor for each point's monitoring period (i.e., the proportionate change in typical daily traffic across the relevant functional zone, between the month of 'pre' monitoring and that of 'post' monitoring). This approach helps control for changes due not just to Covid-19 but also seasonality and other trends, although individual points may of course be affected by locally specific factors such as proximity to a development area.

We present three main measures: medians, the middle value which may be seen as the 'typical' change; means, which are averages across all data points and so incorporate the size of all individual changes (positive or negative); and distribution graphs to more fully illustrate variability in outcomes. As well as the main analysis of actual and expected changes, we conducted sensitivity analyses to explore how findings changed if, for instance, we removed individual boroughs from the analysis. These results are briefly commented upon in the main report, and presented in the Appendix. We also present further analysis of changes in the number of internal road count sites with low levels of motor traffic (here defined as less than 1,000 vehicles per day).

The analysis shows large relative falls in motor traffic inside the schemes themselves, particularly in Inner London. Across London, the median percentage reduction was 32.7% and the mean percentage reduction was 46.9%. Adjusting for expected changes in background motor traffic had little impact on this finding. The reduced traffic has led to a substantial increase in the proportion of monitored internal streets with under 1,000 motor vehicles per day. This may imply a qualitative change in the local environment on at least some such streets, given that other evidence has shown that people living in mini-Holland and emergency LTNs increase their walking and cycling. Conducting sensitivity analyses (e.g. removing one borough at a time) generally made little difference to these results, highlighting relatively consistent impacts.

Average motor traffic counts on monitored boundary roads changed relatively little, and again sensitivity analysis generally showed little impact on these findings. Average actual traffic volumes on boundary roads slightly increased (median change +140 vehicles per day, or 1.3%) or decreased (mean change -192 vehicles per day, or -1.6%), depending on whether median or mean averages are used. The difference between the median and mean reflects the tendency for falls in traffic on boundary roads to be larger than increases. When adjusted for expected changes, this became a 4.5% (288) median or a 0.7% (82) mean increase.

But while the overall picture on boundary roads is of little change, there is substantial variation in both directions, with many LTN boundary roads showing a much larger rise or fall in motor traffic than the median or mean values. We consider that large declines or increases in boundary road motor traffic are unlikely to be primarily caused by LTNs. They may instead point to the impact of individual contextual factors such as local major works, or the distinctive character of a specific road or area relative to wider background trends. The strength of aggregating across so many schemes is that such potentially exogenous factors can be ‘averaged out’ to aggregate overall impacts of LTNs in general across London.

These results suggest that LTNs have substantially reduced motor traffic on internal roads, without having much impact on motor traffic on boundary roads. However, many of the boundary roads may still be polluted, unsafe, and/or difficult to cross or cycle on. Removing LTNs is unlikely to help, but other measures could: for instance, low emission zones have already had substantial impacts on pollution levels, although more ambitious action is needed, like stricter and/or larger low emission zones. Further research could examine impacts of policies seeking to reduce motor traffic and/or its negative impacts on busier roads; for instance, city-wide traffic reduction and clean air measures, extensions of bus priority or cycling infrastructure, improved crossings, reduced speed limits and speed enforcement. Such measures, if effective, can complement and extend the benefits LTNs are having within their boundaries.

Our review also found that the extent, quality, and presentation of reports varied widely, suggesting a need for transport authorities to improve monitoring and evaluation practice. Most worryingly, some had not produced any monitoring and evaluation reports on LTNs that they had introduced. Additionally, regional and national authorities should collate and publicly share traffic count data to facilitate analysis of a range of interventions.

Introduction

About Low Traffic Neighbourhoods

Since the start of the Covid-19 pandemic, Low Traffic Neighbourhoods have been introduced in London, and to a lesser extent, other parts of England. LTNs are schemes that seek to reduce motor traffic in residential areas, using traffic management measures such as 'modal filters' that block through motor traffic while permitting walking and cycling. Modal filters can be camera-enforced (in which case, permitted motor traffic such as emergency vehicles may be exempted) or physical, potentially with un/lockable bollards, restricting access further. Sometimes measures such as short sections of opposed one-way streets are used to similar ends. Figure 1 below illustrates a Low Traffic Neighbourhood in South London introduced during the Covid-19 pandemic, showing on the left two 'traffic cells' (shaded in pink) with new modal filters (the white dots), and on the right one of the modal filters.

Figure 1: a Low Traffic Neighbourhood in Walworth, Southwark (South London)
Reproduced from https://findingspress.org/article/25633-impacts-of-2020-low-traffic-neighbourhoods-in-london-on-road-traffic-injuries

Newly introduced LTNs in London had within six months of the pandemic starting covered 4% of London's population (Aldred et al 2021). Hence a local intervention was introduced across the city on a relatively large scale, although only by some boroughs, and the rate of introduction has slowed since then. However, the design principle has precedents. The London Borough of Waltham Forest had introduced similar schemes pre-2020 as part of its 'mini-Holland' programme, and other boroughs such as Hackney have examples dating back to the 1970s. Smaller-scale examples, sometimes just single bollards or gates, exist across the UK and other countries as reactive measures to deal with specific local problems in one street. Housing estates both public and private often use such design principles, seeking to stop drivers from cutting through such estates from one side to the other. In the Netherlands, the principle is known as 'unbundling' and refers to the goal of separating motor traffic from people walking and cycling, to prioritise and reduce risk to the latter (Schepers et al 2013).

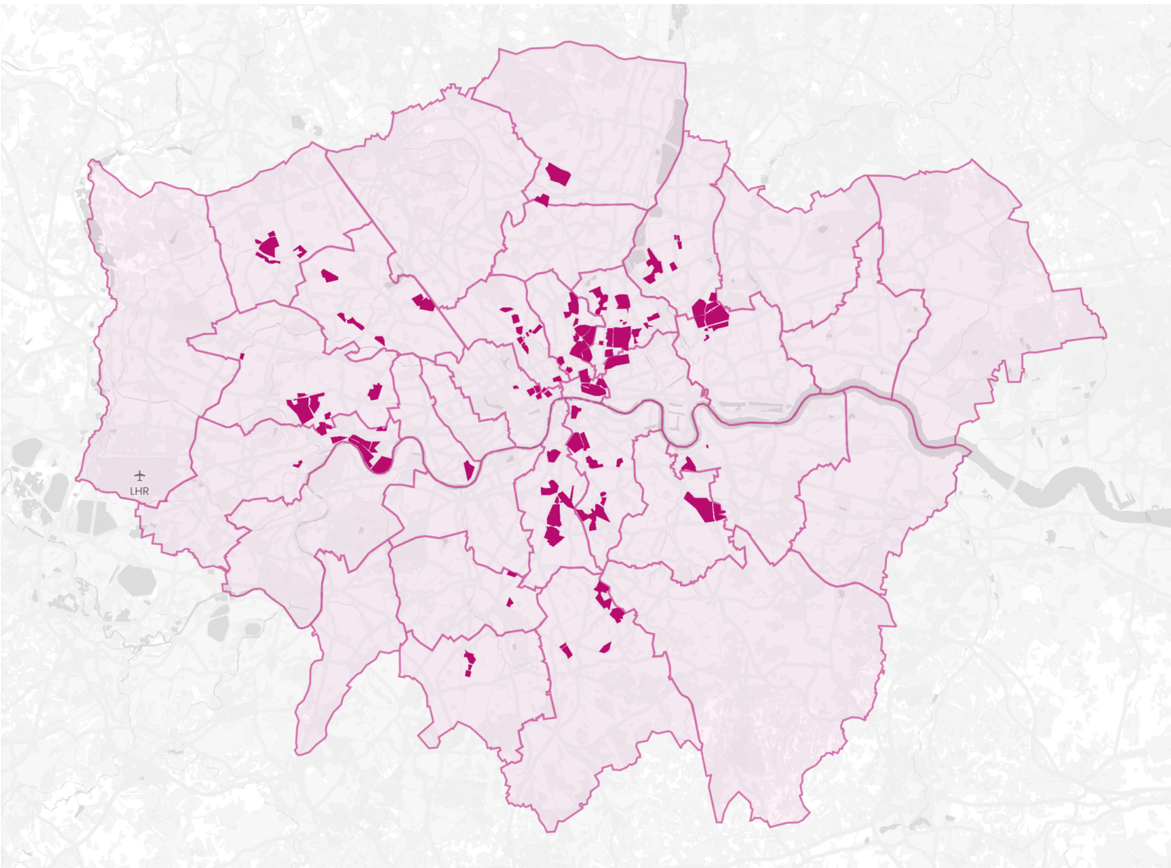

Figure 2: LTNs across London districts, implemented March 2020-March 2022.

Potential Benefits of Low Traffic Neighbourhoods

LTNs sit within a broader set of transport schemes that aim to reduce motor traffic and encourage mode shift away from cars. They seek to cut such traffic both on specific streets covered by modal filtering and within a wider area. There is increasingly academic evidence measuring the impacts of such schemes. Yang et al (2022) describe this as 'a growing and convincing body of literature making the case for cities to adopt traffic restriction strategies such as LTNs'.

Specifically related to LTNs in London, there is evidence from schemes introduced in Waltham Forest (Outer London) and from London's emergency LTNs. This suggests that Waltham Forest and/or emergency LTNs in London have (i) increased levels of walking and cycling among LTN residents (Aldred et al 2021; Aldred and Goodman 2020), (ii) reduced car ownership among LTN residents (Goodman et al 2020), (iii) reduced injuries and risk on roads in LTNs, particularly for pedestrians (Laverty et al 2020, Goodman et al 2021), and (iv) reduced street crime within LTNs (Goodman and Aldred 2021, Goodman et al 2021).

However, this evidence base sits alongside another growing set of literature highlighting challenges experienced by local authorities seeking to introduce such schemes and policies, with varying (but sometimes substantial) levels of public opposition to them. Hickman (2021) writes about LTNs in the West London borough of Ealing:

> "A well intentioned project, aimed at reducing traffic levels in suburban Outer London, had been poorly implemented and was perceived to have gone badly wrong. But this type of neighbourhood is exactly where traffic levels are too high and travel behaviours are environmentally unsustainable."

Some such opposition to traffic restriction measures (from LTNs to road pricing) is narrated around the ways in which they restrict the ability of people in general to use motor vehicles, i.e. a perceived 'freedom to drive'. However, other opposition is related to concerns about more specific potential disbenefits.

Potential Disbenefits of Low Traffic Neighbourhoods

While there exists growing evidence around benefits of traffic reduction measures they could, in unequal societies, have important disadvantages that may, at a minimum, require mitigating measures. For instance, road pricing may be environmentally-beneficial and equitable on a societal level, given the strong, positive relationship between car ownership or use, and income. However, depending on the scheme design and if implemented without mitigation, a charging scheme may cause hardship for some minority groups of car owners with few other options (e.g. low income older people in rural areas with poor public transport).

LTNs do not involve direct financial disincentives to driving, but seek to make it less convenient while making active travel more pleasant. Hence, many of the more worrying concerns about potential disbenefits of LTNs have centred on (i) possible journey time impacts on those with no choice but to drive (like some disabled LTN residents, whose journeys may become longer due to having to leave their neighbourhood through a different route), and (ii) impacts on LTN boundary roads which may see some traffic displacement from internal roads, leading to disbenefits (this could also have knock-on impacts on essential journey times). The present study does not directly cover changes to journey times, which is being examined within a longer-term separate project using Google API to gather information on estimated journey times based on live traffic data.

This report does cover an important possible cause of such delays: increased motor traffic and hence congestion on LTN boundary roads. As noted above, increased journey times for essential car users could be caused by their having to take a longer route (to avoid modal filters within a LTN). If so, this could potentially be addressed by exemptions, for instance for Blue Badge holders. This might even speed up these users' journeys if LTN streets became quieter. Some camera enforced modal filters already have such provisions, although this varies across London LTNs. Hammersmith and Fulham are unusual in exempting all borough residents from filters. More typically, boroughs may exempt users such as specialist school transport, emergency services, refuse vehicles, buses, and/or Blue Badge holders, carers or visitors to disabled residents from some or all camera-enforced filters. Exemptions may vary depending on the type of road. Hackney, for instance, will exempt Blue Badge holders from some traffic filters on distributor roads but not smaller residential streets.

Thus, for those deemed to be essential or priority car users, exemptions may mitigate any delays caused by having to take longer routes out of (or possibly through) LTNs. However, it is harder to mitigate possibly slower journeys caused by increased motor traffic and hence congestion on boundary roads, if these see traffic displacement. Motor traffic displacement to boundary roads could also lead to negative impacts for those living on - and using - these roads. Hence the importance of studying this issue.

One option is to measure possible disbenefits of increased motor traffic directly, rather than through (as here) proxies related to traffic volumes or delays. The papers referenced above on road injuries did not find displacement of injuries to boundary roads, which is encouraging, although repeating the analysis in future with more years of data available will provide more statistical power. Analyses of Waltham Forest and 'emergency' LTNs focused on fire response times found no detrimental impact (Goodman et al 2020, 2021). Yet (perhaps linked to the controversy ongoing about many schemes) 'objective' benefits do not necessarily translate into 'perceived' benefits. For instance, responding to calls in or near emergency LTNs, fire crews reported more delays due to 'traffic calming measures'. While entirely offset by a decrease in delays for other reasons, particularly 'traffic', this could lead to a perception of overall increased delays, despite response times showing that not to be the case.

More recently, Yang et al (2022) analysed three Islington LTNs, sourcing data from Islington Council on traffic and air pollution and using a difference-in-differences approach incorporating data from internal, boundary, and external roads. They concluded that the LTN implementation led to reduced pollution inside LTNs and on their boundaries, comprised of:

> “a statistically significant reduction in average NO2 across boundary and internal sites by 8.9% and 5.7% in comparison [to] external control sites [...] Our study provides evidence that LTN implementation can reduce NO2 and traffic volumes both within LTN boundaries, and also on LTN boundary roads.”

Yang et al could conduct this in-depth analysis as their paper uses detailed air pollution data provided directly by the local authority, rather than sourced from publicly available reports. It would represent a very large amount of work to source comparable data and conduct such analysis across a number of boroughs. Because of this, Yang et al’s paper analyses three LTNs in one London borough. While the results are encouraging, these schemes might be atypical of LTNs introduced across London; and/or impacted by other factors peculiar to that borough.

Another analysis was conducted as a relatively small part of a report for Centre for London, by Bosetti et al (2022). This drew on borough reports to comment on potential motor traffic displacement. It summarised information from monitoring reports from nine schemes on car traffic inside LTNs and on what are called ‘peripheral’ roads, and one report with data only on car traffic inside the LTN. The data is in the form of mean percentage change (by scheme, and by internal versus peripheral road); which if calculated as an average of percentages can mean that relatively small absolute changes skew results strongly positively or negatively; and attempts to summarise data across schemes would not account for the different sizes of schemes and hence potentially different number of data points. There does not seem to be any normalisation in the summarised reports to account for Covid-19, seasonal, or other changes. This means that as Bosetti et al state, it is hard to draw overall conclusions directly from them on LTN impacts on boundary road motor traffic.

Finally, a growing amount of research covers related types of scheme in Barcelona, Spain. A recent article by Nello-Deakin (2022) examined a set of road space reallocation schemes in Barcelona's Eixample district. While not exactly 'LTNs', these schemes were implemented at similar times to London's emergency LTNs and also involved substantial reallocation of road space away from through motor traffic, with related concerns expressed about traffic displacement. Nello-Deakin used open traffic data from the municipality covering intervention and other streets, generally in the form of monthly average traffic counts. This analysis found significant 'traffic evaporation' across the intervention area after accounting for background changes, with little changes on neighbouring streets (what we might call 'boundary roads' in the LTN context). Specifically, there was a very small relative mean traffic increase on neighbouring roads of 0.7% (median +3.9%). This differs from the more pessimistic picture of Superblock impacts in Rodriguez-Rey et al's modelling study (2022). That paper assumed in 6 of 7 scenarios that 'the number of total circulating vehicles will not change despite the measures implemented', i.e. making an a priori assumption that there would only be traffic displacement and no traffic evaporation. (The seventh scenario, which did assume overall traffic reduction of 25% as a result of and alongside Superblocks, tactical urban planning, and a Low Emission Zone, showed substantial air quality benefits).

This Report’s Contribution

Since Bosetti et al (2022) reviewed studies and literature covering London, an increasing number of individual reports on London LTN schemes have been published. Local authorities implementing LTNs are much more likely to monitor motor traffic than to monitor other transport-related outcomes such as bus journey times, cycling flows or (even more so) walking flows. This provides an opportunity to use what is a growing amount of data to draw more general conclusions about LTN-induced changes in motor traffic.

However, little work has been done so far to analyse this publicly available monitoring and evaluation data. One reason might be that the use and presentation of data and calculation of impacts (where provided) varies substantially, making synthesis challenging, especially where summary statistics are aggregated rather than providing individual count point data. Some scheme reports assess overall impacts based on percentage changes across all count points whether internal to the scheme or not; a few attempt normalisation but most do not; some use the same months for ‘pre’ and ‘post’ count points and others do not. More generically, given substantial fluctuation in traffic volumes generally, and the range of other factors (locally, nationally, and globally) affecting traffic counts in London, evidence from individual schemes or even boroughs makes it hard to draw wider conclusions about impacts of LTNs. Hence a robust meta-analysis is needed across as many schemes as possible, including attempts to control consistently for background changes.

In mid-2022, the Active Travel Academy was funded by KR Foundation as part of an ongoing project with the climate action charity Possible to conduct a systematic review of monitoring and evaluation reports as part of a wider programme of research. Our main research question was:

What does the evidence from existing monitoring and evaluation reports indicate about the impact that Low

Traffic Neighbourhoods have had on motor vehicle traffic, on both internal and boundary roads?

We began the study in May/June 2022 and completed it in November 2022. An academic paper based on the analysis has been submitted to a peer reviewed journal with publication likely in mid 2023. We would like to thank our partners and funders, TfL for providing data for normalisation, and boroughs that answered queries when we raised these. In addition thanks are due to Dr. Jamie Furlong, Dr. Anna Goodman, and Johara Meyer for commenting on aspects of the methodology, and to Dr. Jamie Furlong, Dr. Harrie Larrington-Spencer, Luuk van Kessel, Dr. Ersilia Verlinghieri, Dr. Tom Cohen, and colleagues at Possible for commenting on the clarity of the summary presentation. None of our partners, funders, or colleagues are responsible for the analysis conducted and views expressed in this report.

Methods

This report is based on a systematic review of London local authority LTN monitoring and evaluation reports. Accordingly, we have followed systematic procedures firstly to identify relevant reports, and secondly to assess which reports and finally which count sites could be included within a synthesis of traffic count data. The systematicity is a core strength of the method: we included everything that had usable data (on which see below), meaning that we were able to include reports from schemes in 11 boroughs. The data we have analysed is publicly available in the form of these reports. One important disadvantage of the method stems from that very publicness of the data - Yang et al (2022) were able to conduct more in-depth analysis because they had more extensive data sourced directly from one local authority. There is an inevitable trade-off between breadth and depth, and our report offers breadth.

Document Search

In May and June 2022 we systematically searched London local authority websites for monitoring and evaluation reports of all low traffic neighbourhood schemes from the 21 (of 33) London Local Authorities that were known to have installed LTNs since the start of the Covid period, which remained in for more than a short period of time (Redbridge and Wandsworth having installed LTNs but removed them soon afterwards). The search primarily used Google Advanced search tools; i.e. searching within local authority websites using LTN-related keywords, including the names and 'brands' used to refer to specific schemes or by specific boroughs (e.g. 'People Friendly Streets'). We had a pre-existing dataset of London LTNs introduced to date and were able to search for each individually.

In total we found 106 documents covering 69 LTN schemes from local authorities. Of these, 57 schemes had reports with both before and after data on motor vehicle traffic on boundary and internal roads or just boundary roads. For 46 of these schemes, traffic data was extractable for meta analysis (tabular data, with at least one internal or boundary road data point providing actual ‘pre’ and ‘post’ count data from a defined month from 2017 onwards, and the locations of count sites). The earliest of the schemes we could include was introduced in May 2020, and the latest in May 2021. See Figure 3 for an illustration of the search process.

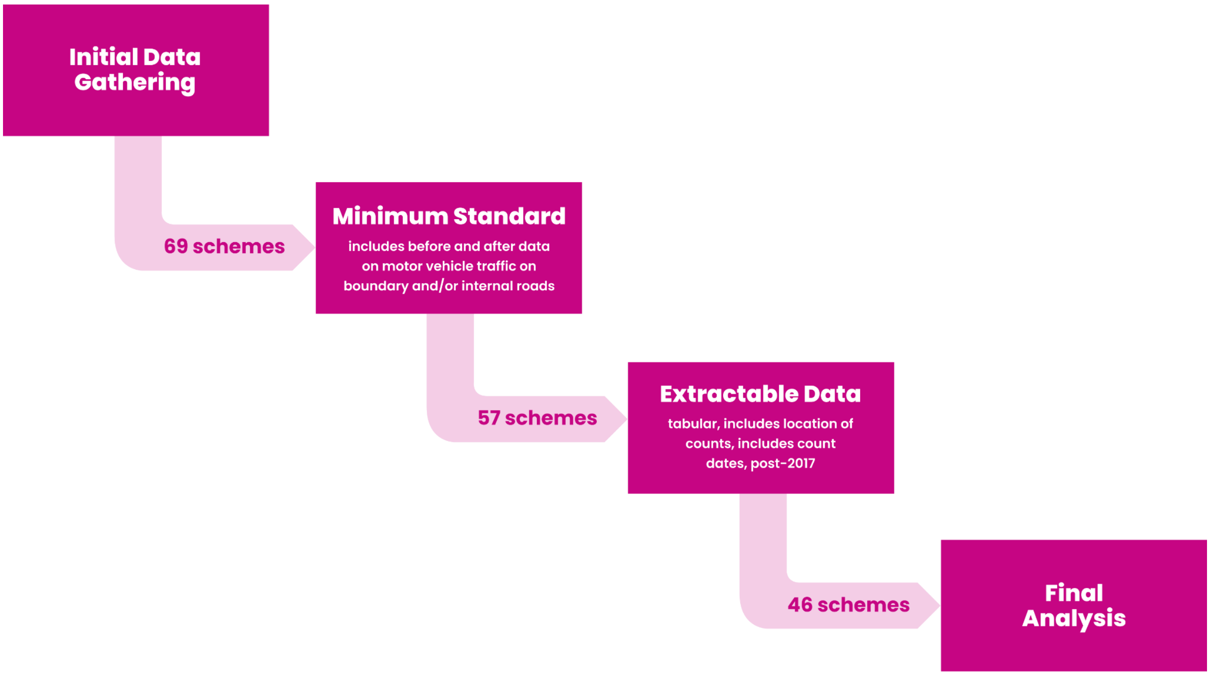

Figure 3: the systematic review, data extraction, and analysis process.

Data Extraction

The 46 schemes that we were able to include in this report were drawn from 11 different local authorities. From these reports, we extracted measures of raw pre/post changes in motor vehicle volumes. We extracted this data at the traffic counter level, recording the spatial location and whether the count point was indicated by the local authority as lying on a boundary road or within the area of the LTN[1]. We recorded all this information on spreadsheets and a GIS file linked by internally generated count point IDs, and held regular meetings between the two authors to discuss uncertainties or disagreement from borough classification. We checked data extracted for a sample of reports to ensure we had not made errors copying over data.

Count Sites

Across all 46 scheme reports that met our inclusion criteria, we found 641 count sites with spatial location data. Included in the 641 are count sites later excluded from analyses, for instance because 'pre' data for that site turned out to be an annual average, or a month could not be found. We removed a small number of sites where 'pre' baseline data was from before January 2017, as we considered pre-2017 data too old to use for this analysis (and that we were unlikely to obtain comparable data to calculate expected background trends).

Figure 4 demonstrates the lack of included count points in Central London. While both City and Westminster introduced some (albeit atypical) LTN-type schemes, we were unable to find reports for these with traffic count data[2]. Outer London is more sparsely covered than Inner London, due to a lack of monitoring reports available for some boroughs (e.g. Croydon, Merton), others not providing tabular count data in reports (e.g. Ealing), and Outer boroughs having been less likely than Inner boroughs to implement schemes in the first place[3].

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[1] In a minority of cases the type of road was not specified, with the counts displayed without this context. In these cases our own (ATA) LTN database was used as the basis for determining which category each count site fell into.

[2] Westminster's schemes were primarily aimed at supporting outdoor dining, so motor traffic reduction would not have been a main aim.

[3] As we are using TfL's Functional Zone classification which is based on the GLA definitions of Inner and Outer, Newham and Haringey count as Inner, and Greenwich as Outer London. ONS uses a different classification when analysing and presenting Census data.

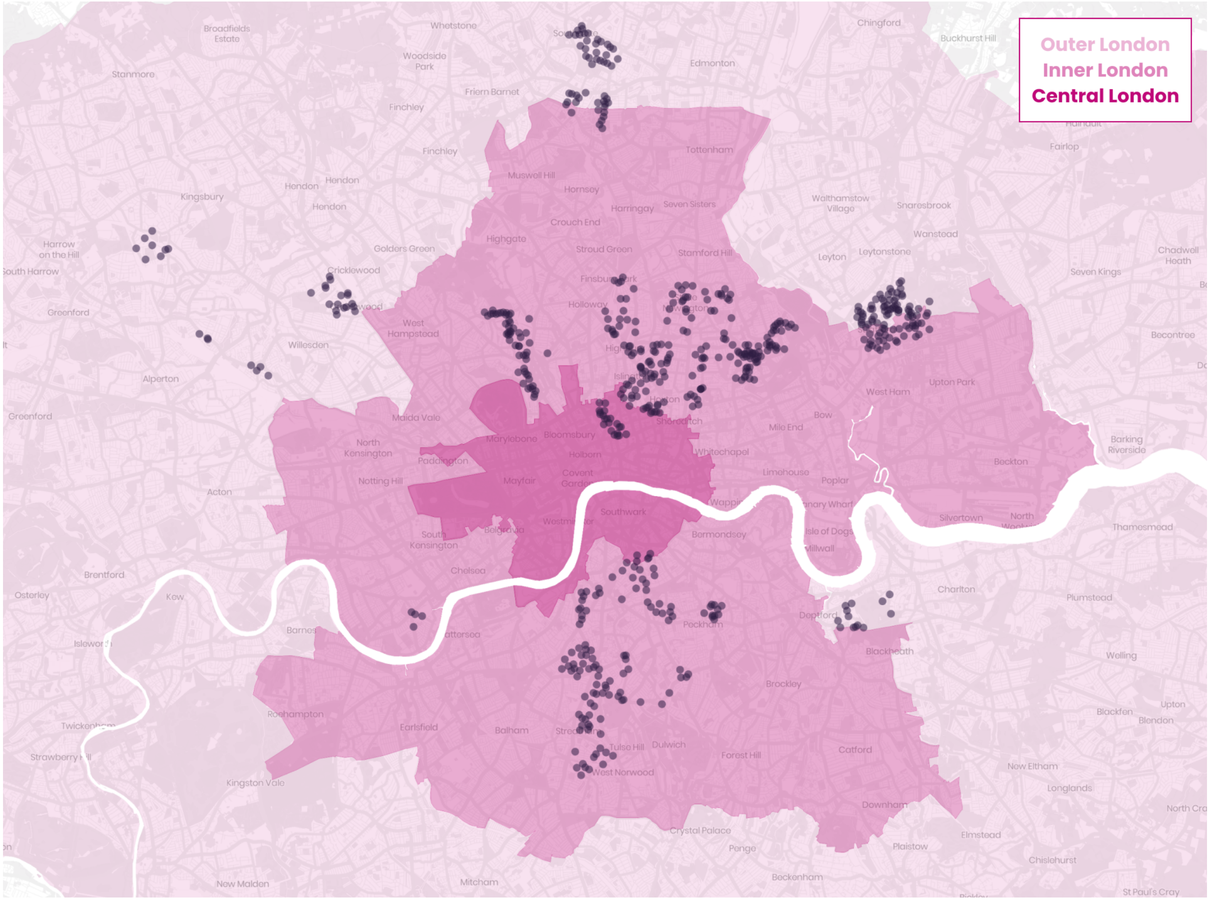

Figure 4: the location of the 587 count points included in the main analysis.

Within Inner London, the count sites tend to cluster North and North-East (Camden, Islington, Hackney), and South-Central (Lambeth, Southwark). The exceptions are a few count sites in Hammersmith and Fulham, a small number at the very North of the Inner Zone, forming part of Enfield's Bowes Quieter Neighbourhood monitoring, and some further East as part of two Newham schemes bordering Waltham Forest.

Selecting data for main analysis

From an initial 641 points we had to remove 40 points (6%) due to data issues, i.e. lack of a valid 'pre' and/or 'post' count date including a month. (For instance, some schemes had one or several points where an annual average was used as a 'pre' figure rather than a specific month). Some minor data issues were also identified (such as using 5 day counts as opposed to the typical 7 day average). These were included in the main analysis, but marked for exclusion during a sensitivity analysis.

We cross-checked local authority classifications against our own (Active Travel Academy; ATA) dataset of LTNs, filters, and boundary roads. This contains the locations for each traffic filter forming part of London's post-March 2020 LTNs. As part of creating this database, we had identified 'LTN areas' consisting of street sections which could expect substantial motor traffic reduction, as well as locations of possible displacement onto boundary roads. This dataset was a useful resource for cross-checking, although in doing this we bore in mind that it generally takes a stricter definition of an 'LTN area' than do borough reports. The ATA map was developed for analysis specifically trying to identify streets that were effectively newly closed to through motor traffic, whereas boroughs are often trying to identify and monitor changes in a larger contiguous 'traffic cell' (even if some streets within it were already quiet and unlikely to see a further reduction, for instance).

After this cross-checking, we removed 14 additional points (2%) from our main analysis, as following checking by two reviewers we were confident that these lay outside the scheme area of influence. Nine were originally classified by a borough as a boundary road and five as internal roads. However, they represented points which did not seem to us either subject to potential traffic displacement, nor to be within the traffic cell of a scheme.

This left us with 587 points from the 46 reports that could be included in the analysis. These used a variety of 'pre' and 'post-intervention' months, taking the latter as being the latest available monitoring point where more than one was provided. Baseline counts were taken between January 2017 and May 2021; while post-intervention counts were taken between July 2020 and February 2022 (Table 1).

Table 1: dates of baseline and post-intervention counts.

Year and month	Baseline counts
2017-01	22
2017-03	1
2017-11	1
2017-12	2
2018-02	1
2018-05	1
2018-07	9
2018-10	48
2018-11	2
2018-12	1
2019-01	2
2019-02	46
2019-03	56
2019-04	3
2019-05	9
2019-06	28
2019-07	3
2019-09	13
2019-10	13
2019-11	37
2019-12	19
2020-01	6
2020-02	2
2020-03	4
2020-06	18
2020-07	60
2020-08	52
2020-09	32
2020-10	31
2020-11	44
2021-05	21
Total	**587**

Year and month	Post-intervention counts
2020-07	1
2020-09	4
2020-12	29
2021-02	9
2021-04	22
2021-05	99
2021-06	60
2021-07	69
2021-09	90
2021-10	121
2021-11	33
2021-12	22
2022-02	28
Total	**587**

From these 587 count points, 174 (30%) were boundary road count sites, and 413 (70%) were internal road count sites. Of these, we had ourselves reclassified 14 (2%) between boundary and internal, only done where (i) there was disagreement between our mapping and the borough mapping and (ii) upon double-checking and discussion, we believed that the borough had made an error. Of these, one was reclassified from boundary to internal, and 13 reclassified from internal to boundary. To assess the impact on our findings of the difference between the borough and ATA definitions of boundary vs. internal roads, the latter has been recorded for each count point for use in a sensitivity analysis.

Calculating Background Trends

We obtained data from TfL to allow us to calculate background trends month-by-month, and hence, estimate the change that might have been expected to occur anyway in that area, if no scheme had been implemented, between 'pre' and 'post' intervention months. These data were geographically disaggregated by the Central Activities Zone, Inner London, and Outer London (Figure 5), which each have different traffic characteristics - and which showed different trends in terms of traffic volumes during Covid times and indeed longer term.

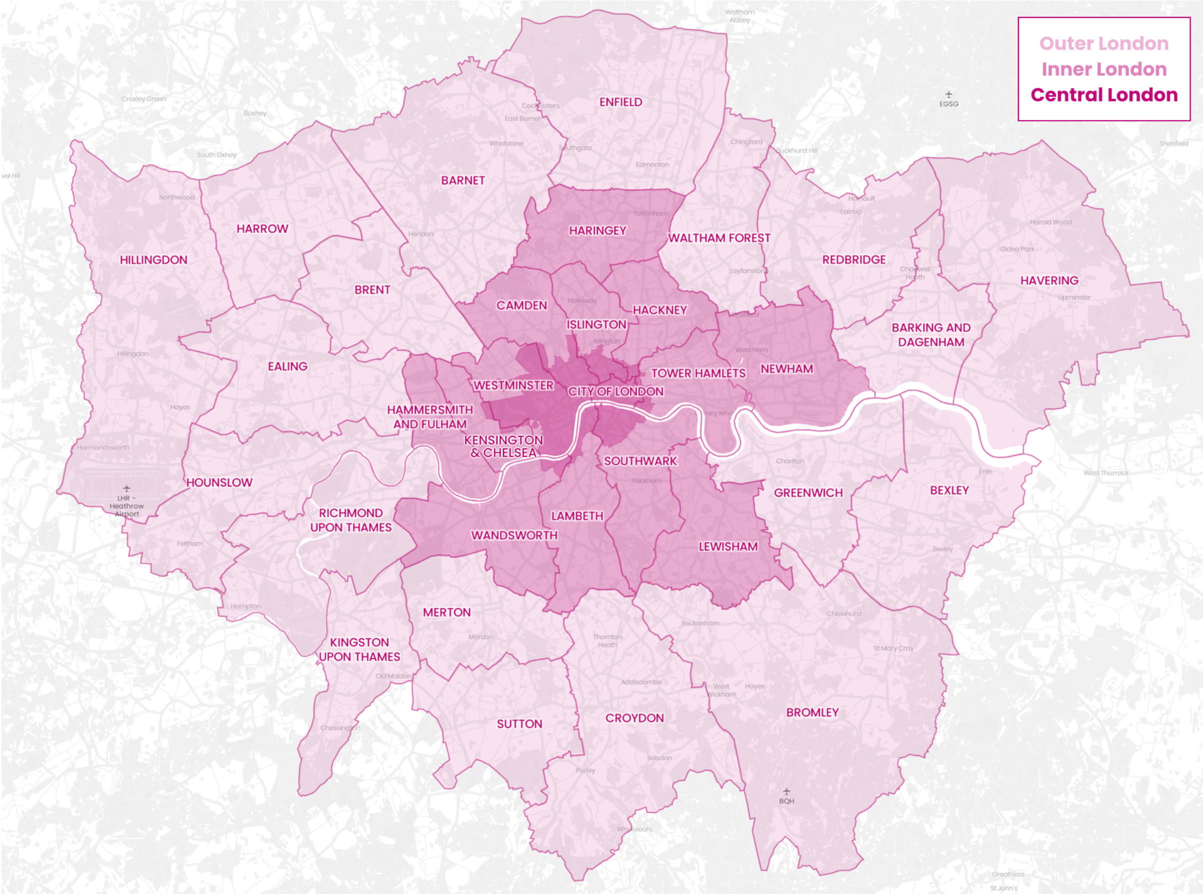

Figure 5: London districts and the three London 'functional zones'.

The TfL dataset on traffic trends covered January 2017-June 2022, showing the typical percentage difference between average daily motor traffic in that functional zone and that in March 2019. Thus for instance, in March 2021 the figure for Inner London was -19%, meaning that average daily motor traffic was 19% less in March 2021 than in March 2019. We initially turned these figures into percentages (and associated ratios) of motor traffic in March 2019. Where average daily motor traffic is 19% less than in March 2019, this is 81% of the March 2019 figure, or a ratio of 0.81 to 1. These percentages were used as 'adjustment factors' as explained below.

Figure 6 shows the fluctuation between January 2017 and June 2022 in typical daily motor traffic levels as a percentage of March 2019 levels. As well as large Covid-era changes for Central areas in particular (less sharp and less sustained for Inner or Outer London), it shows seasonal variation across all zones.

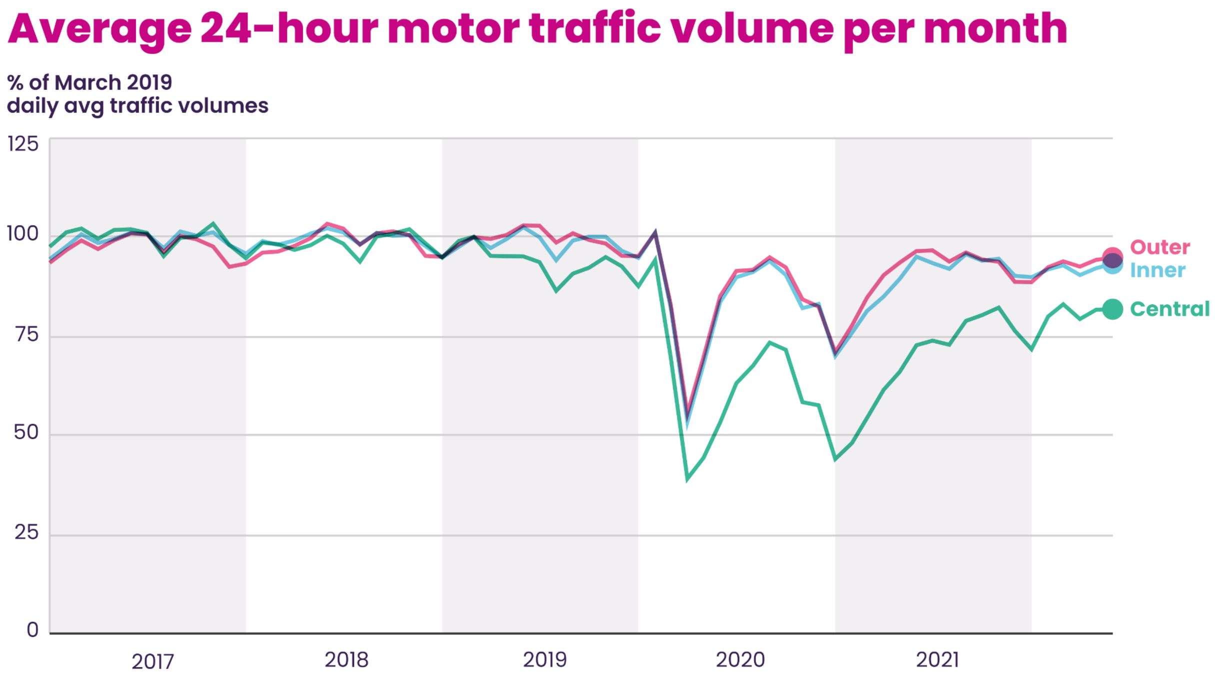

Figure 6: typical daily motor traffic levels as a percentage of March 2019 levels.

We used this dataset to calculate expected average daily motor traffic flows for each count site at the post-intervention point, based on the background trends experienced in its functional zone between baseline and post-intervention month. We did this by dividing the adjustment factor for the post-intervention date by the adjustment factor for the baseline date and then multiplying the resultant background trend factor by the observed baseline flow.

$$Expected\ Flow\ = \left(\frac{Post\text{–}Intervention\ Adjustment\ Factor}{Baseline\ Adjustment\ Factor}\right) * \ Baseline\ Flow$$

For instance, for a count site with a Baseline Flow of 1,000 in Inner London, a Baseline factor of 98% and a Post-Intervention factor of 81%, the Expected Flow would be (81/98)*1000, or 827. This means that based only on background trends in that functional zone between the baseline and post-intervention month, which in this case showed a decline, we would expect the count to have changed from 1,000 at baseline to 827 at follow-up.

The Expected Flow can then be subtracted from the actual post-intervention flow to calculate the difference between observed and expected traffic levels. These figures allow us to estimate deviation from the background traffic fluctuation that might be expected in each count point's particular functional zone (Central, Inner, Outer), between the 'pre' and 'post' intervention count months.

Strengths and Limitations

We consider this to be a substantial piece of work contributing to knowledge about how LTNs may affect motor traffic flows, both within LTNs and on boundary roads. Meta-analysing 46 schemes from 11 boroughs provides a broad coverage and includes some schemes that have since been removed (e.g. Hills and Vales, Greenwich) as well as many still in place. However, there are inevitable limitations:

Scheme factors

- **Limited geographical coverage.** This report only covers London, with most count points in Inner London, followed by Outer London, then the Central zone. Hence the findings can most confidently be applied to London, and within that, to Inner London.

- **Data gaps are not random.** While we found data issues across boroughs (e.g. the use of annual averages or data from a different but nearby site for some points, where pre data was lacking), some boroughs either did not provide any reports at all, or provided them without spatially located tabular count data. Hence we cannot include schemes from Tower Hamlets or Ealing, for instance.

- **Co-occurring schemes and other factors.** During this period, Covid-19 and other non-transport issues affected traffic flows in London, as did ongoing major schemes such as gyratory removal. Our comparison of change to background trends should help control for such other factors across schemes[4]. We caution against drawing conclusions from individual points or schemes in our analysis, or even a whole borough's schemes, due to the possibility that these might be affected by factors that cannot be controlled by applying functional zone trends. By focusing on aggregated or typical results from schemes across functional zones, this problem will be substantially reduced. However, it is still possible, for instance, that in general LTNs tend to be co-located with or near to other interventions, such as cycle tracks, and that some of any effects found here may be due to these.

Data issues

- **Known issues with data quality.** Usually, automatic traffic counts (ATCs) were used to monitor traffic, mostly 'tubes' across the road (in a small minority of cases less accurate radar is used, and in another few, more accurate machine learning sensors). These are not perfect, particularly for cyclist monitoring, although we are here only using motor vehicle data. Still, parked or very slow moving motor traffic may affect the results; although in most cases, count sites are placed away from junctions where queueing is likely, which should reduce this problem. Data problems due to car parking may be more an issue on internal residential roads than on boundary roads. Adjusting for expected changes should help control for such bias as the data used is also largely based on ATCs. However, the data is not perfect (it is possible that changes of a few percent are well within the relevant margin of error, and in fact no change can be concluded)

[4] Individual schemes may be affected in different ways by Covid-19 (and other) trends, for instance, depending on whether a scheme is close to a large hospital or an office district - hence the importance of aggregation across schemes and boroughs to reduce the impact of such individual variation.

and this should be borne in mind. In future, authorities may use more accurate datasets, which will improve the quality of evidence.

- **Unknown problems with data quality.** We have not accessed data directly from counters but used the summaries of this data provided for individual count points (usually, 24-hour 7-day average flow, as used in the background trend figures provided by TfL) in published reports. It would have been unfeasible within time and budget to have requested, cleaned, checked and analysed raw data from nearly 600 counters from 46 schemes. However, it is possible that authorities or contractors have made errors (in one report a clearly wrong count was given for one site, for instance, and as this report was being finalised questions were raised about errors with data from one scheme in a different borough). We believe that a small number of undetected errors should not bias the overall results, and have conducted sensitivity analyses excluding individual boroughs to assess if any one borough's exclusion would substantially change the results.

Analysis issues

- **Limits of background trend analysis.** The data used for this separates London into three functional zones, which is much better than using Greater London as a whole. However, it is still a broad brush distinction in terms of geographical area (and in being in the form of monthly averages); especially for Central London where we only have 33 count points, but also in Outer London. The data collected by TfL tends to be on larger roads, and hence, background trend estimation may be less accurate for internal than for boundary roads. As with borough data, it is largely but not entirely based on ATC data. Therefore, the process is not perfect, although it makes only a small difference to the results overall, probably because boroughs tried to avoid use of count data collected when Covid measures were at their peak and fluctuations greatest.

- **Limitations in what one can conclude from motor traffic counts.** Motor traffic, measured as a daily average, does not correlate in a simple linear fashion with congestion, air and noise pollution, injuries and so on; although in general reduced motor traffic may improve the environment in a range of ways and vice versa. Moreover, interpreting changes is always subjective. We believe that a shift from over to under around 1,000 motor vehicles per day may be transformative, as suggested in Manual for Streets, but that this is not necessarily guaranteed and may also depend on street design, vehicle speeds, and other factors; and that the '1,000 motor vehicles' is a somewhat arbitrary (although frequently used) cut-off. Similarly, the typical (median) and aggregated average (mean) changes on boundary roads that we have found are - we believe - small (some likely to be within margins of error), but they are not zero.

Boroughs and Schemes included in the study

Boroughs

Table 2 provides a high-level summary of boroughs with schemes that we could include in the study.

Table 2: Summary of boroughs and schemes.

Borough	Schemes included	Comment
Barking and Dagenham	0	No LTN schemes as defined by us in this period.
Barnet	0	No LTN schemes as defined by us in this period.
Bexley	0	No LTN schemes as defined by us in this period.
Brent	5	Reports with traffic data found for all schemes introduced.
Bromley	0	No LTN schemes as defined by us in this period.
Camden	5	Reports available for most schemes introduced during this period.
City of London	0	We did not find any scheme reports containing traffic data at time of collation. (City introduced two LTN-type schemes as we defined them, although these were atypical given the largely non-residential nature of City).
Croydon	0	We did not find any scheme reports containing traffic data at time of collation. (Five LTN-type schemes were introduced during the period, although later removed).
Ealing	0	We found six reports on Ealing schemes introduced during this period (most later removed); however, these did not contain tabular data that we could use, only graphs

		and/or summary comments.
Enfield	2	Reports found for both LTN-type schemes introduced during this period.
Greenwich	1	We found a report for one of the two Greenwich LTNs introduced during this period. This has since been removed.
Hackney	11	Reports containing usable traffic data found for almost all the Hackney schemes introduced during this period.
Hammersmith and Fulham	1	The only LTN-type scheme introduced by the borough in this period.
Haringey	0	No LTN schemes as defined by us in this period.
Harrow	0	We found three reports related to four Harrow schemes; however, these lacked pre-post vehicle count data. Internally, the borough used filtering points as count sites and assumed that no motor vehicles passed these following scheme implementation, while boundary road traffic was monitored via queue length surveys and hence was not comparable with other data.
Havering	0	No LTN schemes as defined by us in this period.
Hillingdon	0	No LTN schemes as defined by us in this period.
Hounslow	0	No suitable reports available at time of collation. While borough-wide reports covered seven schemes, these did not contain pre-post figures for individual sites (but rather graphs and/or averages).
Islington	6	Reports found for all but one scheme introduced during the period (this was not installed until February 2022).
Kensington and Chelsea	0	No LTN schemes as defined by us in this period.
Kingston	0	No LTN schemes as defined by us in this period (several modal filters were introduced but we had considered these to affect individual streets rather than areas).

Lambeth	5	Reports found with traffic data for all LTN schemes introduced.
Lewisham	0	No suitable reports available at time of collation. A report on Lee Green (introduced, then later scaled down) did not contain a map indicating locations of count sites so this was not included.
Merton	0	We did not find any reports containing traffic data for the two Merton schemes at time of collation.
Newham	2	We found reports with traffic data for two of the five Newham schemes introduced during this period.
Redbridge	0	No LTN schemes as defined by us in this period (schemes were removed without sufficient time for 'post' monitoring).
Richmond	0	No LTN schemes as defined by us in this period.
Southwark	5	We found reports for all but one LTN scheme introduced by Southwark during this period.
Sutton	0	We did not find any scheme reports containing traffic data at time of collation (Sutton had one scheme, since removed).
Tower Hamlets	0	We did not find any scheme reports containing traffic data at time of collation. Tower Hamlets had two LTN-type schemes (as defined by us) introduced during this period, which remain at the time of writing.
Waltham Forest	3	Out of eight schemes that were introduced during this period, three scheme reports with traffic data were found. An additional report covers a joint scheme with Waltham Forest, and is accounted for above under Newham.
Wandsworth	0	No LTN schemes as defined by us in this period (schemes were removed without sufficient time for 'post' monitoring).
Westminster	0	We did not find any scheme reports containing traffic data at time of collation. (LTN-type schemes existed although these were atypical as largely focused around restaurants/'streateries', and seasonal).

Schemes

Summary of count sites per borough

Table 3 shows the number of boundary and internal count sites included for each borough, and indicates where we have changed a classification from internal to boundary or vice versa. In all cases except one, this change involved our reclassifying a road the borough had classed as internal as a boundary road. Only one in Hackney, on Downs Road, was classed by the borough as a boundary but reclassified by us as an internal count point.

Table 3: Count site numbers per borough by road type, as used in main analysis.

Borough	Total	Boundary	Internal	Changed from Borough definition
Brent	32	12	20	2
Camden	53	10	43	0
Enfield	50	8	42	0
Greenwich	13	5	8	1
Hackney	125	44	81	8
Hammersmith and Fulham	4	4	0	0
Islington	91	31	60	0
Lambeth	78	18	60	1
Newham	16	7	9	0
Newham/WF	34	6	28	0
Southwark	45	20	25	2
Waltham Forest	46	9	37	0
Total	**587**	**174**	**413**	**14**

Schemes by borough

Brent

Five reports on schemes included. These were introduced in September 2020 with all but one (Stonebridge) removed following a council decision in January 2022. These are:

- Preston Healthy Neighbourhood
- Tokyngton and Wembley Central Area Healthy Neighbourhoods
- Stonebridge and Harlesden Area Healthy Neighbourhood
- Olive Road Healthy Neighbourhood
- Dollis Hill Healthy Neighbourhood

These reports were all fairly straightforward with a small number of sites using ATCs and no attempt to normalise, although the count metrics varied (e.g. some were 5-day). Most reports contained the comment that the schemes had not been enforced, and that this might affect the results. One (Tokyngton) seemed to contain some incorrect data for one of the points (a boundary road). Several count sites were classified differently to the borough in the main analysis we conducted, where we disagreed over the status of a road hosting a count site.

Camden

Five schemes included, all at the time of writing still in place. Most of these are relatively detailed reports (e.g. including air quality data, sometimes pedestrian data), and some contain normalised as well as raw figures. Usually but not always, ATCs were used (machine learning sensors were used in some cases). Not all the reports clearly distinguished boundary and internal roads (rather referring to a 'scheme area') and for the two that did not, we based our classification on our own dataset. For the other three, we used the borough classification in the main analysis where we differed (which was largely due to our tighter definition of LTN area).

These schemes are

- Arlington Road Area
- Camden Road
- Constantine and Savernake Road
- Kentish Town
- Queen's Crescent

We found three other reports (Covent Garden North, Rochester Terrace, and Prowse) but these had data issues affecting our ability to include them.

Enfield

Two schemes included, both still in place (Bowes Quieter Neighbourhood and Fox Lane Quieter Neighbourhood). Both used ATCs. For Fox Lane, we were in agreement with the borough as to how to classify count points (as internal or boundary). For Bowes, the borough had designated a larger area than we had as constituting the LTN, hence this had additional boundary roads and internal roads. We have used the borough definitions in the main analysis. Both reports used 5 rather than the more usual 7 day averages. At the time of finalising the report questions were being raised about contractor errors in data relating to one of the two Enfield schemes (Fox Lane). Our sensitivity analysis shows that removing Enfield from analysis makes virtually no difference to results, in any case.

Greenwich

One scheme was included, Hills and Vales (since removed). ATCs were used and of the 16 count points, in the main analysis we changed one from internal to boundary (in line with ATA mapping) and three count points were judged external in that we thought motor traffic levels were unlikely to be positively or negatively affected by the scheme.

Hackney

We were able to include data from eleven schemes from Hackney out of twelve for which we initially found reports (Elsdale St/Mead Place, Hackney Downs, Haggerston, Homerton North, Homerton Station, Hoxton West, London Fields, Marcon Place, Shore Place, Walford Road and Wayland Avenue). The twelfth, an early monitoring report on the Stoke Newington LTN, lacked comparable data and/or locations.

With so many LTNs introduced, the monitoring picture is more complicated than in most other boroughs (for instance, a boundary road for one scheme later became an internal road in another). Hackney's monitoring reports varied from short summaries to much more detailed reports incorporating analysis of consultation responses, discussion of wider literature etc. Mostly, ATCs were used although in some cases the borough used machine learning sensors. In some cases we had to exclude count points where baseline data referred to annual average flows (rather than specific months). In some of the reports (e.g. Hackney Downs) we reclassified a minority of sites between internal and boundary based on our own mapping, where we felt confident our classification was correct.

Hammersmith and Fulham

The SW7 scheme was characterised in our earlier distributional analysis as being a borderline LTN (due to wide-ranging resident exceptions applying to all living in the borough). A report is included which has pre-post data from seven sites although two we considered external not boundaries (these also had only estimated data).

Islington

Six schemes are included (Amwell, Canonbury East, Canonbury West, Clerkenwell Green, Highbury, and St Peters). These are relatively lengthy reports that tend to follow a similar format and to include traffic alongside other data (e.g. crime, air quality). Traffic is generally measured using ATCs and we used borough definitions of internal and boundary roads.

Lambeth

Five schemes are included (Ferndale, Oval, Railton, Streatham Hill, Tulse Hill). Each scheme has multiple report documents, and the borough provides normalised alongside raw figures for each scheme. Often multiple follow-up dates are included. Usually the data comes from ATCs (in a few cases radar, for instance) but in some cases data from the software company The Floow (sourced from black boxes installed in cars at the demand of insurance companies) has been used alongside count data on nearby roads to impute 'pre' data.

Newham

Two schemes are included, these being Maryland and Odessa on the boundary with Waltham Forest. Seven-day daily averages from ATCs were used in most cases. The reports use 2018 figures for 'pre' saying that they are most typical, but also caveat that general traffic changes in the borough have been higher than in comparator boroughs since then due to Olympic legacy-related development. This may result in boundary road motor traffic growth in particular.

Southwark

Five schemes included (Brunswick Park, Dulwich Village, East Dulwich, North Peckham, Walworth). These generally used ATCs although in some cases radar or video counts were used. In a couple of the schemes several count points were reclassified in line with ATA definitions where we believed we were correct. Two schemes had conducted partial normalisation to a month in 2019, which we treated as if the count were taken then; these have been excluded in the 'Non Standard Counts' sensitivity analysis.

Waltham Forest

Three schemes (Langthorne, Montague, Woodhouse) included plus an additional one is a joint scheme with Newham (Odessa). These were fairly straightforward with ATC count data and no disagreements over how to classify points.

Analysis

Main Analysis

Our main analysis presents before and after changes for (i) internal and (ii) boundary roads, providing both actual changes and changes relative to background change in the relevant functional area of London. In other words, it separates traffic changes inside and on the boundary of LTNs introduced between May 2020 and May 2021 in London (for which data was available) from changes that might have anyway been expected over the relevant monitoring period in that functional area. The main analysis:

1. Uses the latest 'post' intervention monitoring data available where schemes have multiple 'post' data collection points, as representing impact after a scheme has 'bedded in' rather than soon afterwards.

2. Uses in almost all cases borough definitions of whether a count point is 'internal' or 'boundary', except in a small minority of cases where we believe the report has made an error (where a report does not clearly classify count points as internal or boundary, we used our own definitions, but with a wider definition of 'internal' than used for our equity analysis, where we had sought to identify only streets with newly restricted traffic rather than those within the wider traffic cell[5]).

3. Presents both actual changes and changes adjusted to account for Covid-era and other longer-term and seasonal changes, as measured

[5] For equity analysis, it seemed important to identify streets likely to benefit directly from a reduction in motor traffic. However, for studying scheme impact on motor traffic within LTNs, we believed that any street within the wider traffic cell is relevant, as some might not see much change or even an increase.

in the three functional areas of London (Central, Inner, Outer).

We considered the key outcome measures to be:

1. Median pre and post daily traffic counts and median change across all sites in terms of traffic volume change and the median percentage change - these represent the 'typical' or middle point for each measure reported upon. This in relation to both actual changes, and those changes adjusted for background trends in the relevant functional zone.

2. Mean pre and post daily traffic counts, mean traffic volume change, and this change as a percentage of mean 'before counts' - these measures representing an average of the aggregated volumes and changes, incorporating the relative size of outliers and/or the comparative size of increases and decreases. This in relation to both actual changes and changes adjusted for background changes in the relevant functional zone.

3. Distributions, especially of changes, providing information about the extent of clustering or variation around means and medians, skews in either direction, and the extent and nature of outliers.

We also provide analysis showing how many count points have 1,000+ motor vehicles per day 'pre' and how many 'post', i.e. the extent to which monitored streets are pedestrian-priority as per the level estimated in Manual for Streets (1,000 motor vehicles per day is assumed to be roughly equivalent to 100 in the busiest peak hour).

> "A study of public transport in London Borough Pedestrian Priority Areas [...] concluded that there is a self-limiting factor on pedestrians sharing space with motorists, of around 100 [motor vehicles per hour]. Above this, pedestrians treat the general path taken by motor vehicles as a

'road' to be crossed rather than as a space to occupy. The speed of vehicles also had a strong influence on how pedestrians used the shared area. Although this research project concentrated on PPAs, it is reasonable to assume that these factors are relevant to other shared space schemes." (DfT 2007:83)

We present further analysis splitting results by functional area, although noting that Outer and particularly Central London have relatively few count sites compared to Inner London.

Sensitivity Analysis

We briefly summarise key points from, and then provide in the Appendix a set of results for the following sensitivity analyses:

- The main analysis, re-run eleven times, each time excluding one of the boroughs, to establish whether removing data from any borough substantially changes the results.
- The main analysis, re-run but (i) removing data where the counts referred to 5-day rather than 7-day averages or where baseline counts had been normalised or estimated using telemetry services, (ii) using borough definitions of internal and boundary roads, except for roads we had judged to be external to schemes, (iii) (ii) using borough definitions of internal and boundary roads, including those roads we had judged to be external to schemes, and (iv) the ATA's 'strict definition' of LTNs and boundary roads (which results in a number of additional points being judged as 'external' and hence not analysed).

Findings

Main Analysis

The results of the main analysis are below. Summary statistics as well as graphs of distributions are used to convey the findings. Table 4 and Table 5 present the median and mean results together for internal and then boundary roads, also outlined in accompanying text. In citing percentage changes, the median is the middle percentage by value; the mean percentage changes are calculated as the mean change in motor vehicles divided by the mean baseline value (to avoid small absolute changes having a disproportionate effect).

The medians give a sense of typicality for each measure, while the means provide an aggregated average. Hence for instance, where the differences between the median and values above it are systematically smaller in magnitude than the difference between the median and values below it, the mean will reflect this and be lower than the median.

Note that medians do not add up in the same way that means do - i.e. adding the median baseline to the median difference from baseline does not result in the median after figure. This is because the 'middle value' will refer to different sites in each case.

Internal Roads

Median (middle value) results

- On internal roads, a median baseline of 1,226 vehicles per day fell to 666. Had the expected trend been followed, the median 'after' count would have been 1,202.
- The actual median change was a reduction of 364 motor vehicles per day, and the median difference from the predicted change was a reduction of 332 vehicles per day.

- The actual median percentage change was a 32.7% reduction, and the median difference from the predicted percentage change was a reduction of 31.8%.

Mean average results

- On internal roads, a mean baseline of 1,816 vehicles per day reduced to 964. Had the expected trend been followed, the mean 'after' count would have been 1,779.

- The actual mean change was a reduction of 852 motor vehicles per day, and the mean difference from the predicted change was a reduction of 815 vehicles per day.

- The actual mean percentage change, calculated by dividing the mean change by the mean 'pre' figure, was a 46.9% reduction, and the mean difference from the predicted percentage change a reduction of 44.9%.

Comments on changes

Whether measured through median or mean averages, internal roads see a substantial relative reduction in motor traffic - of almost half for mean averages, and almost a third for medians. Adjusting for expected changes made relatively little difference to the percentage reduction. The robustness of results to different measures highlights the systematic impact of LTN schemes within their area, shown also in the distributional charts.

Table 4: median and mean motor traffic counts, pre- and post-, for internal roads.

	Medians (middle values)	Means (average of all values)
Baseline	1226	1816
After Observed	666	964
Difference from Baseline	-364	-852
% difference from Baseline	-32.7%	-46.9%
After Predicted	1202	1779
Difference from Predicted	-332	-815
% difference from Predicted	-31.8%	-44.9%

Boundary Roads

Median (middle value) results

- On boundary roads, a median baseline of 10,999 vehicles per day grew very slightly to 11,040. Had the expected trend been followed, the median 'after' count would have been 10,523.
- The actual median change was a rise of 140 motor vehicles per day, and the median difference from the predicted change was an increase of 288 vehicles per day.
- The actual median percentage change was a 1.3% increase, and the median difference from the predicted percentage change was an increase of 4.5%.

Mean average results

- On boundary roads, a mean baseline of 11,679 vehicles per day reduced to 11,487. Had the expected trend been followed, the mean 'after' count would have been 11,405.

- The actual mean change was a reduction of 192 motor vehicles per day, and the mean difference from the predicted change was an increase of 82 vehicles per day.

- The actual mean percentage change, calculated by dividing the mean change by the mean 'pre' figure, was a 1.6% reduction, and the mean difference from the predicted percentage change was a rise of 0.7%.

Comments on changes

Average differences are typically modest as means or as medians, with the distributional charts highlighting the lack of a clear systematic pattern by contrast to the impacts within LTNs. The actual changes are in different directions for medians and means, although both are small (median change of +1.3% vs. -1.6%). These may be compared in magnitude to Inner London's non-holiday seasonal fluctuation: for instance, mean average daily traffic in March 2019 was 1.4% higher than in May 2019. There are small mean and median increases when adjusting for background trends (+4.5% median, +0.7% mean).

Taking perhaps the most 'negative' result, the median boundary road saw a rise of 288 motor vehicles daily during the monitoring period in question, compared to background trends in the relevant functional areas. In practice, due to those background trends being towards slight decline, the actual median rise was half this (140; plausibly within a margin of error). In other words, during the monitored periods, the typical boundary road saw little change in motor traffic. However, this likely lack of impact will depend on the extent to which the background, small reduction in traffic, experienced during those periods, has since been maintained. This will partly depend on the introduction of measures to discourage driving and to support walking, cycling, and public transport.

Table 5: median and mean motor traffic counts, pre- and post-, for boundary roads.

	Medians (middle values)	Means (average of all values)
Baseline	10999	11679
After Observed	11040	11487
Difference from Baseline	140	-192
% difference from Baseline	1.3%	-1.6%
After Predicted	10523	11405
Difference from Predicted	288	82
% difference from Predicted	4.5%	0.7%

Distributions: Internal and Boundary Roads

Figure 7 (beeswarm plot) and Figure 8 (histogram) highlight the different patterns on internal and boundary roads, here both showing the difference from the expected change based on functional areas. Three -quarters of monitored internal roads saw declines. There is a long tail of outliers seeing very substantial declines, and only two outliers showing substantial growth. Overall the picture shows a clear tendency to fall, which we consider highly likely to be caused by the schemes. This picture is backed up by Figure 8, a histogram, which is strongly skewed for internal roads.

By contrast, the boundary road graphs show a much more 'normal' distribution; with variation either side of the mean and median (+82, +288). On their side of the modal (most common) category, the number of streets in each category declines in a similar manner, in a pattern more similar to the bell curve than the skew seen for internal roads. This shows a wide variation either side of the median, median, and modal averages, not just identified outliers but also within the curve itself. Combined with the relatively small 'typical' or average changes at the centre of the distribution, this largely highlights the potential contribution of exogenous factors to variation at an individual main road count site, compared to the wider functional area trends from month to month.

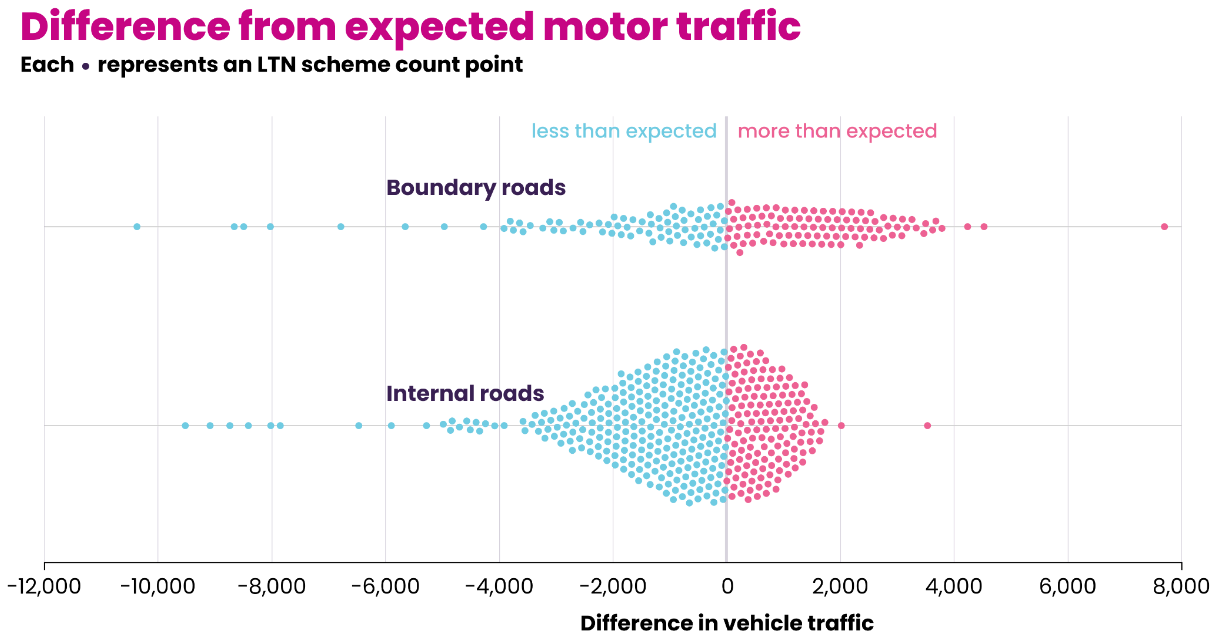

Figure 7: beeswarm plot showing changes in motor traffic compared to expected values.

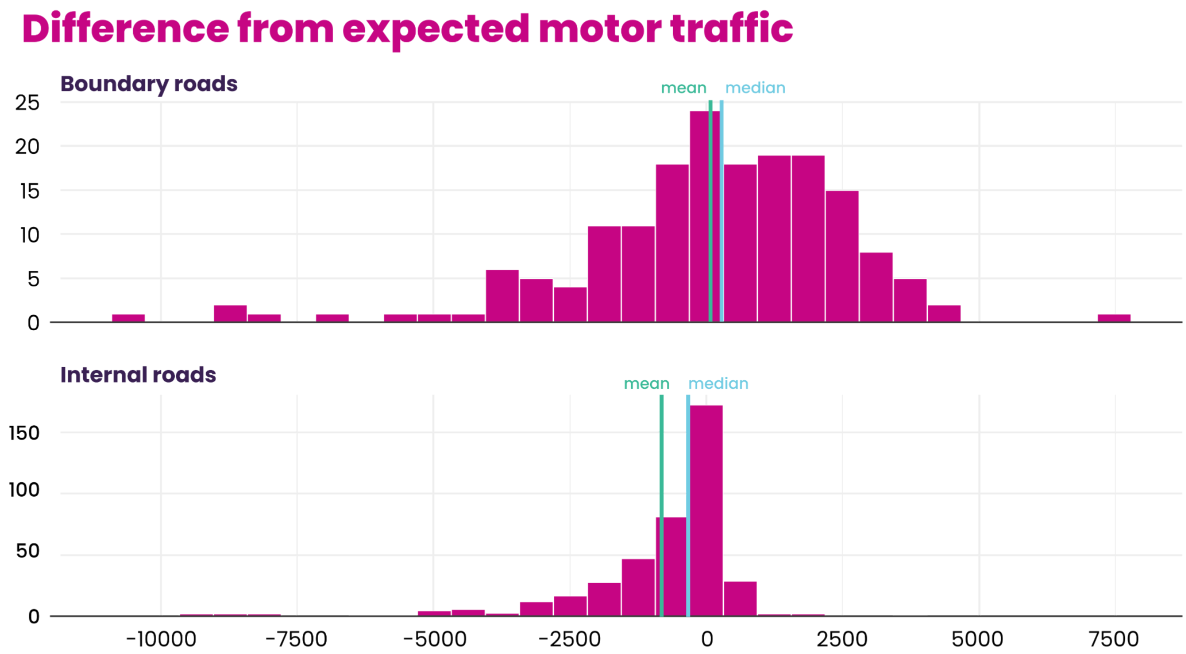

Figure 8: histogram showing changes in motor traffic compared to expected values.

Additional Analysis

Here we present results split by functional zone, some more information on internal road changes, and briefly report on sensitivity analysis.

Internal roads

Figure 9 shows actual changes in internal road traffic volumes by comparison to their baseline traffic volumes. It illustrates the strong and consistent relationship between baseline traffic volumes and post-intervention change in traffic.

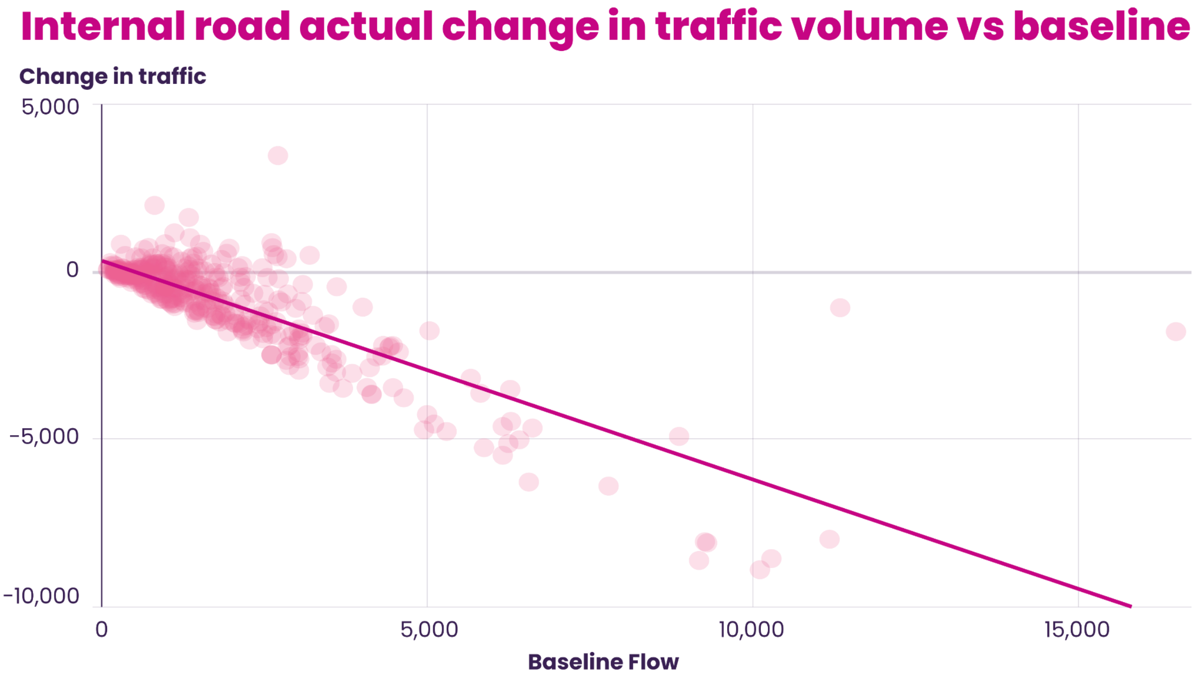

Figure 9: change in motor traffic on internal roads against baseline levels.

Table 6 shows the number of internal roads showing any rise and/or fall in actual motor traffic, split up by Central, Inner, and Outer London. 74% of the 413 internal road count sites saw a fall in motor traffic, but this was slightly higher (78%) in Inner London and lower (65%, 63%) in Central and Outer London.

Table 6: internal roads seeing a rise or fall in actual motor traffic.

	Traffic decline	Traffic increase	Total
Central	13	7	20
	65.0%	35.0%	100.0%
Inner	221	61	282
	78.4%	21.6%	100.0%
Outer	70	41	111
	63.1%	36.9%	100.0%
Total	**304**	**109**	**413**
	73.6%	**26.4%**	**100.0%**

Secondly, we present detailed summary statistics on internal road motor traffic changes broken down between the Central, Inner, and Outer zones. For medians, the typical count point in Inner London achieves higher relative and absolute reductions than those in Outer London, on roads that are typically initially busier (baseline median 1449 motor vehicles per day compared to 843 in Outer London). When considering means, similar patterns appear. Across all London schemes, motor traffic fell on average 45% more than predicted; this is -47% in Inner London, but somewhat less in Central and Outer London (-39% and -37%).

Table 7: traffic changes on internal roads, by functional zone of London.

	Medians				**Means**			
	Central	Inner	Outer	Total	Central	Inner	Outer	Total
Number of cases	20	282	111	413	20	282	111	413
Baseline	816	1449	843	1226	1429	2083	1208	1816
After Observed	453	778	493	666	729	1068	741	964

Difference from Baseline	-212	-484	-99	-364	-701	-1015	-467	-852
% Difference from Baseline	-17%	-41%	-20%	-33%	-49%	-49%	-39%	-47%
After Predicted	876	1407	861	1202	1289	2049	1182	1779
Difference from Predicted	-147	-418	-101	-332	-560	-981	-441	-815
% Difference from Predicted	-26%	-40%	-18%	-32%	-39%	-47%	-37%	-45%

As well as presenting the average changes on internal roads, we looked at movement under or over the 1,000 motor vehicles per day threshold. While more research is needed, 1,000 motor vehicles per day (roughly in line with a peak hour average of 100) is often taken as a threshold for streets starting or ceasing to become more pedestrian-friendly. Specifically, the figure of 100 at peak hour is cited in Manual for the Streets as being the limit at which pedestrians are likely to stop walking in the carriageway. Noting that further studies would be useful, including to delineate other features that may affect pedestrian behaviour (e.g. street design, number of pedestrians, motor vehicle speeds), we believe this is a useful broad metric for looking at potential qualitative change in street experience.

Table 8: internal roads above and below the 1000 motor vehicle threshold.

	Post < 1000	Post > 1000	Total
Baseline < 1000	150 (88%)	21 (12%)	171
Baseline > 1000	123 (51%)	119 (49%)	242
Grand Total	**273 (66%)**	**140 (34%)**	**413**

Across London, 242 of 413 internal roads (59%) initially carried over 1,000 motor vehicles per day. After the interventions, only 140 (34%) did. Of the 273/413 internal roads that had under 1,000 motor vehicles per day post-intervention, 123 of these were newly quietened. There were also 21 roads that moved from having under 1,000 to over 1,000 motor vehicles per day. Of the 123 newly quietened streets, Figure 10 illustrates the post-intervention distribution of flows. The modal (most common) category is 600-700 motor vehicles per day, and a large majority (93/123) see reductions to between 0-800 motor vehicles per day (i.e. not moving to being just under the threshold).

Newly quietened streets, post flow level

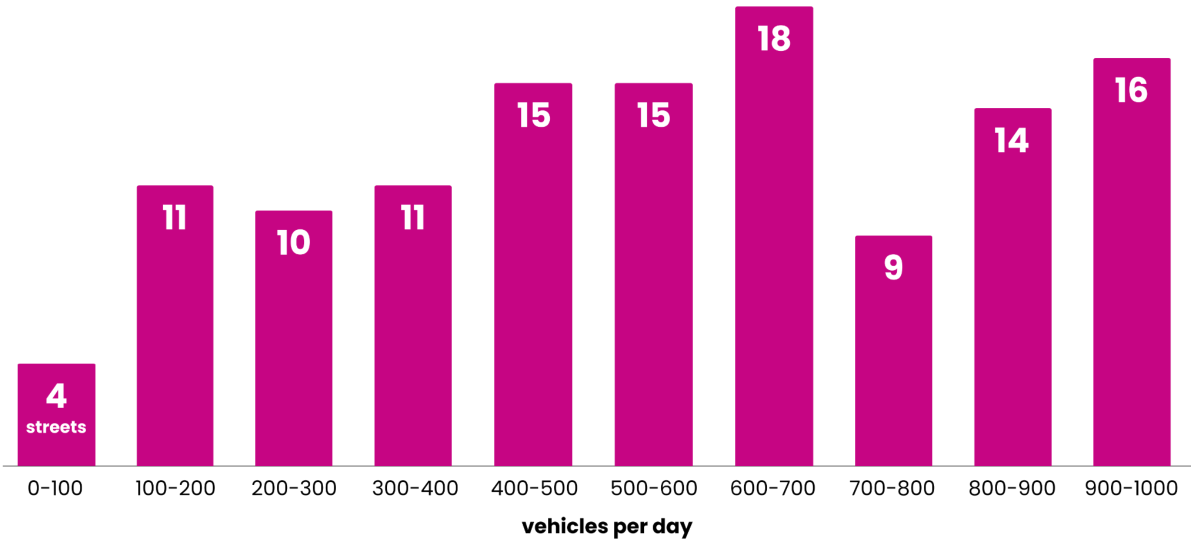

Figure 10: bar chart showing new motor traffic levels for newly quietened streets.

Boundary roads

Table 9 shows the number of boundary roads showing a rise and/or fall in actual motor traffic, split up by Central, Inner, and Outer London, as shown above for internal roads. Inner London, with 124 boundary road count sites, sees an equal split between motor traffic decreases and increases - 62 of each. Central has 6 with traffic decline and 7 with traffic growth. Outer London has a less even split, with 38% (14) seeing declines and 23 (62%) seeing growth. Interestingly, the better performance of Inner London with respect to boundary sites sits alongside Table 6 showing that internal roads were also more likely in Inner London to see motor traffic decline.

Table 9: motor traffic growth or decline on boundary roads, by functional zone.

	Traffic decline	Traffic increase	Total
Central	6	7	13
	46.2%	53.8%	100.0%
Inner	62	62	124
	50.0%	50.0%	100.0%
Outer	14	23	37
	37.8%	62.2%	100.0%
Total	**82**	**92**	**174**
	47.1%	**52.9%**	**100.0%**

Table 10 shows boundary road changes broken down between the Central, Inner, and Outer zones. There are very few Central boundary road count sites - 13 - so we would caution against taking too much from these results (which suggest that motor traffic on those boundary roads reduced slightly more than might otherwise have been expected). For Inner London, the results are broadly similar to the all-London figures, with actual figures showing a small decrease for actual mean averages and no change (-2 vehicles) for median averages. Taking into account expected changes, the Inner London median boundary road count is 351 vehicles daily or 4.2% higher than might have been expected, while the mean boundary road count is 105 vehicles daily or 0.9% higher than might have been expected.

Outer London figures show that actual counts on boundary road sites declined, when mean averages are used. Because the background trend at these sites across the relevant monitoring periods was slightly more towards decline than for Inner London sites, these become a slightly higher rise than expected compared to Inner London (6.5% median rise and 1.7% mean increase). These figures are only based on 37 sites, whereas there are 111 Outer London internal road count points, so caution should be taken in interpreting these.

Table 10: changes on boundary roads, by functional zone of London.

	Medians				**Means**			
	Central	Inner	Outer	Total	Central	Inner	Outer	Total
Number of cases	13	124	37	174	13	124	37	174
Baseline	7755	11166	10223	10999	9477	11568	12823	11679
After Observed	7120	11459	10150	11040	9523	11333	12692	11487
Difference from Baseline	106	-2	355	140	46	-235	-131	-192
% Difference from Baseline	0.4%	0.0%	2.1%	1.3%	0.5%	-2.0%	-1.0%	-1.6%
After Predicted	7179	10908	9840	10524	10032	11228	12478	11405
Difference from Predicted	-59	351	410	288	-509	105	215	82
% Difference from Predicted	-0.8%	4.2%	6.5%	4.5%	-5.4%	0.9%	1.7%	0.7%

Sensitivity Analysis

Most differences found during the sensitivity analysis were very small (see Table 12, Appendix). For boundary roads the three most prominent deviations from the headline findings occurred (i) when non-standard counts were removed (5 day counts, counts estimated from telemetry data, baseline counts normalised to a specific month), (ii) when the schemes from the borough of Brent were removed, and (iii) roads were classified only using the borough definitions. This represented (respectively) +2.1, +1.5, and +0.9 changes from the overall figures for median % difference from predicted.

For internal roads, the three most prominent deviations from the headline findings occurred when (i) roads were classified only using the stricter ATA definitions, (ii) the points from the borough of Waltham Forest were removed, and (iii) again when the points from the borough of Brent were removed. This represented -6.1%, -4.4%, and -4.2% respectively in terms of changes from the overall median % difference from predicted.

Discussion

Summary of Findings

This is the first systematic review of motor traffic volume changes associated with Low Traffic Neighbourhoods in London. We have summarised changes on internal and boundary roads across 46 different schemes in 11 boroughs, including nearly 600 separate data points. This allows us to generalise across a range of contexts and LTNs, providing median and mean averages and distributional data. Data on seasonal and longer-term changes in three functional zones allows us to separate estimated likely background changes from changes due to LTNs. While as with any study there are limitations related to the data sources, the methods, and the analysis (see above), we believe that these results represent the best evidence so far on the impacts of LTNs in London on motor traffic both within schemes and on their boundary roads.

The results suggest that LTNs in London introduced between May 2020 and May 2021 have typically resulted in a substantial relative reduction in motor traffic inside the scheme area, with particularly strong reductions in Inner London. The typical monitored internal road is now well under 1,000 motor vehicles per day, rather than being above this threshold, which may generate a qualitative change in walking and cycling experiences as also suggested by research highlighting growth in active travel associated with LTN introduction.

On boundary roads, by contrast, we found little change. In terms of raw numbers, 'pre' and 'post' monitoring sites on boundary roads were similar, around 11,000 motor vehicles per day (with a very small rise if comparing medians, or a very small fall if comparing means). Median and mean changes became a small relative increase when background trends were accounted for. In other words, there was on average little change in traffic volumes on boundary roads between 'pre' and ‘post’ monitoring, generated by a combination of a typically small zone-wide motor traffic reduction combined with another typically small rise in motor traffic on LTN boundary roads. The picture of little change on average in motor vehicle numbers on boundary roads is good news for the potential for exemptions to limit journey length and hence time increases for key users, if this is judged necessary.

Substantial variation as well as some extreme outliers highlight the danger in drawing conclusions about causation (in either direction) about boundary road impacts in particular from a small or selected group of schemes. For instance, a handful of boundary roads saw a reduction of 5,000-10,000 motor vehicles per day, but we consider such changes very likely due to other factors rather than specific features of their LTNs, as with the boundary road that saw a rise of nearly 10,000 motor vehicles per day.

Even excluding outliers, a quarter of boundary road count sites saw decreases of 1,000-5,000 motor vehicles per day, while a quarter saw growth of 1,750-4,500 motor vehicles per day (adjusted for expected changes). Again, we consider much of this unlikely to be directly caused by the LTN in question. Larger variations in either direction may in part or entirely result from exogenous atypicality affecting a specific area or scheme, which cannot easily be controlled for. For instance, Newham’s monitoring and evaluation reports highlight the likely impact of Olympic development on boundary roads, and this will be inadequately controlled for by our functional zone normalisation. However, further research could seek to identify genuine scheme factors that may promote motor traffic reductions rather than growth on boundary roads.

The picture of little aggregate or typical change on boundary roads suggests we should look elsewhere for causes and potential solutions for their traffic burdens. For instance, a paper by Hajmohammadi and Heydecker (2022) found that introducing the Ultra Low Emission Zone in April 2019 led to reductions in NO, NO_2, and NOx concentrations both within the implementation zone and the wider low emission zone (LEZ) and Greater London area. In the LEZ zone, most similar to the Inner London area (where most of our studied schemes lie) there was a reduction of 18% in NO, 17% in NOx, and 11% in NO_2. Even more ambitious city-wide clean air measures could play a substantial role in reducing the most harmful motor traffic and hence its burden, particularly on busier roads.

Even if substantially increased motor traffic on a boundary road is not primarily related to LTN introduction, it is still a problem that authorities need to address. Similarly, while substantially reduced motor traffic on another boundary road may not in itself be an LTN benefit, it is nevertheless likely to be good news but potentially to need 'locking-in' through policies to redistribute road space and support walking, cycling, and public transport in the longer term. Hence, while individual boundary road monitoring results from this study should not necessarily be taken as showing the impact of an individual LTN, they are crucial information for transport authorities.

This leads us to our final point here. We encountered a range of data issues. Most problematically, some boroughs have failed to publish any monitoring and evaluation reports at all, or have produced reports where data is in formats that do not lend themselves to independent re-analysis (e.g. graphs rather than tabular format). In some cases tables were presented, but it was challenging to extract data from these images. This also represents an accessibility barrier for those using screen readers, for instance.

We need improved monitoring and evaluation, including the provision of more accessible, transparent, and standardised data. In the UK this is a potential role for organisations like Transport for London, Combined Authorities, the Department for Transport or Active Travel England, Transport Scotland, the Welsh Government, and the Department for Infrastructure. Nello-Deakin's (2022) analysis of traffic reduction measures in

Barcelona was facilitated by the municipal authority publishing in one place open access monthly average traffic count figures from locations across the city. The provision of this data across London and nationally could permit academics and others to much more easily explore the impacts of a range of interventions, and would allow the use of (for instance) more sophisticated normalisation approaches than we were able to use here.

Conclusion

In conclusion, our findings suggest that LTNs can have an important role in reducing motor traffic on minor streets. After scheme introduction, most monitored internal streets were below 1,000 motor vehicles per day, and other evidence suggests such reductions may then increase walking and cycling. Both reducing motor traffic and increasing walking and cycling have large benefits. Impacts on motor traffic on boundary roads are small, typically or in aggregate. Boundary roads (and other main roads for which LTNs are not suitable) do however urgently also need improvement. Many such roads, with typically 11,000 motor vehicles per day in London (although in some cases much more) are hostile for walking and cycling, and have poor injury and pollution records. Realising the potential benefits of LTNs may also depend on improving such roads, which often represent severance for continuing pedestrian journeys or parts of cycle routes which are off-putting to most potential riders.

Schemes Included

Table 11 shows a list of the schemes included, and links to find out more about the schemes and access the reports analysed.

Table 11: Schemes included

Scheme	Borough	Introduced	URL 1	URL2	URL3
Dollis Hill Healthy Neighbourhood	Brent	Nov-20	https://consultation.bre/highways-and-infrastrollis-hill-area-healthy-rhood/?_ga=2.22758264.1613125104-4098822684	https://legacy.brent.gov.uk/media/16419949/dollis-hill-area-hn-review.pdf	
Olive Road Healthy Neighbourhood	Brent	Dec-20	https://www.brent.gov.uk/services-for-residents/transport-and-streets/brent-healthy-neighbourhoods/olive-road-healthy-neighbourhood/	https://legacy.brent.gov.uk/media/16419929/olive-road-hn-review-final.pdf	
Preston Healthy Neighbourhood	Brent	Aug-20	https://consultation.brent.gov.uk/highways-and-infrastructure/preston-area-healthy-neighbourhood/supporting_documents/Healthy%20Neighbourhood	https://legacy.brent.gov.uk/media/16419946/prestons-road-area-ltn-review.pdf	

Scheme	Borough	Introduced	URL 1	URL2	URL3
			%20%20Preston%20Area%20PM29.pdf		
Stonebridge and Harlesden Area Healthy Neighbourhood	Brent	Aug-20	https://consultation.brent.gov.uk/highways-and-infrastructure/stonebridge-harlesden-area-healthy-neighbourhood-s/supporting_documents/PM14%20Stonebridge%20and%20Harlesden%20Healthy%20Neighbourhood%20Letter%2028.07.20%20v4.pdf	https://legacy.brent.gov.uk/media/16419931/stonebridge-and-harlesden-hn-review-final.pdf	
Tokyngton and Wembley Central Area Healthy Neighbourhoods	Brent	Sep-20	https://www.brent.gov.uk/your-community/coronavirus/changes-to-council-services/transport-and-streets/	https://legacy.brent.gov.uk/media/16419950/wembley-area-hn-review.pdf	
Arlington Road Area LTN	Camden	Sep-20	https://www.camden.gov.uk/documents/20142/181204604/Arlington+Road+Area+Low+Traffic+Neighbourhood+Map+and+images.pdf/56616d22-ad5c-04db-fa44-50b92311956b?t=1600436656853	https://s3-eu-west-2.amazonaws.com/commonplace-customer-assets/safetravelcamden/FACTSHEET_Arlington%20Rd%20LTN.pdf	https://s3-eu-west-2.amazonaws.com/commonplace-customer-assets/safetravelcamden/Arlington%20Rd%20Interim%20factsheet.pdf

Scheme	Borough	Introduced	URL 1	URL2	URL3
Constantine and Savernake Road	Camden	May-20	https://www.camden.gov.uk/making-travel-safer-in-camden#dhmm	https://democracy.camden.gov.uk/documents/s99673/Appendix%20B%20-%20Monitoring%20Report.pdf	
Kentish Town	Camden	Jun-20	https://www.camden.gov.uk/making-travel-safer-in-camden#duwd	https://democracy.camden.gov.uk/documents/s99623/Appendix%20A%20-%20Monitoring%20Data%20Sheet.pdf	
Queen's Crescent	Camden	May-21	https://www.camden.gov.uk/documents/20142/181204604/Queens+Crescent+Business+Letter+May+21.pdf/9c9f180c-691c-99db-09d1-19b3cd9c23a9?t=1621519821068	https://s3-eu-west-2.amazonaws.com/commonplace-customer-assets/safetravelcamden/FACTSHEET_Queens%20Crescent%20%20Updated%20Feb%2022.pdf	
Rochester Terrace	Camden	May-20	https://www.camden.gov.uk/making-travel-safer-in-camden#rgtq	https://consultations.wearecamden.org/supporting-communities/prowseplaceandwilmotplace/supporting_documents/Wilmot%20Place_Monitoring%20report.pdf	
Bowes QN	Enfield	Jul-20	https://letstalk.enfield.gov.uk/bowesQN	https://governance.enfield.gov.uk/mgAi.aspx?ID=52202#mgDocuments	
Fox Lane QN	Enfield	Sep-20	https://letstalk.enfield.gov.uk/foxlaneQN	https://governance.enfield.gov.uk/mgAi.aspx?ID=52431#mgDocuments	

Scheme	Borough	Introduced	URL 1	URL2	URL3
Hills and Vales	Greenwich	Aug-20	https://www.royalgreenwich.gov.uk/downloads/file/4748/west_greenwich_traffic_reduction_technical_drawing_of_the_trial_measures	https://committees.royalgreenwich.gov.uk/Document.ashx?czJKcaeAi5tUFL1DTL2UE4zNRBcoShgo=GMy6DOPVEaNVBqfGk2FnYOv0sHT7yxpq0qmTCsgiK6i%2bHgBiyX5z6w%3d%3d&rUzwRPf%2bZ3zd4E7Ikn8Lyw%3d%3d=pwRE6AGJFLDNlh225F5QMaQWCtPHwdhUfCZ%2fLUQzgA2uL5jNRG4jdQ%3d%3d&mCTIbCubSFfXsDGW9IXnlg%3d%3d=hFflUdN3100%3d&kCx1AnS9%2fpWZQ40DXFvdEw%3d%3d=hFflUdN3100%3d&uJovDxwdjMPoYv%2bAJvYtyA%3d%3d=ctNJFf55vVA%3d&FgPlIEJYlotS%2bYGoBi5olA%3d%3d=NHdURQburHA%3d&d9Qjj0ag1Pd993jsyOJqFvmyB7X0CSQK=ctNJFf55vVA%3d&WGewmoAfeNR9xqBux0r1Q8Za60lavYmz=ctNJFf55vVA%3d&WGewmoAfeNQ16B2MHuCpMRKZMwaG1PaO=ctNJFf55vVA%3d	
Elsdale Street/Mead Place	Hackney	Dec-20	https://rebuildingagreenerhackney.commonplace.is/proposals/elsdale-street-and-mead-place		
Hackney Downs LTN	Hackney	Aug-20	https://rebuildingagreenerhackney.commonplace.is/schemes/proposals/hackney-downs-low-traffic-neighbourhood/details	https://drive.google.com/file/d/1_YkNyoNQfrKs0DT7f1Uuy3czzmJDeNwN/view	
Haggerston	Hackney	Nov-20	https://rebuildingagreenerhackney.commonplace.is/proposals/weymouth-terrace-in-haggerston-ltn	https://drive.google.com/file/d/1tJaNH5w-1J2no1yz-ON3y5Vf3k-bT0mF/view	

Scheme	Borough	Introduced	URL 1	URL2	URL3
Homerton North	Hackney	Sep-20	https://rebuildingagreenerhackney.commonplace.is/schemes/proposals/homerton/details	https://news.hackney.gov.uk/download/1035757/homertonlowtrafficneighbourhoodnovember2020trafficcounts.pdf	https://drive.google.com/file/d/1MhELva2NdXTxwgBVqNmX03dELEb_gJce/view
Homerton Station	Hackney	Aug-20	https://rebuildingagreenerhackney.commonplace.is/schemes/proposals/homerton/details	https://news.hackney.gov.uk/download/1035757/homertonlowtrafficneighbourhoodnovember2020trafficcounts.pdf	https://drive.google.com/file/d/1MhELva2NdXTxwgBVqNmX03dELEb_gJce/view
Hoxton West LTN	Hackney	Aug-20	https://rebuildingagreenerhackney.commonplace.is/schemes/proposals/hoxton-west-low-traffic-neighbourhood/details	https://hackney.gov.uk/hoxton-west-ltn	
London Fields LTN	Hackney	Sep-20	https://rebuildingagreenerhackney.commonplace.is/schemes/proposals/london-fields-low-traffic-neighbourhood/details	https://drive.google.com/file/d/1LprG97mjz0ISC9KCY4GYL9vzN02iEz93/view	
Marcon Place	Hackney	Nov-20	https://rebuildingagreenerhackney.commonplace.is/proposals/hackney-central-marcon-place-wayland-avenue		
Shore Place	Hackney	Nov-20	https://rebuildingagreenerhackney.common	https://drive.google.com/file/d/12iEt-Yl3gRte96H2wSy9C_O7RiyVBRxb/view	

Scheme	Borough	Introduced	URL 1	URL2	URL3
			place.is/proposals/shore-place		
Walford Road	Hackney	Sep-20	https://consultation.hackney.gov.uk/streetscene/walford-road-area/	https://drive.google.com/file/d/1c-sxsMaGT6x6li3AxKEDofmJjkoQuLS0/view	
Wayland Avenue	Hackney	Nov-20	https://rebuildingagreenerhackney.commonplace.is/proposals/hackney-central-marcon-place-wayland-avenue		
SW6 LTN	Hammersmith and Fulham	Jul-20	https://southfulhamstreetseasthome.commonplace.is/schemes/proposals/a-detailed-explanation-of-the-scheme/details	http://democracy.lbhf.gov.uk/ieDecisionDetails.aspx?AIId=66261	
Amwell People Friendly Streets	Islington	Oct-20	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20202021/20201026amwellpfspdf1.pdf	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20211217amwellpfspreconsultationmonitoringreport.pdf	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20210812amberwellpeoplefriendlystreetsinterimmonitoringreport.pdf
Canonbury West	Islington	Oct-20	https://www.islington.gov.uk/roads/people-friendly-streets	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20211013canonburywestpfsinterimmonitoringreportoct2021.pdf	

Scheme	Borough	Introduced	URL 1	URL2	URL3
Canonbury East	Islington	Jul-20	https://www.islington.gov.uk/roads/people-friendly-streets	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20211101canonburyeastpfspreconsultationmonitoringreport.pdf	https://www.islington.gov.uk/-/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20210518canonburyeastpfstrialinterimmonitoringreport1.pdf?la=en&hash=179887D791543E673C39025290CB58DBABF783EC
Clerkenwell Green	Islington	Sep-20	https://www.islington.gov.uk/roads/people-friendly-streets	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20211104clerkenwellgreenpeoplefriendlystreetspreconsultationmonitoringreport.pdf	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20210518clerkenwellgreenpfstrialinterimmonitoringreport.pdf
Highbury	Islington	Jan-21	https://www.islington.gov.uk/roads/people-friendly-streets/highbury	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20220207highburypfspreconsultationmonitoringreport2.pdf	https://www.islington.gov.uk/-/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20211018october2021highburypfsinterimmonitoringreport1.pdf?la=en&hash=23DC2DE3B6CF1BB9B4B41E5471A36C089693CD22

Scheme	Borough	Introduced	URL 1	URL2	URL3
St. Peters LTN	Islington	Jul-20	https://www.islington.gov.uk/-/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20202021/20201124pfsstpeters161120pdf.pdf?la=en&hash=AD8F482D94EA405819F72A4EA3146E3C54B5610F	https://www.islington.gov.uk/-/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20211222appendix6stpetersconsultationanalysisreportsteer.pdf?la=en&hash=221059642CCFBEB54C5CD899C2CCF68E49CB0FE4	https://www.islington.gov.uk/~/media/sharepoint-lists/public-records/transportandinfrastructure/information/adviceandinformation/20212022/20210618stpeterspeoplefriendlystreetsinterimmonitoringreport.pdf
Ferndale LTN	Lambeth	Jun-20	https://fdstreets.commonplace.is/about	https://beta.lambeth.gov.uk/streets-roads-transport/low-traffic-neighbourhood-monitoring-reports/ferndale-low-traffic-neighbourhood-monitoring-reports	
Oval Triangle LTN	Lambeth	Jul-20	https://www.hounslow.gov.uk/info/20053/transport/2171/hounslows_streetspace/2	https://beta.lambeth.gov.uk/sites/default/files/2021-03/Oval%20LTN%20Monitoring%20Stage%201%20Report_SYSTRA_FINAL_LBedit.pdf	https://beta.lambeth.gov.uk/sites/default/files/2021-03/Oval%20LTN%20Monitoring%20Stage%201%20Report%20Appendices.pdf
Railton LTN	Lambeth	Jun-20	https://rtstreets.www.rtstreets.commonplace.is/about	https://beta.lambeth.gov.uk/streets-roads-transport/low-traffic-neighbourhood-monitoring-reports/railton-low-traffic-neighbourhood-monitoring-reports	
Streatham Hill LTN	Lambeth	Aug-20	https://streathamhilllowtrafficneighbourhoodproposals.commonplace.is/schemes/proposals/what-is-changin	https://beta.lambeth.gov.uk/streets-roads-transport/low-traffic-neighbourhood-monitoring-reports/streatham-hill-low-traffic-neighbourhood-stage-two-monitoring-report	

Scheme	Borough	Introduced	URL 1	URL2	URL3
			g-details-of-the-temporay-scheme/details		
Tulse Hill LTN	Lambeth	Sep-20	https://tulsehillltn.commonplace.is/about	https://beta.lambeth.gov.uk/streets-roads-transport/low-traffic-neighbourhood-monitoring-reports/tulse-hill-low-traffic-neighbourhood-monitoring-reports	
South Leytonstone LTN Maryland	Newham	Aug-20	https://newhamwalthamforestltn.commonplace.is/overview	https://s3-eu-west-2.amazonaws.com/commonplace-customer-assets/newhamwalthamforestltn/Area%202-LTN%20Infographic%20v5.pdf	
South Leytonstone LTN Odessa	Newham/ Waltham Forest	Aug-20	https://newhamwalthamforestltn.commonplace.is/overview	https://s3-eu-west-2.amazonaws.com/commonplace-customer-assets/newhamwalthamforestltn/Area%202-LTN%20Infographic%20v5.pdf	
Brunswick Park	Southwark	Jan-21	https://brunswickpark.commonplace.is/about	https://moderngov.southwark.gov.uk/documents/s103144/Appendix%2012.pdf	https://moderngov.southwark.gov.uk/ieDecisionDetails.aspx?Id=7484
Dulwich Village LTN	Southwark	Nov-20	https://dulwichvillagestreetspace.commonplace.is/about	https://www.southwark.gov.uk/assets/attach/48151/Dulwich-LTN-Monitoring-Report-August-2021.pdf	https://moderngov.southwark.gov.uk/documents/s101510/Appendix%20C%201%20-%20Dulwich%20Streetspace%20June%20infographic%20report.pdf
East Dulwich	Southwark	Aug-20	https://eastdulwichstreetspace.commonplace.is/about	https://www.southwark.gov.uk/assets/attach/48151/Dulwich-LTN-Monitoring-Report-August-2021.pdf	https://moderngov.southwark.gov.uk/documents/s101510/Appendix%20C%201%20-%20Dulwich%20Streetspace%20June%20infographic%20report.pdf

Scheme	Borough	Introduced	URL 1	URL2	URL3
North Peckham	Southwark	Dec-20	https://northpeckham.commonplace.is/about	https://moderngov.southwark.gov.uk/documents/s103144/Appendix%2012.pdf	https://moderngov.southwark.gov.uk/ieDecisionDetails.aspx?Id=7484
Walworth Healthy Streets	Southwark	Jun-20	https://walworthstreetspace.commonplace.is/about	https://moderngov.southwark.gov.uk/documents/s102970/Appendix%20C%202%20Main%20report%20June%202021%20OH%20Walworth%20Streetspace.pdf	
South Leytonstone LTN Langthorne	Waltham Forest	Nov-20	https://southleytonstoneltn.commonplace.is/proposals/a-detailed-explanation-of-the-scheme		
South Leytonstone LTN Montague	Waltham Forest	Nov-20	https://southleytonstoneltn.commonplace.is/proposals/a-detailed-explanation-of-the-scheme		
South Leytonstone LTN Woodhouse	Waltham Forest	Nov-20	https://southleytonstoneltn.commonplace.is/proposals/a-detailed-explanation-of-the-scheme		

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Appendix - Sensitivity Analysis

Table 12: Sensitivity Analysis.

MEDIANS								
Excluded Values	Road Type	Baseline	After Observed	Difference from Baseline	% Difference from Baseline	After Predicted	Difference from Predicted	% Difference from Predicted
Brent	Boundary	10897.5	11039.5	142.0	2.1	10470.6	395.2	6.0
	Internal	1230.0	635.0	-595.0	-36.2	1205.0	-360.2	-35.9
Camden	Boundary	11075.0	11368.0	293.0	1.8	10473.1	370.3	5.5
	Internal	1200.2	678.5	-521.7	-30.6	1193.1	-303.7	-30.4
Enfield	Boundary	10462.0	10654.5	192.5	0.7	10168.7	287.5	4.5
	Internal	1226.0	701.0	-525.0	-33.9	1201.8	-332.4	-31.8
Greenwich	Boundary	11116.0	11114.0	-2.0	0.9	10558.3	241.3	4.1
	Internal	1226.0	682.0	-544.0	-31.2	1201.8	-300.2	-30.7
Hackney	Boundary	10490.5	10738.0	247.5	1.8	10470.6	233.4	4.5
	Internal	1133.0	615.5	-517.5	-33.3	1172.7	-307.7	-34.9
Hammersmith and Fulham	Boundary	10897.5	11039.5	142.0	1.8	10470.6	370.3	5.2
	Internal	1226.0	666.0	-560.0	-32.7	1201.8	-332.4	-31.8

MEDIANS								
Excluded Values	Road Type	Baseline	After Observed	Difference from Baseline	% Difference from Baseline	After Predicted	Difference from Predicted	% Difference from Predicted
Islington	Boundary	10375.0	10408.0	33.0	0.1	9879.5	241.9	4.1
	Internal	1230.0	701.0	-529.0	-30.7	1182.7	-292.1	-30.3
Lambeth	Boundary	11075.0	10879.0	-196.0	1.1	10542.1	219.5	4.0
	Internal	1185.0	648.0	-537.0	-28.5	1182.7	-272.5	-30.0
Newham	Boundary	11125.0	11074.0	-51.0	0.9	10631.4	241.3	4.1
	Internal	1209.7	659.0	-550.7	-33.3	1187.9	-321.0	-31.9
Newham/WF	Boundary	11075.0	11094.0	19.0	1.3	10542.1	287.5	4.5
	Internal	1266.0	703.0	-563.0	-34.0	1254.2	-344.6	-32.3
Southwark	Boundary	11133.9	11235.5	101.6	1.5	10662.2	305.8	4.2
	Internal	1167.5	650.0	-517.5	-32.2	1156.2	-298.9	-31.0
Waltham Forest	Boundary	11142.7	11379.0	236.3	0.5	10642.0	241.3	4.1
	Internal	1333.0	702.5	-630.5	-36.1	1320.8	-379.1	-36.1

MEDIANS								
Additional Sensitivity Analyses	Road Type	Baseline	After Observed	Difference from Baseline	% Difference from Baseline	After Predicted	Difference from Predicted	% Difference from Predicted
Standard Counts Only	Boundary	10624.0	11005.0	381.0	3.7	10420.1	550.8	6.6
	Internal	1167.5	642.0	-525.5	-34.3	1139.8	-321.0	-32.2
Borough Road Classification, except 'externals'	Boundary	11244.0	11434.5	190.5	2.1	10771.7	418.3	5.4
	Internal	1259.0	694.0	-565.0	-30.7	1243.4	-300.2	-30.4
Borough Road Classification, plus 'externals'	Boundary	10832.0	11005.0	173.0	1.2	10521.0	315.6	4.2
	Internal	1220.0	675.0	-545.0	-32.2	1196.0	-309.7	-31.2
ATA Road Classification	Boundary	11075.0	11235.5	160.5	1.1	10542.1	287.5	4.5
	Internal	1206.0	628.0	-578.0	-38.8	1196.0	-377.4	-37.8

MEANS								
Excluded Values	Road Type	Baseline	After Observed	Difference from Baseline	% Difference from Baseline	After Predicted	Difference from Predicted	Difference as a % Change from Baseline
Brent	Boundary	11632.9	11511.9	-121.1	-1.0	11378.3	133.5	1.1
	Internal	1847.6	929.2	-918.3	-49.7	1810.3	-881.1	-47.7
Camden	Boundary	11723.5	11581.8	-141.7	-1.2	11494.0	87.8	0.7
	Internal	1836.1	969.7	-866.3	-47.2	1791.2	-821.5	-44.7
Enfield	Boundary	11103.3	10922.3	-181.0	-1.6	10791.5	130.8	1.2
	Internal	1825.1	981.5	-843.6	-46.2	1785.0	-803.5	-44.0
Greenwich	Boundary	11738.6	11532.1	-206.4	-1.8	11470.4	61.7	0.5
	Internal	1815.0	970.9	-844.1	-46.5	1779.0	-808.1	-44.5
Hackney	Boundary	11838.6	11798.5	-40.1	-0.3	11735.7	62.8	0.5
	Internal	1702.4	918.0	-784.3	-46.1	1692.4	-774.4	-45.5
Hammersmith and Fulham	Boundary	11558.2	11505.1	-53.2	-0.5	11298.3	206.8	1.8
	Internal	1815.9	963.6	-852.3	-46.9	1778.8	-815.2	-44.9

MEANS								
Excluded Values	Road Type	Baseline	After Observed	Difference from Baseline	% Difference from Baseline	After Predicted	Difference from Predicted	Difference as a % Change from Baseline
Islington	Boundary	11494.8	11029.1	-465.7	-4.1	10895.9	133.2	1.2
	Internal	1816.7	992.5	-824.3	-45.4	1744.7	-752.3	-41.4
Lambeth	Boundary	11660.1	11487.6	-172.6	-1.5	11435.2	52.4	0.4
	Internal	1732.3	921.0	-811.3	-46.8	1713.2	-792.1	-45.7
Newham	Boundary	11771.3	11509.9	-261.4	-2.2	11495.6	14.3	0.1
	Internal	1796.4	967.5	-828.9	-46.1	1759.8	-792.3	-44.1
Newham/WF	Boundary	11724.6	11534.3	-190.3	-1.6	11464.8	69.5	0.6
	Internal	1886.5	998.5	-888.0	-47.1	1847.0	-848.5	-45.0
Southwark	Boundary	12066.8	11815.3	-251.5	-2.1	11820.3	-5.0	0.0
	Internal	1773.8	936.0	-837.8	-47.2	1743.3	-807.4	-45.5
Waltham Forest	Boundary	11871.6	11643.8	-227.8	-1.9	11611.0	32.8	0.3
	Internal	1925.1	1009.6	-915.5	-47.6	1884.8	-875.1	-45.5

MEANS								
Additional Sensitivity Analyses	Road Type	Baseline	After Observed	Difference from Baseline	% Difference from Baseline	After Predicted	Difference from Predicted	Difference as a % Change from Baseline
Standard Counts Only	Boundary	11009.7	11081.0	71.3	0.6	10817.0	264.0	2.4
	Internal	1769.6	894.8	-874.7	-49.4	1746.5	-851.7	-48.1
Borough Road Classification, except 'externals'	Boundary	12240.1	12076.4	-163.8	-1.3	11979.6	96.7	0.8
	Internal	1880.5	1036.0	-844.4	-44.9	1831.5	-795.4	-42.3
Borough Road Classification, plus 'externals'	Boundary	11700.0	11528.8	-171.2	-1.5	11409.9	118.9	1.0
	Internal	1808.1	963.6	-844.5	-46.7	1771.1	-807.5	-44.7
ATA Road Classification	Boundary	11486.5	11312.1	-174.3	-1.5	11183.5	128.6	1.1
	Internal	1847.7	914.2	-933.5	-50.5	1805.1	-890.8	-48.2