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Assessing the Air Quality Impact of Lambeth's Low Traffic Neighbourhoods: Pre-Scheme and Post-Scheme Scenarios, Ferndale

Draft report

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1. Summary

Lambeth Council commissioned Cambridge Environmental Research Consultants Ltd (CERC) to carry out air quality modelling to assess the impact of Lambeth's Low Traffic Neighbourhoods (LTNs). The LTNs involve the closure of residential roads to motor vehicles at specific locations to prevent rat-running. With significantly less traffic in residential areas, LTNs become far easier and attractive to walk and cycle in, with improved air quality amongst a range of benefits; however, they also have the potential to worsen traffic and hence air quality on boundary roads.

The first stage of the modelling was provided in the report *Assessing the Air Quality Impact of Lambeth's Low Traffic Neighbourhoods: borough-wide modelling for 2019 base year*. This modelling determined the current baseline (2019) levels of NO_2, PM_{10} and $PM_{2.5}$ across the borough of Lambeth.

Using traffic monitoring data as inputs into the air quality model, the second part of the assessment considers pre-scheme and post-scheme scenarios to assess the air quality impact of the LTNs. Concentrations of NO_2, PM_{10} and $PM_{2.5}$ were modelled for assessment against national air quality objectives. This report presents the assessment of Ferndale LTN. Previous reports present the assessment of Oval, Railton, Tulse Hill and Streatham Hill LTNs. The assessment of the remaining scheme areas, Larkhall Rise and Cornwall Road LTN, will follow in a later report as traffic monitoring data becomes available.

The model-set up and all other emissions data were the same as for the current (2019) baseline modelling. Air quality modelling was carried out using ADMS-Urban (version 5.0.0.1) dispersion model and the emissions inventory toolkit EMIT, both developed by CERC. Emissions data, including traffic data were updated to represent the pre-scheme and post-scheme scenarios.

Concentrations of NO_2, PM_{10} and $PM_{2.5}$ were modelled at receptor locations and on a grid of receptor points, to generate pollution maps for the scheme area. The receptor locations included sensitive receptors, e.g. schools, hospitals and other educational establishments. The modelled concentrations represent the pre-scheme and post-scheme scenarios.

The expected change in concentrations due to the implementation of the LTNs were assessed using significance criteria from Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM) guidance for Land-Use Planning & Development Control. This is a widely used method for assessing air quality impacts for planning purposes

1.1. NO_2 concentrations

At the sensitive receptor locations, there are no modelled exceedences of the annual average air quality standard for NO_2. The change in annual average NO_2 concentrations between the post-scheme and pre-scheme scenarios ranges between a 0.7 $\mu g/m^3$ reduction and a 0.1 $\mu g/m^3$ increase in concentrations. Using the EPUK IAQM significance criteria, for NO_2, the impact of the scheme is classed as *Negligible* at all sensitive receptors in Ferndale LTN.

The air quality objectives for NO_2 are met within Ferndale LTN.

There are some exceedences of the annual air quality objective of 40 µg/m³ for NO_2 along LTN boundary roads A203, Brixton Road (A23) and Bedford Road (B221). The extent of the exceedences is similar for both scenarios.

There are no modelled exceedences of the 99.79th percentile of hourly average NO_2 concentrations across the scheme area, including at all sensitive receptor concentrations.

Across the majority of Ferndale LTN, annual average NO_2 concentrations are predicted to change by 5% or less of the air quality objective of 40 µg/m^3.

Comparing the concentration ranges for annual average NO_2 against the impact descriptors indicates that the significance of the air quality impact ranges from *Substantial Adverse to Substantial Beneficial*, with the impact classed as *Negligible* for most locations. Note that this analysis does not consider the type of location where these exceedences occur, i.e. whether or not they are representative of locations relevant for long-term exposure.

Areas where *Beneficial* or *Adverse* impacts are predicted in Ferndale LTN include:

- *Substantial Beneficial to Slight Beneficial* impacts on LTN roads Ferndale Road, Shannon Grove, Nursey Road, Bernays Grove, Tunstall Road, Brighton Terrace, Trinity Gardens, Concanon Road, Sandmere Road, Solon Road, Dalyell Road, Combermere Road and Bellefields Road;
- *Substantial Beneficial to Slight Beneficial* impacts on the boundary road Brixton Road (A23);
- *Slight Adverse* impacts on the LTN road Stockwell Green; and
- *Substantial Adverse to Slight Adverse* impacts on boundary roads A203, Landor Road, Stockwell Green and Bedford Road.

1.2. PM_{10} concentrations

There are no modelled exceedences of the annual average air quality standard for PM_{10} across the scheme areas, including at all sensitive receptor locations. Using the EPUK IAQM significance criteria, the impact within Ferndale LTN, including at sensitive receptor locations, is classed as *Negligible.* There are however some *Slight Beneficial* impacts predicted along the boundary road Brixton Road (A23).

Using the EPUK IAQM significance criteria with the WHO guideline value of 20 µg/m^3 for annual average PM_{10}, the impact of the scheme can be classed as *Negligible* at all sensitive receptor locations except for Stockwell Primary Pre-School where the impact is classed as *Moderate Beneficial.* Across the majority of Ferndale LTN, the impact is classified as *Negligible*. Areas where *Beneficial* and *Adverse* impacts are predicted for PM_{10} using the WHO guideline values are similar to areas predicted for NO_2 using the national air quality objective.

There are no modelled exceedences of the 90.41st percentile of 24-hour average PM_{10} concentrations across the scheme areas, including at all sensitive receptor locations.

1.3. $PM_{2.5}$ concentrations

There are no modelled exceedences of the annual average air quality standard for $PM_{2.5}$ across Ferndale LTN, including at all sensitive receptor locations. Using the EPUK IAQM significance criteria, the impact of the scheme for $PM_{2.5}$ is classed as *Negligible* at all locations.

Using the EPUK IAQM significance criteria with the WHO guideline value of 10 $\mu g/m^3$ for annual average $PM_{2.5}$, the impact of the scheme can be classed as *Negligible* at all sensitive receptor locations except for Stockwell Primary Pre-School where the impact is *Moderate Beneficial*. Across the majority of Ferndale LTN, the impact is classified as *Negligible*. Areas where *Beneficial* and *Adverse* impacts are predicted for $PM_{2.5}$ using the WHO guideline values are similar to areas predicted for NO_2 using the national air quality objective.

2. Introduction

Low Traffic Neighbourhoods (LTNs) involve the closure of residential roads to motor vehicles at specific locations to prevent rat-running. With significantly less traffic in residential areas, LTNs become far easier and attractive to walk and cycle in, with improved air quality amongst a range of benefits; however, they also have the potential to worsen traffic and hence air quality on boundary roads.

Lambeth Council commissioned Cambridge Environmental Research Consultants Ltd (CERC) to carry out an air quality modelling to assess the impact of its LTNs:

- Cornwall Road LTN
- Oval LTN
- Ferndale LTN
- Railton LTN
- Tulse Hill LTN
- Streatham Hill LTN
- Larkhall Rise modal filter[1]

The LTNs have been delivered within or across Lambeth's five Air Quality Focus Areas:

1. A23 from Brixton to Streatham
2. Kennington Oval//Camberwell New Road (A202)/Kennington Park Road (A3)
3. Vauxhall Cross
4. Clapham Road (A3)
5. Waterloo Road

The first stage of the modelling was provided in the report *Assessing the Air Quality Impact of Lambeth's Low Traffic Neighbourhoods: borough-wide modelling for 2019 base year*. This modelling determined the current baseline (2019) levels of NO_2, PM_{10} and $PM_{2.5}$ across the borough of Lambeth.

Using traffic monitoring data as input to the air quality model, the second part of the assessment considers pre-scheme and post-scheme scenarios to assess the air quality impact of the LTNs. Concentrations of NO_2, PM_{10} and $PM_{2.5}$ were modelled for assessment against national air quality objectives.

This report presents the assessment of Ferndale LTN. Previous reports present the assessment of Oval, Railton, Tulse Hill and Streatham Hill LTNs. The assessment of the remaining scheme areas, Larkhall Rise and Cornwall Road LTN, will follow in a later report as traffic monitoring data becomes available.

In this report, Section 3 presents the air quality standards, with which the calculated concentrations are compared, and Section 4 provides the criteria used to carry out the impact magnitude assessment of the LTN schemes. Section 5 outlines the changes to the traffic emissions data for the pre-scheme and post-scheme scenarios.

[1] Larkhall Rise modal filter is not considered to be a LTN

With the exception of these changes, the model set-up and emissions data is the same as that used in the current baseline (2019) assessment. Full details of the model set-up and model verification are provided in the current baseline (2019) report. Section 6 provides modelled concentrations for the pre-scheme and post-scheme scenarios and a discussion of the results is provided in Section 7. Appendix A includes a description of ADMS-Urban as a modelling tool.

3. Air quality standards

The EU *Ambient Air Quality Directive* (2008/50/EC) sets binding limits for concentrations of air pollutants, which take into account the effects of each pollutant on the health of those who are most sensitive to air quality. The Directive has been transposed into English legislation as the *Air Quality Standards Regulations 2010* [2] [3], which also incorporates the provisions of the *Fourth Daughter Directive* (2004/107/EC).

The Air Quality Standards Regulations 2010 include limit values and target values. Local authorities are required to work towards air quality objectives. In doing so, they assist the Government in meeting the limit values. The limit values are presented in Table 3.1.

As part of the 2018 London Environment Strategy [4], the Mayor of London's actions to improve air quality include achieving the World Health Organisation (WHO) guideline values by 2030. This report makes reference to the WHO guideline values from 2005, relevant for the time at which the 2018 Environment Strategy was published. The 2005 WHO guidelines included values of 40 $\mu g/m^3$ for annual average NO_2 concentrations, 200 $\mu g/m^3$ for (maximum) hourly average NO_2 concentrations, 20 $\mu g/m^3$ for annual average PM_{10} concentrations, 50 $\mu g/m^3$ for (the 99th percentile of) 24-hour average PM_{10} concentrations, 10 $\mu g/m^3$ for annual average $PM_{2.5}$ concentrations, and 25 $\mu g/m^3$ for (the 99th percentile of) 24-hour average $PM_{2.5}$ concentrations. Note that in September 2021, the WHO introduced new air quality guidelines and these have not been considered in this report.

Table 3.1: Air quality objectives

	Value ($\mu g/m^3$)	**Description of standard**
NO_2	200	Hourly mean not to be exceeded more than 18 times a calendar year (modelled as 99.79th percentile)
	40	Annual average
PM_{10}	50	24-hour mean not to be exceeded more than 35 times a calendar year (modelled as 90.41st percentile)
	40	Annual average
$PM_{2.5}$	25	Annual average

The short-term objectives, i.e. those measured hourly or over 24 hours, are specified in terms of the number of times during a year that a concentration measured over a short period of time is permitted to exceed a specified value. For example, the concentration of NO_2 measured as the average value recorded over a one-hour period is permitted to exceed the concentration of 200 $\mu g/m^3$ up to 18 times per year. Any more exceedences than this during a one-year period would represent a breach of the objective.

[2] http://www.legislation.gov.uk/uksi/2010/1001/contents/made
[3] Note limit and target values are not affected by *The Air Quality Standards (Amendments) Regulation 2016*
[4] https://www.london.gov.uk/sites/default/files/london_environment_strategy_0.pdf

It is convenient to model objectives of this form in terms of the equivalent percentile concentration value. A percentile is the concentration below which lie a specified percentage of concentration measurements. For example, consider the 98th percentile of one-hour concentrations over a year. Taking all of the 8760 one-hour concentration values that occur in a year, the 98th percentile value is the concentration below which 98% of those concentrations lie. Or, in other words, it is the concentration exceeded by 2% (100 – 98) of those hours, that is, 175 hours per year. Taking the NO_2 objective considered above, allowing 18 exceedences per year is equivalent to not exceeding for 8742 hours or for 99.79% of the year. This is therefore equivalent to the 99.79th percentile value. It is important to note that modelling exceedences of short term averages is generally not as accurate as modelling annual averages.

Table 3.2 gives examples from the London Local Air Quality Management technical guidance (LLAQM.TG(19))[5] of where the air quality objectives should apply. Note that this table differs from the equivalent table in Defra's national (outside London) guidance, LAQM. TG(16), includes clarifications that the annual average objective applies to school playgrounds and the grounds of hospitals and care homes.

[5] https://www.london.gov.uk/sites/default/files/llaqm_technical_guidance_2019.pdf

Table 3.2: Examples of where the air quality objectives should apply, as provided in the draft technical guidance LLAQM.TG(19)

Averaging period	**Objectives should apply at:**	**Objectives should generally not apply at:**
Annual average	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools (including all of playgrounds), hospitals (and their grounds), care homes (and their grounds) etc.	Building facades of offices or other places of work where members of the public do not have regular access. Hotels, unless people live there as their permanent residence. Gardens of residential properties Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
24-hour mean	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties (where relevant for public exposure e.g. seating or play areas)	Kerbside sites (as opposed to locations at the building facade), or any other location where public exposure is expected to be short term.
Hourly average	All locations where the annual mean and 24-hour mean objectives apply and: Kerbside sites (for example pavements of busy shopping streets). Those parts of car parks, bus stations and railway stations etc. Which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or longer. Any outdoor locations where members of the public might reasonably expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.

4. Significance criteria

The significance of the air quality impacts as a result of the LTN schemes was assessed using The Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM) guidance for Land-Use Planning & Development Control[6].

The impact magnitude criteria presented in the EPUK and IAQM guidance can be applied to any Air Quality Assessment Level (AQAL), such as the air quality objectives considered in this assessment.

Table 4.1 (reproduced from Table 6.3 of the document) sets out the impact descriptors. A concentration decrease of 0.5% or more from the baseline is considered a *Beneficial* impact and an increase of 0.5% or more is considered an *Adverse* impact.

Table 4.1: Impact descriptors

Long term average concentration at receptor in assessment year	**% change in concentration relative to Air Quality Assessment level (AQAL)**			
	1	2-5	6-10	>10
75% or less of AQAL	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Moderate	Substantial	Substantial	Substantial

Note percentages used in defining these descriptors are rounded to the nearest whole number

[6] Land-Use Planning & Development Control: Planning for Air Quality (January 2017) http://www.iaqm.co.uk/text/guidance/air-quality-planning-guidance.pdf

5. Emissions data

This section outlines the changes the current baseline (2019) emissions inventory to represent the pre-scheme and post-scheme scenarios. Unless otherwise stated, the emissions are the same as outlined in Section 6 of the current (2019) baseline report.

The following sections are not included as the information provided remains the same:

- Traffic emission factors;
- Time varying emissions;
- Industrial sources; and
- Other emissions.

5.1. Traffic data

As part of the monitoring programme for Lambeth's LTNs, data collection of traffic flows was carried out at survey sites using Automatic Traffic Counters (ATCs). The ATC sites are located within and on roads that surround the LTN areas. In the current (2019) baseline modelling, 82 survey sites were considered. For the assessment of Oval, Railton, Tulse Hill and Streatham Hill LTNs, 10 new survey sites were introduced. An additional 8 sites were introduced for the assessment of Ferndale LTN: F14 to F21. Site F4 is no longer included, as data collection was not carried out at this location. Traffic flow data for the ATC sites was provided by SYSTRA.

In this second part of the assessment, two scenarios, pre-scheme and post-scheme are modelled to assess the current air quality impact of the LTNs, based on the traffic monitoring programme. This report includes pre-scheme and post-scheme ATC data for Oval, Railton and Tulse Hill, Streatham Hill and Ferndale LTNs. The inclusion of ATC data for the remaining scheme areas will follow in a later report as traffic monitoring data becomes available. Note that, as the assessments of Oval, Railton, Tulse Hill and Streatam Hill LTNs have been provided in a separate report, only the air quality assessment for Ferndale LTN is presented in this report.

The pre-scheme scenario is represented by traffic data normalised to represent what would have happened with the COVID-19 pandemic, but without the LTNs. The COVID-19 pandemic led to a decrease in traffic for all motor vehicles compared to 2019 levels. As shown in Figure 5.1, the change in car traffic and Transport for London (TfL) bus traffic was most heavily impacted. Throughout 2021, car traffic and TfL bus traffic remains below the levels of an equivalent day or week prior to the pandemic.

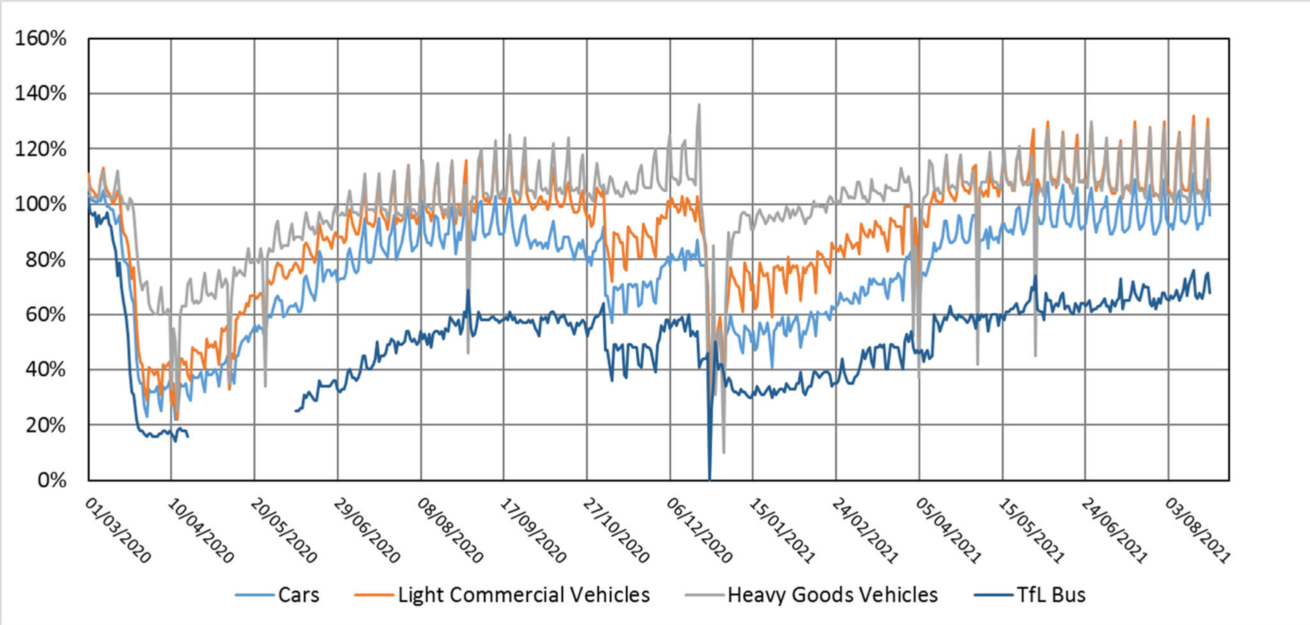

Figure 5.1: Use of transport modes in Great Britain since 1st March 2020. Figures are percentages of an equivalent day or week prior to the pandemic.[7]

To calculate the pre-scheme scenario traffic data, flow data prior to installation of the LTN was normalised to April 2021, when the most recent traffic counts were conducted. The normalisation process was carried out by SYSTRA based on the volume of traffic at continuous traffic counters in Lambeth for locations where consistent data are available. The scaling factor used for the normalisation process differs by site, as data were drawn from a variety of different studies occurring between 2017 and early 2020.

The post-scheme scenario is represented by traffic data collected in Stage 2 of the LTN monitoring programme. Data collected in Stage 2 represents the LTNs after council enforcement of LTN trails had started.

Further information on the traffic data can be found in the traffic monitoring reports by SYSTRA.

The traffic data for the pre-scheme and post-scheme scenarios were provided in AADT (Annual Average Daily Totals) format, split into motorcycles, cars, light goods vehicles and heavy goods vehicles. To match the eleven vehicle categories used for emission calculations, Car flows were split into Car and Taxi flows and heavy goods vehicle flows were split into Bus, Rigid HGV and Articulated HGV flows. The vehicle splits were taken from LAEI 2016 data.

In addition to the traffic data for each ATC site, pre-scheme and post-scheme traffic data was provided for TfL permanent ATC sites in Lambeth. At these sites, an AADT was calculated for each scenario, split into the eleven vehicle categories using LAEI 2016 data.

On scheme roads where pre-scheme and post-scheme data is not yet available, traffic and emissions data were calculated using 2019 ATC flow data, the same as used for the current (2019) baseline modelling. The assessment of these roads will follow in a later report as traffic monitoring data becomes available.

[7] https://www.gov.uk/government/statistics/transport-use-during-the-coronavirus-covid-19-pandemic

On all other roads in the borough, traffic and emissions data remain the same as for the current (2019) baseline modelling, calculated using DfT traffic counts for 2019 or LAEI 2016 traffic data projected to 2019 using borough-average growth factors derived from DfT traffic counts.

Figure 5.2 shows the network of explicitly modelled roads for the pre-scheme and post-scheme assessments. Major roads are defined as roads which form part of the LAEI road network. The Ferndale LTN roads which use ATC site traffic flows are shown in detail in Figure 5.3.

As described in the current (2019) baseline modelling, major roads within 750 m of the borough boundary were modelled in detail and emissions from other minor roads and more distant major roads were modelled as a part of the aggregated grid source. The widths for all roads were calculated using OS Mastermap data.

5.2. Traffic speeds

The LAEI 2016 speeds were used along all major roads, as described in the current (2019) baseline report. These speeds were used in preference to other datasets as they provide a good level of detail at junctions.

5.3. Road traffic fleet assumptions

The road traffic fleet assumptions remain the same as described in the current (2019) baseline report.

The current (2019) baseline modelling used Emission Factor Toolkit v10.1 projections for 2019. The modelling also considered renewals for the bus fleet in the scheme area associated with the Low Emissions Bus Zone.

In October 2021, the borough of Lambeth will be impacted by the expansion of the Ultra Low Emissions Zone (ULEZ). The expansion of the ULEZ may impact LTN schemes with traffic monitoring periods extending past the expansion of the ULEZ. Potential benefits from the expansion of the ULEZ have not been assessed.

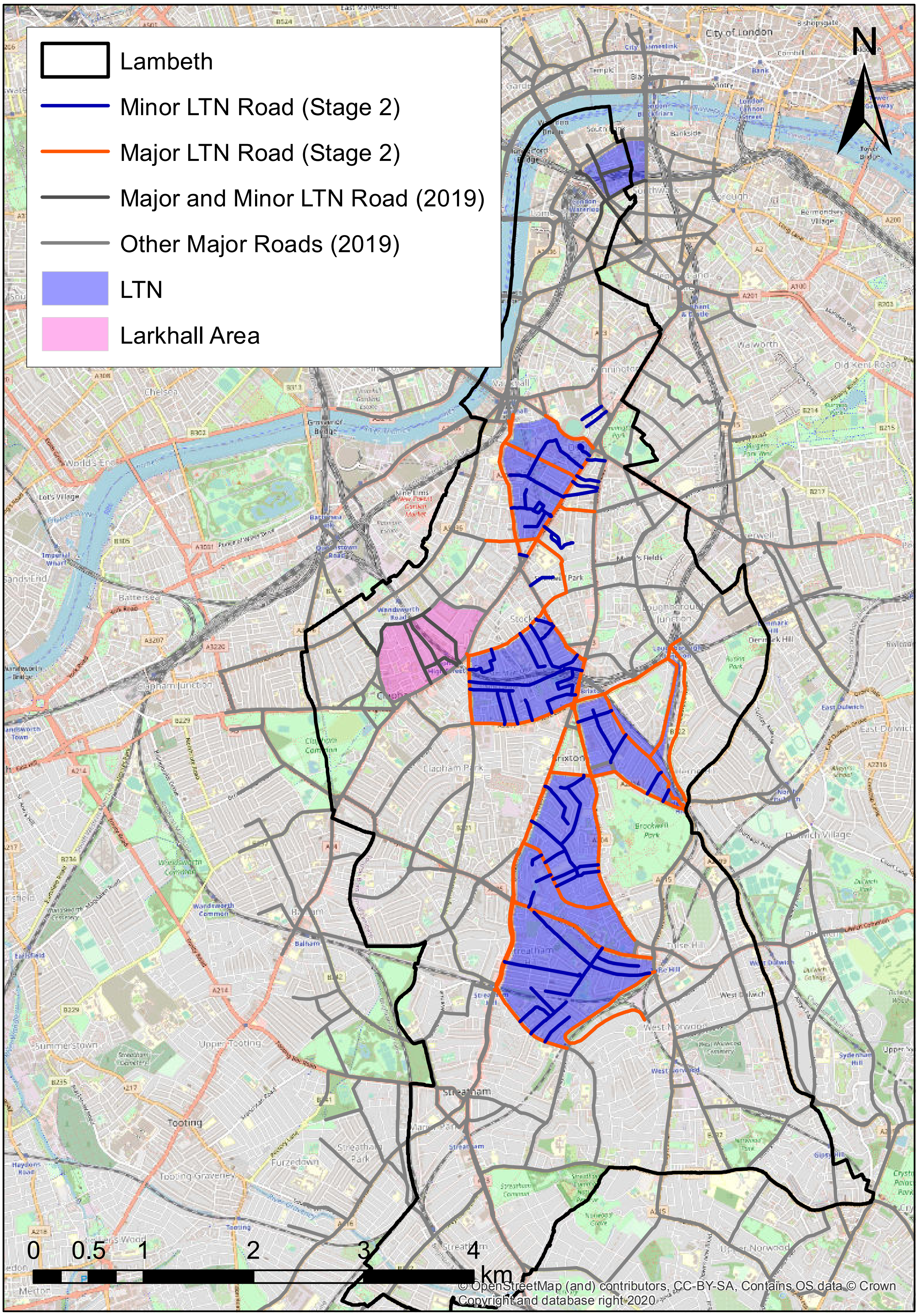

Figure 5.2: Map of explicitly modelled roads for the pre-scheme and post-scheme assessment

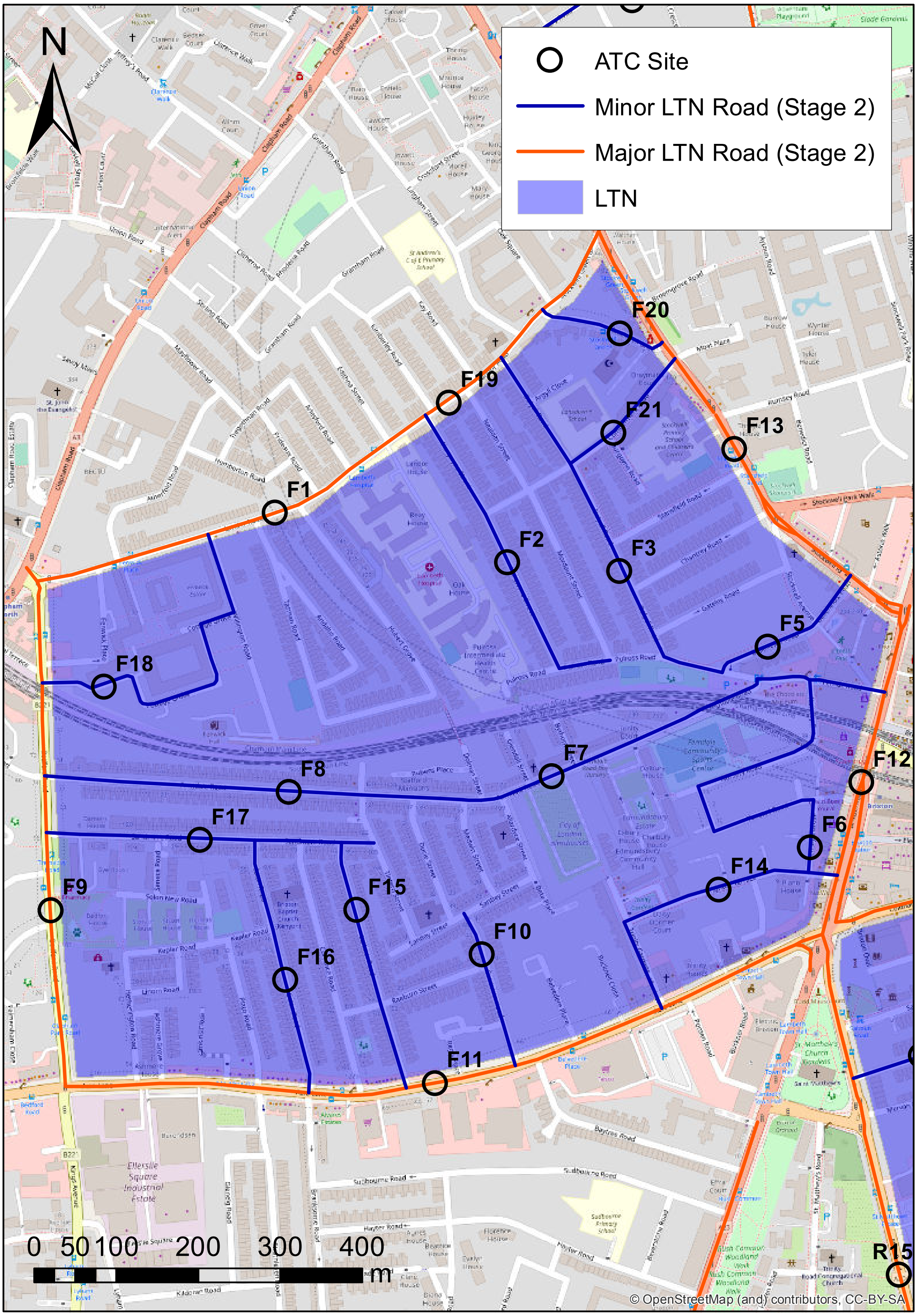

Figure 5.3: Map of explicitly modelled roads with ATC data for the pre-scheme and post-scheme assessment of Ferndale LTN

6. Model concentrations

This section presents modelled NO_2 and PM_{10} concentrations for the pre-scheme and post-scheme scenarios.

As described in the previous section, the modelling uses road traffic emissions calculated using pre-scheme and post-scheme traffic data from the ATC sites. All other model inputs are for 2019, including meteorological and background (contribution from outside London).

6.1. Receptor locations

Concentrations were calculated at sensitive receptor locations in and around Ferndale LTN, representing any schools, hospitals, care homes and other educational establishments. Receptors were modelled at a height of 1.5 m. Note that, in the model, the sensitive receptors were represented by points on the building facades where members of the public might be regularly exposed. Figure 6.1 shows the location sensitive receptors across Lambeth; receptors in and around Ferndale LTN are summarised in Table 6.1.

Table 6.2 provides the maximum façade concentration modelled at each sensitive receptor location for the pre-scheme and post-scheme scenarios. Note that this report includes only those sensitive receptor locations associated with Ferndale LTN.

There are no modelled exceedences of the relevant air quality standards for NO_2, PM_{10} or $PM_{2.5}$.

The change in annual average NO_2 concentrations between the post-scheme and pre-scheme scenarios ranges between a 0.7 $\mu g/m^3$ reduction (2% of air quality objective) in concentrations and a 0.1 $\mu g/m^3$ increase (less than 1% of air quality objective) in concentrations.

Table 6.2 highlights changes in magnitude of annual average NO_2 concentrations of 0.2 $\mu g/m^3$ or more. Using the EPUK IAQM significance criteria, for NO_2, the impact of the scheme is classed as *Negligible* at all locations.

There are no increases in annual average PM_{10} and $PM_{2.5}$ concentrations, only a small (0.1 $\mu g/m^3$) decrease at Stockwell Primary Pre-School, representing less than 1 % of the air quality objective. Using the EPUK IAQM significance criteria, the impact of the scheme at all sensitive receptors, for PM_{10} and $PM_{2.5}$, is classed as *Negligible*.

Using the EPUK IAQM significance criteria with the WHO guideline values of 20 $\mu g/m^3$ for annual average PM_{10}, and 10 $\mu g/m^3$ for annual average $PM_{2.5}$, the impact of the scheme can be classed as *Negligible* at all sensitive receptor locations except for Stockwell Primary Pre-School where the impact is *Moderate Beneficial.*

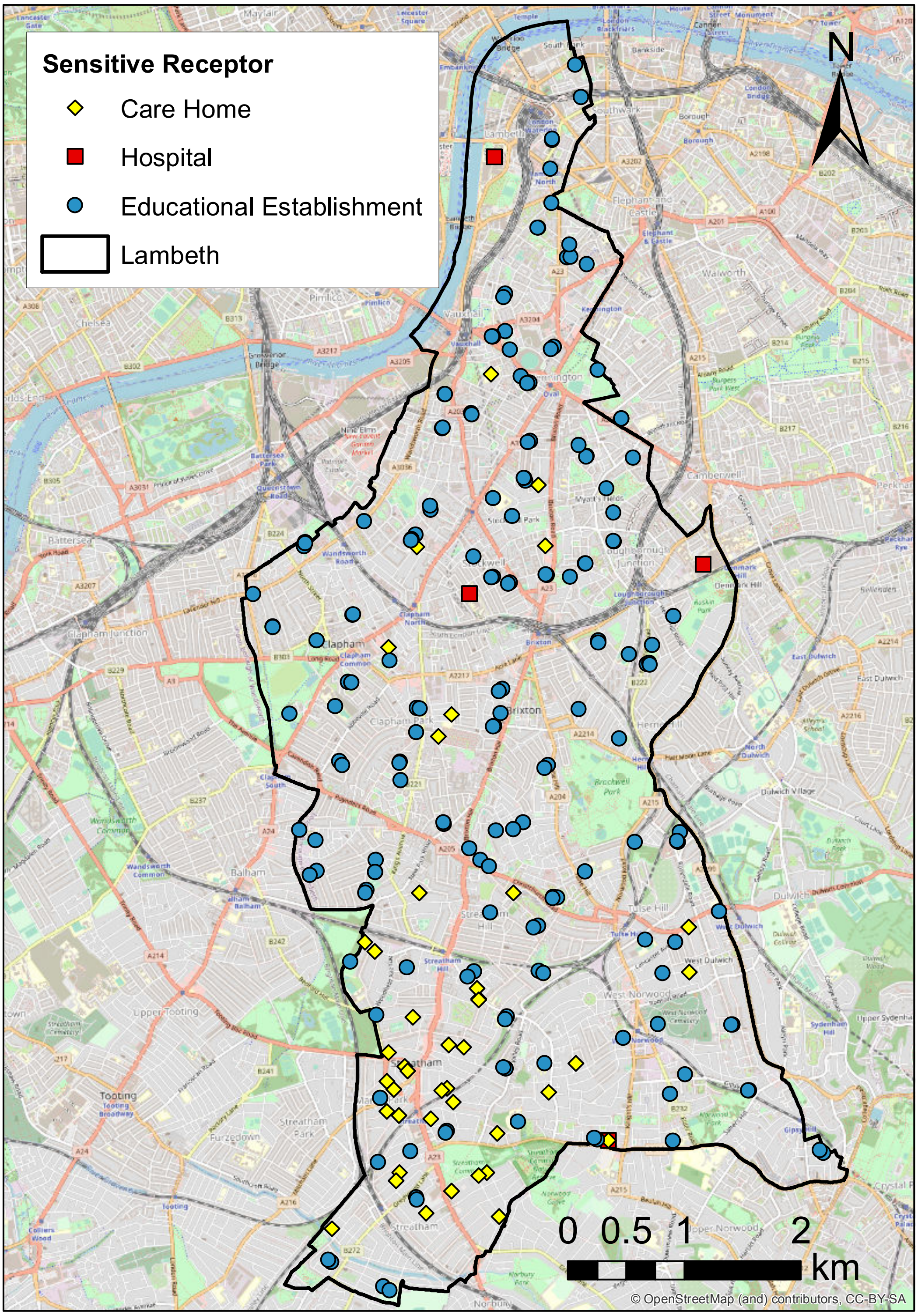

Figure 6.1: Locations of modelled sensitive receptors

Table 6.1: Sensitive receptor locations, Ferndale LTN

ID	Receptor Name	Receptor Type	Location (x, y)
4	Lambeth Hospital	Hospital	530467, 175781
61	Lansdowne	Special School	530682, 175907
83	Stockwell	Primary School	530810, 175920
193	Stockwell Primary School & Children's Centre	Nursery	530810, 175920
203	Stockwell Primary Pre-School	Pre-School	530652, 175907

Table 6.2: Modelled pre-scheme and post-scheme concentrations at sensitive receptors (µg/m³) at locations within or on boundary roads of Ferndale LTN. Changes in annual average NO_2 concentrations greater than or equal to 0.2 µg/m³ are highlighted in orange (increases) and blue (reductions)

ID	Pre-Scheme					Post-Scheme				
	Annual average NO_2	99.79^{th} percentile of 1-hour NO_2	Annual average PM_{10}	90.41^{st} percentile of 24-hour PM_{10}	Annual average $PM_{2.5}$	Annual average NO_2	99.79^{th} percentile of 1-hour NO_2	Annual average PM_{10}	90.41^{st} percentile of 24-hour PM_{10}	Annual average $PM_{2.5}$
4	27.7	103	20.2	37	12.8	27.8	103	20.2	37	12.8
61	28.0	104	20.7	37	12.9	28.0	104	20.7	37	12.9
83	28.6	104	21.3	38	13.1	28.6	104	21.3	38	13.1
193	28.6	104	21.3	38	13.1	28.6	104	21.3	38	13.1
203	29.1	106	20.8	37	13.0	28.4	104	20.7	37	12.9

6.2. Contour maps

Concentrations were calculated on a regular grid of receptors on a 20 m resolution and at additional roadside, kerbside and building facade points. The additional set of receptors was used to represent the steep concentration gradient from the roadside to the building facades. The model output was used to generate 5 m resolution contour maps across the scheme area using the natural neighbour interpolation method.

This section provides contour maps for Ferndale LTN only. The assessment of Oval, Railton, Tulse Hill and Streatham Hill LTN scheme areas has been described in a previous report and the assessment of other scheme areas will follow as traffic monitoring data becomes available.

Figure 6.2 shows modelled annual average NO_2 concentrations for the pre-scheme and post-scheme scenarios. There are some exceedences of the annual air quality objective along LTN boundary roads A203, Brixton Road (A23) and Bedford Road (B221). The extent of the exceedences is similar for both scenarios.

Figure 6.3 shows modelled 99.79th percentile of hourly average NO_2 concentrations for the pre-scheme and post-scheme scenarios. Modelled concentrations meet the hourly air quality objective of 200 $\mu g/m^3$ for both scenarios across Ferndale LTN.

Figure 6.4 shows modelled annual average PM_{10} concentrations for the pre-scheme and post-scheme scenarios. Modelled concentrations meet the annual average air quality objective of 40 $\mu g/m^3$ for both scenarios across Ferndale LTN.

Figure 6.5 shows modelled 90.41st percentile of 24-hour average PM_{10} concentrations for the pre-scheme and post-scheme scenarios. There are some exceedences of the daily average air quality objective of 50 $\mu g/m^3$ at the junction of LTN boundary roads A203 and Brixton Road (A23). The extent of the exceedences is similar for both scenarios.

Figure 6.6 shows modelled annual average $PM_{2.5}$ concentrations for the pre-scheme and post-scheme scenarios. Modelled concentrations meet the annual air quality objective of 25 $\mu g/m^3$ for both scenarios across Ferndale LTN.

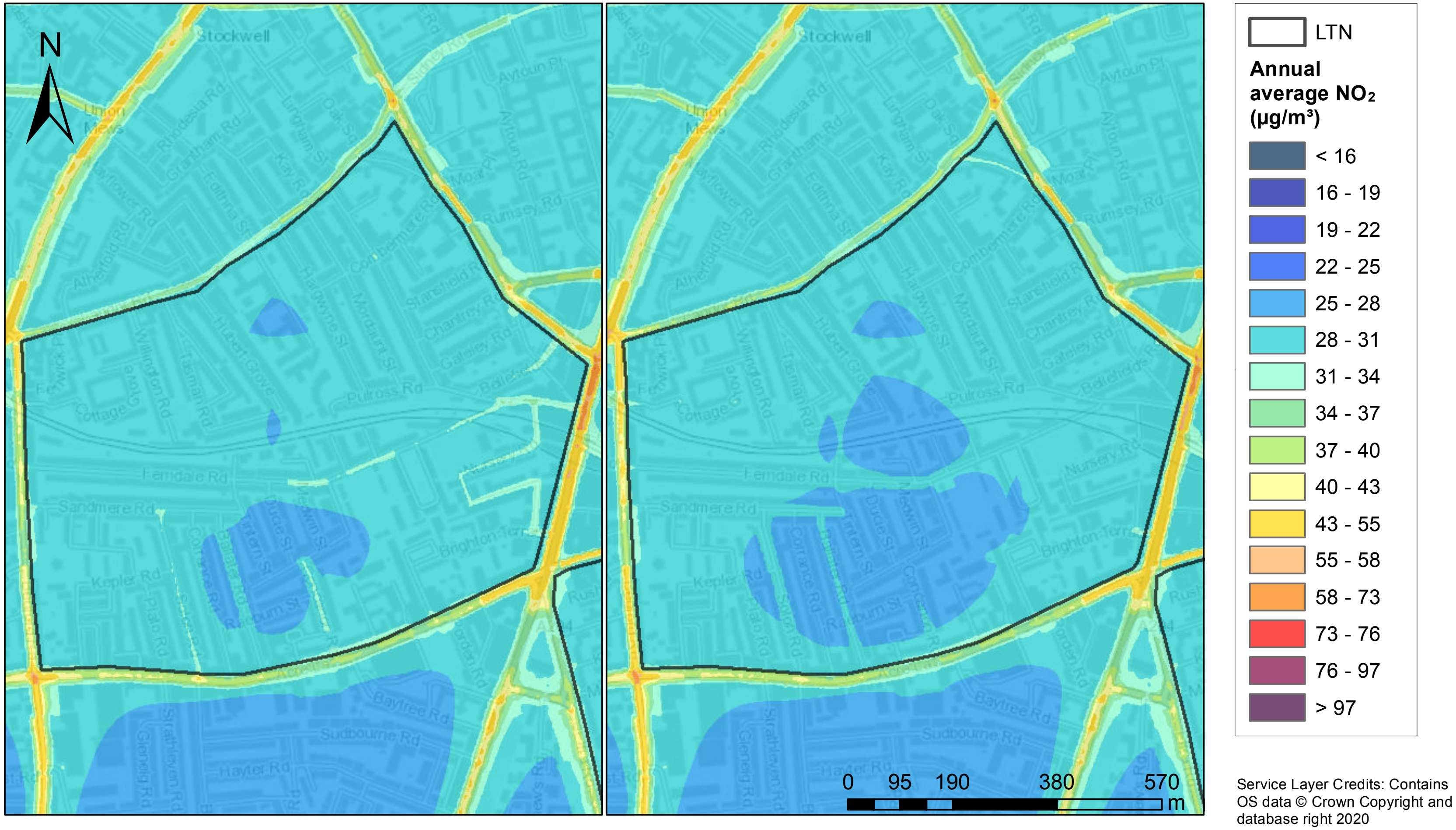

Figure 6.2: Pre-Scheme (left) and Post-Scheme (right) annual average NO_2 concentrations (µg/m³), Ferndale LTN

Figure 6.3: Pre-Scheme (left) and Post-Scheme (right) 99.79th percentile of hourly average NO_2 concentrations (µg/m³), Ferndale LTN

Figure 6.4: Pre-Scheme (left) and Post-Scheme (right) annual average PM_{10} concentrations (µg/m³), Ferndale LTN

Figure 6.5: Pre-Scheme (left) and Post-Scheme (right) 90.41st percentile of 24-hour average PM_{10} concentrations (µg/m³), Ferndale LTN

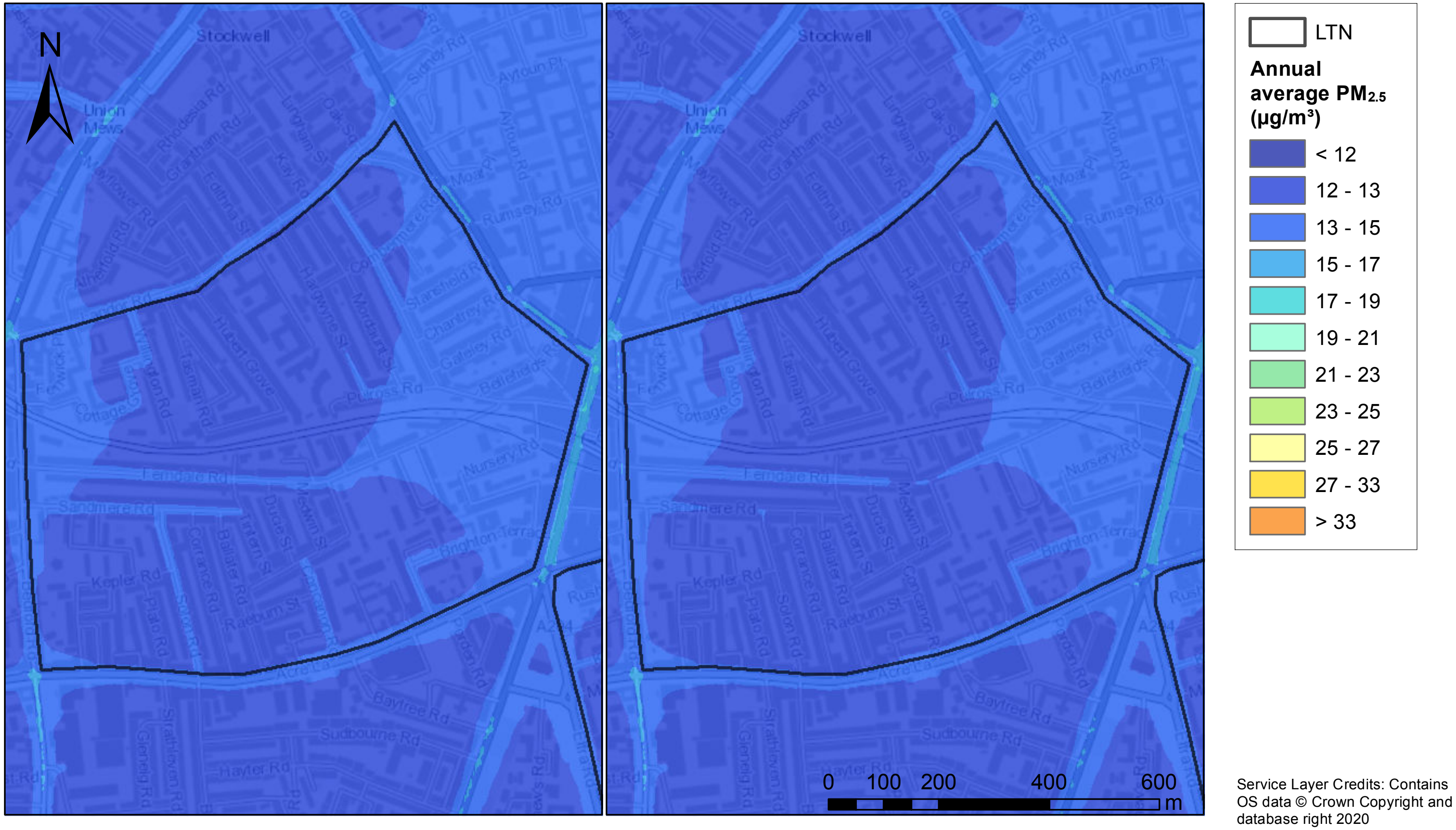

Figure 6.6: Pre-Scheme (left) and Post-Scheme (right) annual average $PM_{2.5}$ concentrations ($\mu g/m^3$), Ferndale LTN

6.3. Difference maps

Difference maps were calculated by subtracting the modelled annual average concentrations of the pre-scheme scenario from the post-scheme scenario. The resulting concentrations are shown on a map where: areas coloured red show an increase in concentrations with the scheme in place; areas coloured blue show a decrease in concentrations; and areas with no colour show no significant change in concentrations. The colour scale used reflects the percentage change criteria used in the EPUK IAQM significance criteria described in Section 4.

Figure 6.7 shows difference and IAQM impact descriptor plots for annual average NO_2 concentrations for Ferndale LTN. The plots use a colour scale reflecting the EPUK IAQM significance criteria.

Annual average NO_2 concentrations for the majority of Ferndale LTN fall into either the *< 75% of AQAL* or *76-94% of AQAL* long term concentration bands, the exception being some locations close to busy LTN boundary roads that fall into higher bands.

Across the majority of Ferndale LTN, annual average NO_2 concentrations are predicted to change by 5% or less of the air quality objective of 40 $\mu g/m^3$.

Comparing the concentration ranges for annual average NO_2 against the impact descriptors indicates that the significance of the air quality impact ranges from *Substantial Adverse to Substantial Beneficial*, with the impact classed as *Negligible* for most locations. Note that this analysis does not consider the type of location where these exceedences occur, i.e. whether or not they are representative of locations relevant for long-term exposure.

Areas where *Beneficial* or *Adverse* impacts are predicted in Ferndale LTN include:

- *Substantial Beneficial to Slight Beneficial* impacts on LTN roads Ferndale Road, Shannon Grove, Nursey Road, Bernays Grove, Tunstall Road, Brighton Terrace, Trinity Gardens, Concanon Road, Sandmere Road, Solon Road, Dalyell Road, Combermere Road and Bellefields Road;
- *Substantial Beneficial to Slight Beneficial* impacts on the boundary road Brixton Road (A23);
- *Slight Adverse* impacts on the LTN road Stockwell Green; and
- *Substantial Adverse to Slight Adverse* impacts on boundary roads A203, Landor Road, Stockwell Green and Bedford Road.

Figure 6.8 shows difference and EPUK IAQM impact descriptor plots for Ferndale LTN for annual average PM_{10}. The impact is classified as *Negligible* within Ferndale LTN and there are some *Slight Beneficial* impacts predicted along the boundary road Brixton Road (A23).

Figure 6.9 shows difference and EPUK IAQM impact descriptor plots for Ferndale LTN using the WHO guideline value of 20 µg/m^3 for annual average PM_{10}. Across the majority of Ferndale LTN, the impact is classified as *Negligible*. Areas where *Beneficial* and *Adverse* impacts are predicted for PM_{10} using the WHO guideline values are similar to areas predicted for NO_2 using the national air quality objective.

Figure 6.10 shows a difference plot of annual average $PM_{2.5}$ concentrations for Ferndale LTN. Due to significantly lower concentrations, relative to the air quality objective of 25 µg/m^3, the impact of the predicted changes in annual average $PM_{2.5}$ concentrations is classed as *Negligible*.

Figure 6.11 shows difference and EPUK IAQM impact descriptors plots for Ferndale LTN using the WHO guideline value of 10 µg/m^3 for annual average $PM_{2.5}$. Areas where *Beneficial* and *Adverse* impacts are predicted for $PM_{2.5}$ using the WHO guideline values are similar to areas predicted for NO_2 using the national air quality objective.

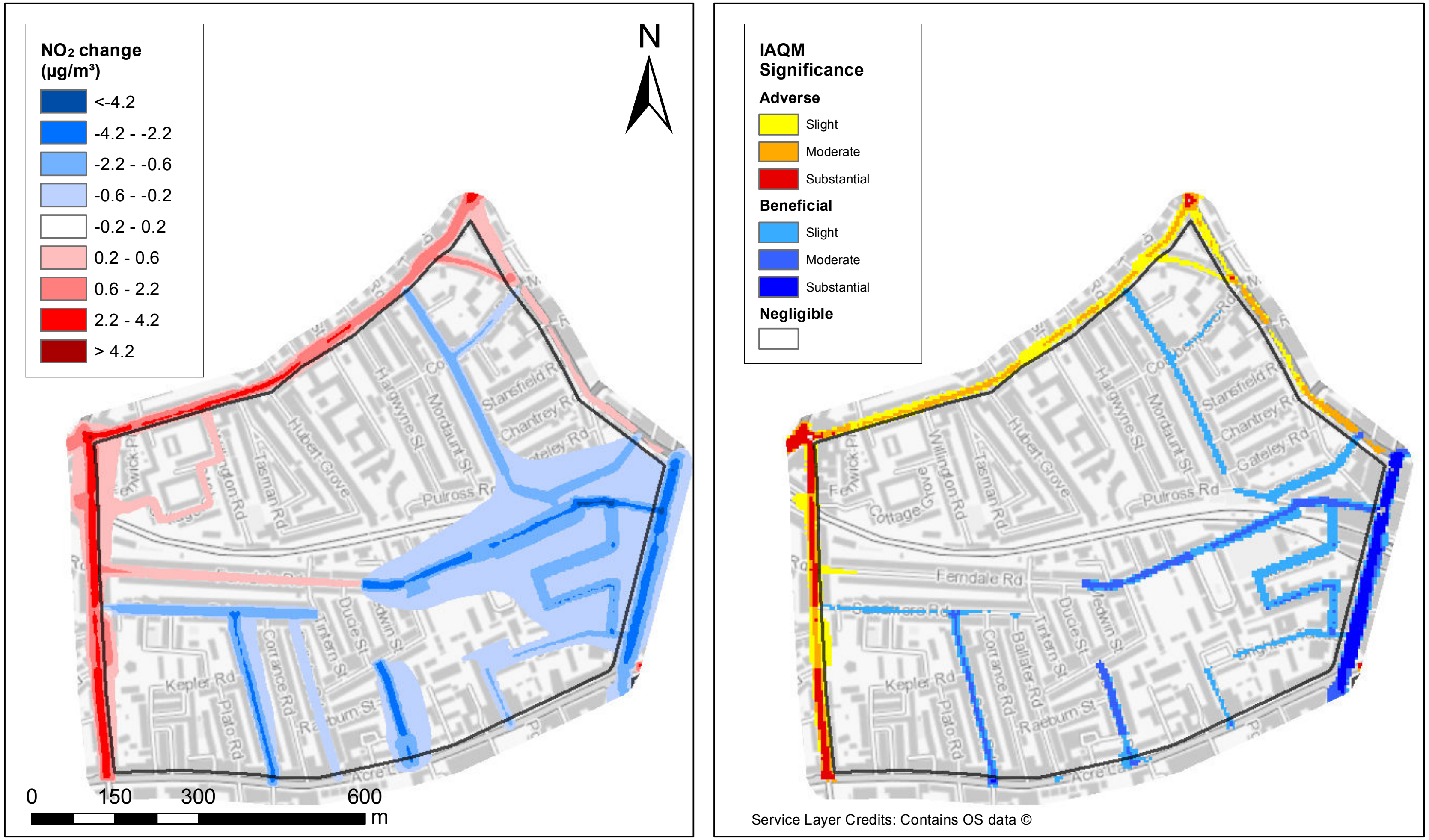

Figure 6.7:Difference plot (post-scheme minus pre-scheme) of annual average NO_2 concentrations coloured by EPUK IAQM concentration change bands (left) and impact descriptor plot coloured by EPUK IAQM significance criteria (right), Ferndale LTN

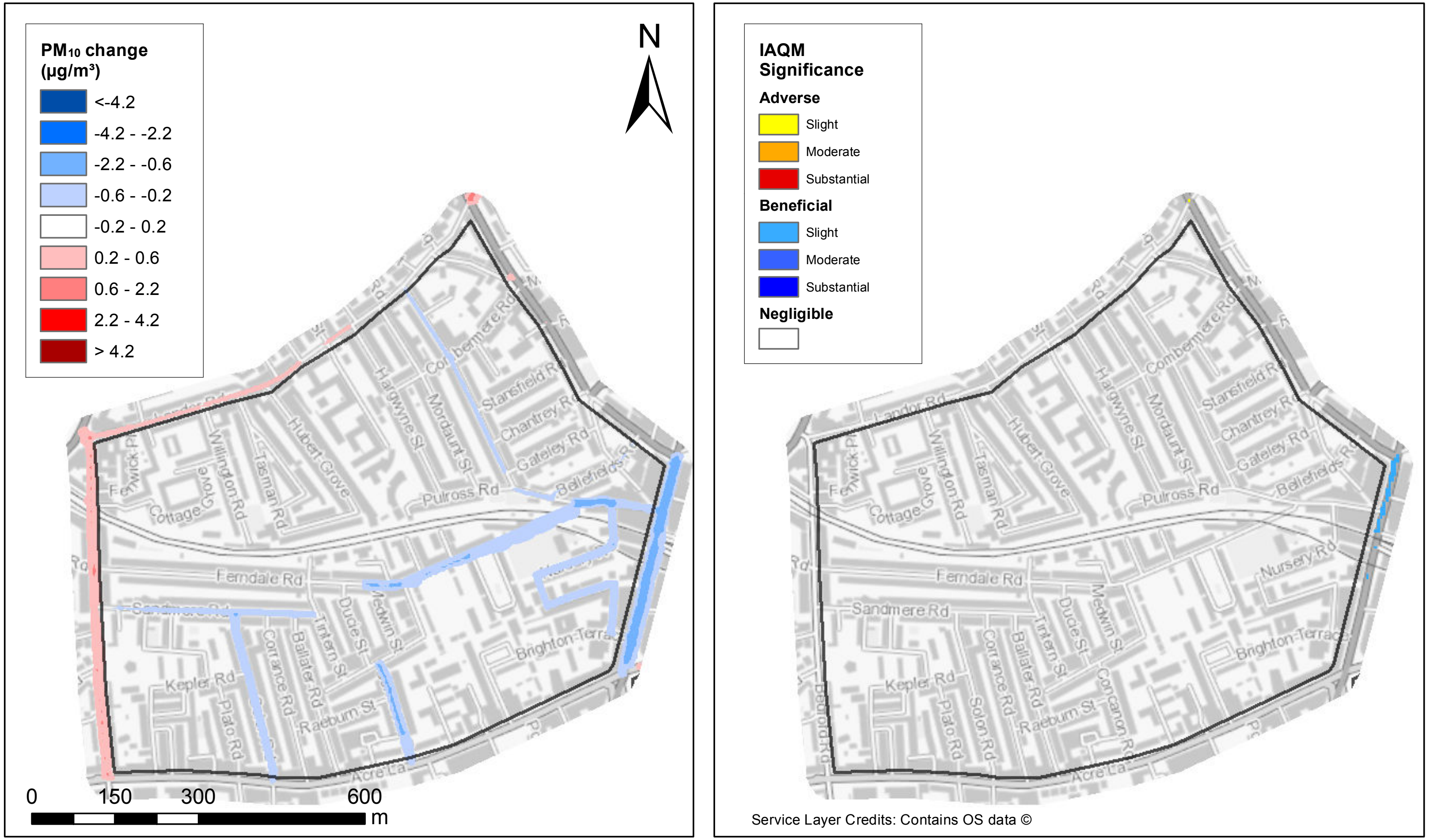

Figure 6.8: Difference plot (post-scheme minus pre-scheme) of annual average PM_{10} concentrations coloured by EPUK IAQM concentration change bands (left) and impact descriptor plot coloured by EPUK IAQM significance criteria (right), Ferndale LTN

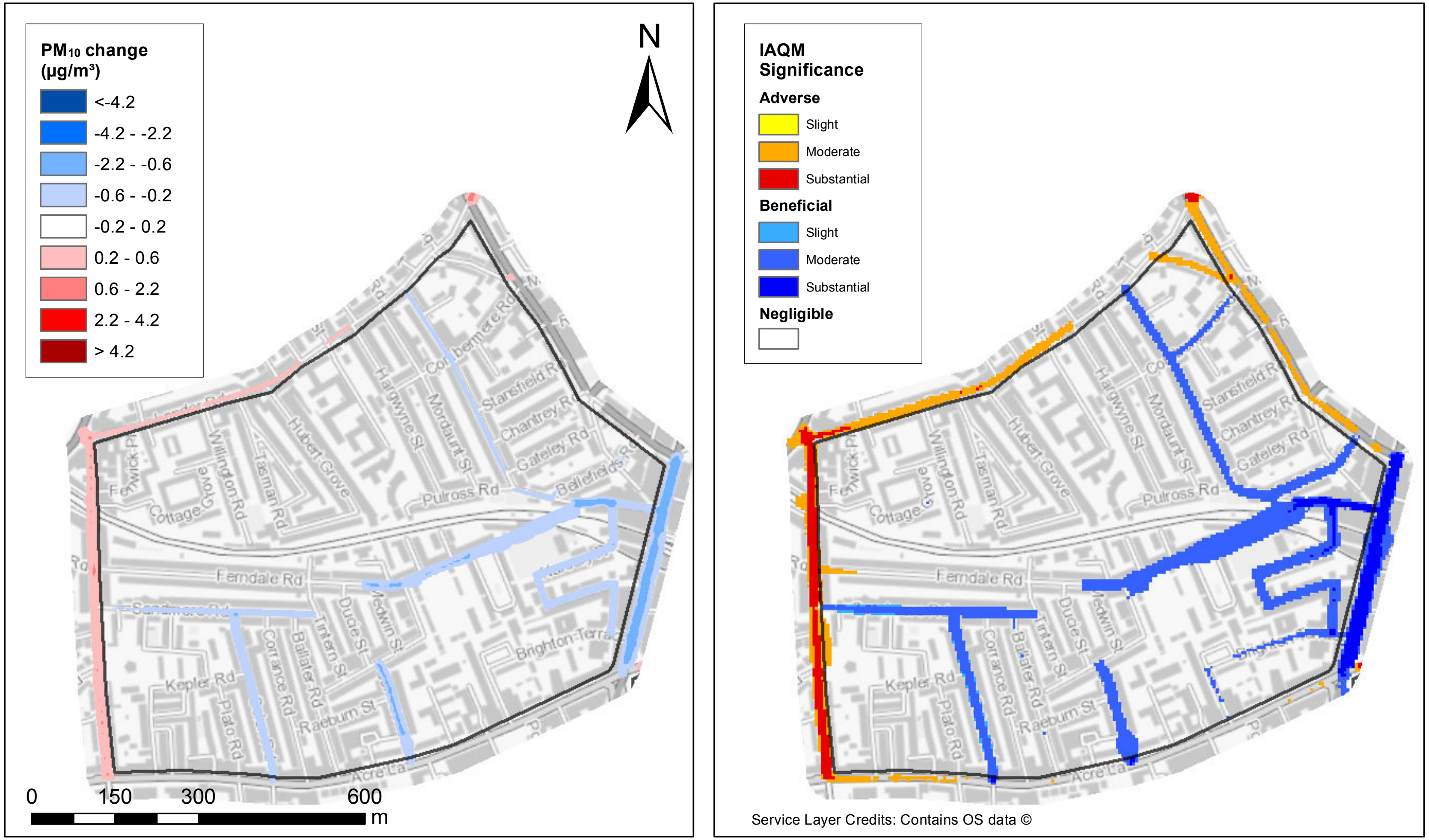

Figure 6.9: Difference plot (post-scheme minus pre-scheme) of annual average PM_{10} concentrations coloured by EPUK IAQM concentration change bands (left) and impact descriptor plot coloured by EPUK IAQM significance criteria based on WHO guidelines (right), Ferndale LTN

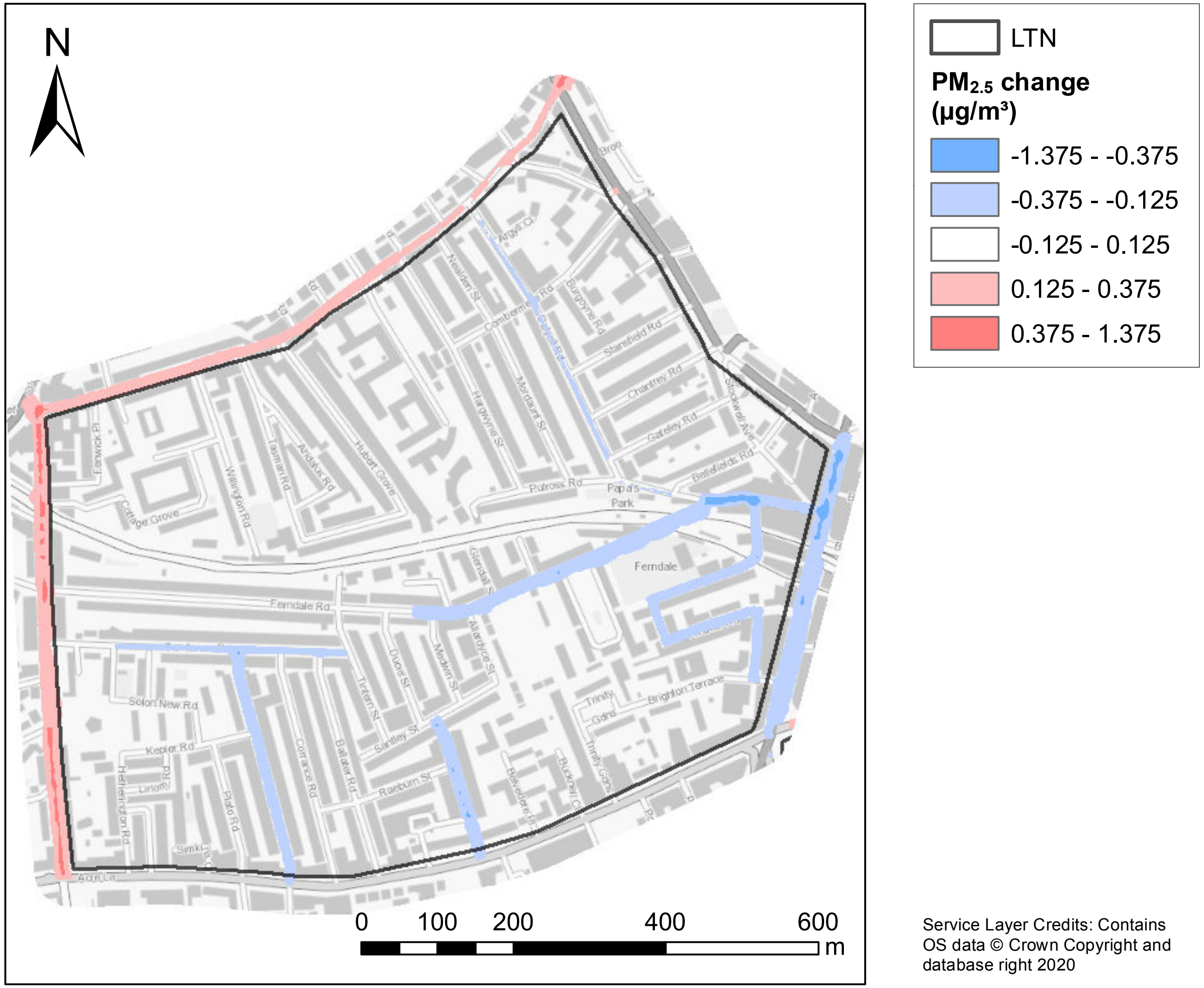

Figure 6.10: Difference plot (post-scheme minus pre-scheme) of annual average $PM_{2.5}$ concentrations, coloured by EPUK IAQM concentration change bands, Ferndale LTN

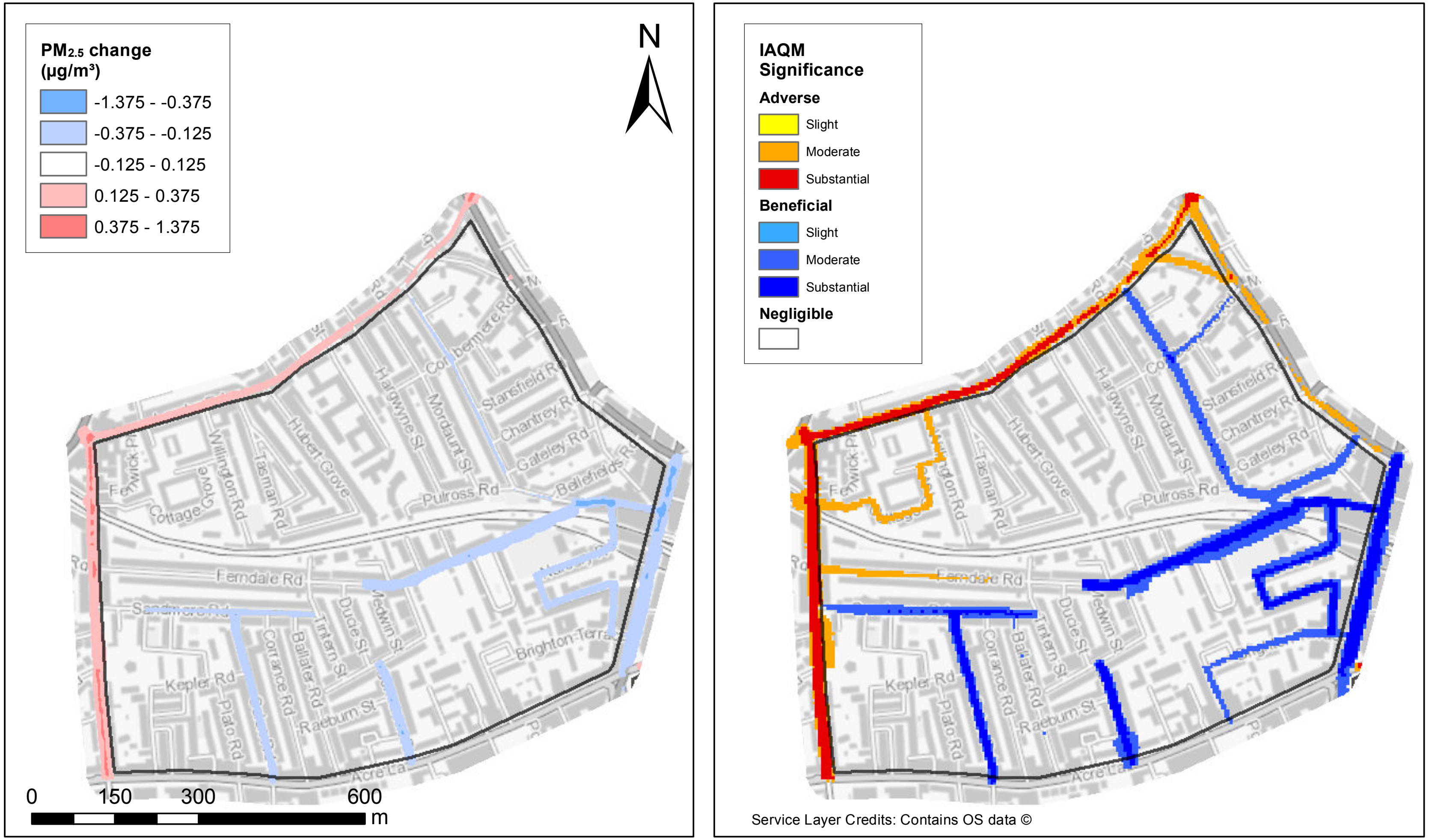

Figure 6.11: Difference plot (post-scheme minus pre-scheme) of annual average $PM_{2.5}$ concentrations coloured by EPUK IAQM concentration change bands (left) and impact descriptor plot coloured by EPUK IAQM significance criteria based on WHO guidelines (right), Ferndale LTN

7. Discussion and conclusions

Lambeth Council commissioned Cambridge Environmental Research Consultants Ltd (CERC) to carry out air quality modelling to assess the impact of Lambeth's Low Traffic Neighbourhoods (LTNs).

The first stage of the modelling, provided in a separate report *Assessing the Air Quality Impact of Lambeth's Low Traffic Neighbourhoods: borough-wide modelling for 2019 base year* determined the current baseline (2019) levels of NO_2, PM_{10} and $PM_{2.5}$ across the borough of Lambeth.

Using traffic monitoring data as inputs into the air quality model, the second part of the assessment considers pre-scheme and post-scheme scenarios to assess the air quality impact of the LTNs. Concentrations of NO_2, PM_{10} and $PM_{2.5}$ were modelled for assessment against national air quality objectives. This report presents the assessment of Ferndale LTN. Previous reports present the assessment of Oval, Railton, Tulse Hill and Streatham Hill LTNs. The assessment of the remaining scheme areas, Larkhall Rise and Cornwall Road LTN, will follow in a later report as traffic monitoring data becomes available.

7.1. NO_2 concentrations

At the sensitive receptor locations, there are no modelled exceedences of the annual average air quality standard for NO_2. The change in annual average NO_2 concentrations between the post-scheme and pre-scheme scenarios ranges between a 0.7 µg/m³ reduction and a 0.1 µg/m³ increase in concentrations. Using the EPUK IAQM significance criteria, for NO_2, the impact of the scheme is classed as *Negligible* at all sensitive receptors in Ferndale LTN.

The air quality objectives for NO_2 are met within Ferndale LTN.

There are some exceedences of the annual air quality objective of 40 µg/m³ for NO_2 along LTN boundary roads A203, Brixton Road (A23) and Bedford Road (B221). The extent of the exceedences is similar for both scenarios.

There are no modelled exceedences of the 99.79th percentile of hourly average NO_2 concentrations across the scheme area, including at all sensitive receptor concentrations.

Across the majority of Ferndale LTN, annual average NO_2 concentrations are predicted to change by 5% or less of the air quality objective of 40 µg/m³.

Comparing the concentration ranges for annual average NO_2 against the impact descriptors indicates that the significance of the air quality impact ranges from *Substantial Adverse to Substantial Beneficial*, with the impact classed as *Negligible* for most locations. Note that this analysis does not consider the type of location where these exceedences occur, i.e. whether or not they are representative of locations relevant for long-term exposure.

Areas where *Beneficial* or *Adverse* impacts are predicted in Ferndale LTN include:

- *Substantial Beneficial to Slight Beneficial* impacts on LTN roads Ferndale Road, Shannon Grove, Nursey Road, Bernays Grove, Tunstall Road, Brighton Terrace, Trinity Gardens, Concanon Road, Sandmere Road, Solon Road, Dalyell Road, Combermere Road and Bellefields Road;
- *Substantial Beneficial to Slight Beneficial* impacts on the boundary road Brixton Road (A23);
- *Slight Adverse* impacts on the LTN road Stockwell Green; and
- *Substantial Adverse to Slight Adverse* impacts on boundary roads A203, Landor Road, Stockwell Green and Bedford Road.

7.2. PM_{10} concentrations

There are no modelled exceedences of the annual average air quality standard for PM_{10} across the scheme areas, including at all sensitive receptor locations. Using the EPUK IAQM significance criteria the impact within Ferndale LTN, including at sensitive receptor locations is classed as *Negligible.* There are however some *Slight Beneficial* impacts predicted along the boundary road Brixton Road (A23).

Using the EPUK IAQM significance criteria with the WHO guideline value of 20 µg/m^3 for annual average PM_{10}, the impact of the scheme can be classed as *Negligible* at all sensitive receptor locations except for Stockwell Primary Pre-School where the impact is classed as *Moderate Beneficial.* Across the majority of Ferndale LTN, the impact is classified as *Negligible*. Areas where *Beneficial* and *Adverse* impacts are predicted for PM_{10} using the WHO guideline values are similar to areas predicted for NO_2 using the national air quality objective.

There are no modelled exceedences of the 90.41st percentile of 24-hour average PM_{10} concentrations across the scheme areas, including at all sensitive receptor locations.

7.3. $PM_{2.5}$ concentrations

There are no modelled exceedences of the annual average air quality standard for $PM_{2.5}$ across Ferndale LTN, including at all sensitive receptor locations. Using the EPUK IAQM significance criteria, the impact of the scheme for $PM_{2.5}$, is classed as *Negligible* at all locations.

Using the EPUK IAQM significance criteria with the WHO guideline value of 10 µg/m^3 for annual average $PM_{2.5}$, the impact of the scheme can be classed as *Negligible* at all sensitive receptor locations except for Stockwell Primary Pre-School where the impact is *Moderate Beneficial*. Across the majority of Ferndale LTN, the impact is classified as *Negligible*. Areas where *Beneficial* and *Adverse* impacts are predicted for $PM_{2.5}$ using the WHO guideline values are similar to areas predicted for NO_2 using the national air quality objective.

APPENDIX A: Summary of ADMS-Urban

ADMS-Urban is a scientifically advanced but practical air pollution modelling tool, which has been developed to provide high resolution calculations of pollution concentrations for all sizes of study area relevant to the urban environment. The model can be used to look at concentrations near a single road junction or over a region extending across the whole of a major city. ADMS-Urban is used worldwide to assess air quality impact for a wide range of planning and policy studies, incorporating elements such as Low Emission Zones, traffic management, clean vehicle technologies and modal shift. In the UK, it is used extensively for air quality review and assessment carried out by local government.

The following is a summary of the capabilities and validation of ADMS-Urban. More details can be found on the CERC web site[8].

ADMS-Urban is a development of the Atmospheric Dispersion Modelling System (ADMS), which has been developed to investigate the impacts of emissions from industrial facilities. ADMS-Urban allows full characterisation of the wide variety of emissions in urban areas, including an extensively validated road traffic emissions model. It also includes a number of other features, which include consideration of:

- the effects of vehicle movement on the dispersion of traffic emissions;
- the behaviour of material released into street-canyons;
- the chemical reactions occurring between nitrogen oxides, ozone and Volatile Organic Compounds (VOCs);
- the pollution entering a study area from beyond its boundaries;
- the effects of complex terrain on the dispersion of pollutants;
- the effects of the urban canopy on the dispersion of pollutants; and
- the effects of a building on the dispersion of pollutants emitted nearby.

Further details of these features are provided below.

Studies of extensive urban areas are necessarily complex, requiring the manipulation of large amounts of data. To allow users to cope effectively with this requirement, ADMS-Urban runs in Windows 10 and Windows 8 environments. The manipulation of data is further facilitated by the ADMS-Urban Mapper, which allows for the visualisation and manipulation of geospatial information, and by the CERC Emissions Inventory Toolkit, EMIT.

[8] https://www.cerc.co.uk/environmental-software/ADMS-Urban-model.html

Dispersion Modelling

ADMS and ADMS-Urban use boundary layer similarity profiles to parameterise the variation of turbulence with height within the boundary layer, and the use of a skewed-Gaussian distribution to determine the vertical variation of pollutant concentrations in the plume under convective conditions.

The main dispersion modelling features of ADMS-Urban are as follows:

- ADMS-Urban is an **advanced dispersion model** in which the boundary layer structure is characterised by the height of the boundary layer and the Monin-Obukhov length, a length scale dependent on the friction velocity and the heat flux at the surface. This method supersedes methods based on Pasquill Stability Categories, as used in, for example, the US models Caline and ISC. Concentrations are calculated hour by hour and are fully dependent on prevailing weather conditions.
- For convective conditions, a **non-Gaussian vertical profile of concentration** allows for the skewed nature of turbulence within the atmospheric boundary layer, which can lead to high concentrations near to the source.
- A **meteorological processor** calculates boundary layer parameters from a variety of input data, typically including date and time, wind speed and direction, surface temperature and cloud cover. Meteorological data may be raw, hourly averaged or statistically analysed data.

Emissions

Emissions into the atmosphere across an urban area typically come from a wide variety of sources. There are likely to be emissions from road traffic, as well as from domestic heating systems and industrial emissions from chimneys. To represent the full range of emissions configurations, the explicit source types available within ADMS-Urban are:

- **Roads**, for which emissions are specified in terms of vehicle flows and the additional initial dispersion caused by moving vehicles is also taken into account.
- **Industrial points**, for which plume rise and stack downwash are included in the modelling.
- **Areas**, where a source or sources is best represented as uniformly spread over an area.
- **Volumes**, where a source or sources is best represented as uniformly spread throughout a volume.

In addition, sources can also be modelled as a regular grid of emissions. This allows the contributions of large numbers of minor sources to be efficiently included in a study while the majority of the modelling effort is used for the relatively few significant sources.

ADMS-Urban can be used in conjunction with CERC's Emissions Inventory Toolkit, EMIT, which facilitates the management and manipulation of large and complex data sets into usable emissions inventories.

Presentation of Results

The results from the model can be based on a wide range of averaging times, and include rolling averages. Maximum concentration values and percentiles can be calculated where appropriate meteorological input data have been input to the model. This allows ADMS-Urban to be used to calculate concentrations for direct comparison with existing air quality limits, guidelines and objectives, in whatever form they are specified.

ADMS-Urban has an integrated Mapper which facilitates both the compilation and manipulation of the emissions information required as input to the model and the interpretation and presentation of the air quality results provided. ADMS-Urban can also be integrated with ArcGIS or MapInfo.

Complex Effects - Street Canyons

ADMS-Urban incorporates two methods for representing the effect of street canyons on the dispersion of road traffic emissions: a basic canyon method based on the *Operational Street Pollution Model (OSPM)*[9], developed by the Danish National Environmental Research Institute (NERI); and an advanced street canyon module, developed by CERC. The basic canyon model was designed for simple symmetric canyons with height similar to width and assumes that road traffic emissions originate throughout the base of the canyon, i.e. that the emissions are spread across both the road and neighbouring pavements.

The advanced canyon model[10] was developed to overcome these limitations and is our model of choice. It represents the effects of channelling flow along and recirculating flow across a street canyon, dispersion out of the canyon through gaps in the walls, over the top of the buildings or out of the end of the canyon. It can take into account canyon asymmetry and restricts the emissions area to the road carriageway.

[9] Hertel, O., Berkowicz, R. and Larssen, S., 1990, 'The Operational Street Pollution Model (OSPM).' *18th International meeting of NATO/CCMS on Air Pollution Modelling and its Applications.* Vancouver, Canada, pp741-749.

[10] Hood C, Carruthers D, Seaton M, Stocker J and Johnson K, 2014. *Urban canopy flow field and advanced street canyon modelling in ADMS-Urban.* 16th International Conference on Harmonisation within Atmospheric Dispersion Modelling for Regulatory Purposes, Varna, Bulgaria, September 2014. http://www.harmo.org/Conferences/Proceedings/_Varna/publishedSections/H16-067-Hood-EA.pdf

Complex Effects - Chemistry

ADMS-Urban includes the *Generic Reaction Set (GRS)*[11] atmospheric chemistry scheme. The original scheme has seven reactions, including those occurring between nitrogen oxides and ozone and parameterisations of the large number of reactions involving a wide range of Volatile Organic Compounds (VOCs). In addition, an eighth reaction has been included within ADMS-Urban for the situation when high concentrations of nitric oxide (NO) can convert to nitrogen dioxide (NO_2) using molecular oxygen.

In addition to the basic GRS scheme, ADMS-Urban also includes a trajectory model[12] for use when modelling large areas. This permits the chemical conversions of the emissions and background concentrations upwind of each location to be properly taken into account.

Complex Effects - Terrain

As well as the effect that complex terrain has on wind direction and, consequently, pollution transport, it can also enhance turbulence and therefore increase dispersion. These effects are taken into account in ADMS-Urban using the FLOWSTAR[13] model developed by CERC.

Complex Effects – Urban Canopy

As wind approaches an urban area of relatively densely packed buildings, the wind profile is vertically displaced. The wind speed and turbulence levels are also reduced within the area of buildings. These effects are taken into account in ADMS-Urban by modifying the wind speed and turbulence profiles based on parameters describing the amount and size of buildings within an urban area.

Data Comparisons – Model Validation

ADMS-Urban is a development of the Atmospheric Dispersion Modelling System (ADMS), which is used throughout the UK by industry and the Environment Agency to model emissions from industrial sources. ADMS has been subject to extensive validation, both of individual components (e.g. point source, street canyon, building effects and meteorological pre-processor) and of its overall performance.

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[11] Venkatram, A., Karamchandani, P., Pai, P. and Goldstein, R., 1994, 'The Development and Application of a Simplified Ozone Modelling System.' *Atmospheric Environment,* Vol 28, No 22, pp3665-3678.

[12] Singles, R.J., Sutton, M.A. and Weston, K.J., 1997, 'A multi-layer model to describe the atmospheric transport and deposition of ammonia in Great Britain.' In: *International Conference on Atmospheric Ammonia: Emission, Deposition and Environmental Impacts. Atmospheric Environment*, Vol 32, No 3.

[13] Carruthers D.J., Hunt J.C.R. and Weng W-S. 1988. 'A computational model of stratified turbulent airflow over hills – FLOWSTAR I.' Proceedings of Envirosoft. In: *Computer Techniques in Environmental Studies,* P. Zanetti (Ed) pp 481-492. Springer-Verlag.

ADMS-Urban has been extensively tested and validated against monitoring data for large urban areas in the UK and overseas, including London, Birmingham, Manchester, Glasgow, Riga, Cape Town, Hong Kong and Beijing, as part of projects supported by local governments and research organisations. A summary of model validation studies is available online[14]. CERC have co-authored[15] a number of papers presenting results from ADMS-Urban, and other organisations have published the outcomes of their applications of the model[16].

[14] www.cerc.co.uk/Validation
[15] www.cerc.co.uk/CERCCoAuthorPublications
[16] www.cerc.co.uk/CERCSoftwarePublications