APPENDIX 3

Southampton Clean Air Zone – Air Quality Results Report (AQ3)

Report for Southampton City Council and New Forest District Council

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Southampton CAZ Feasibility Study

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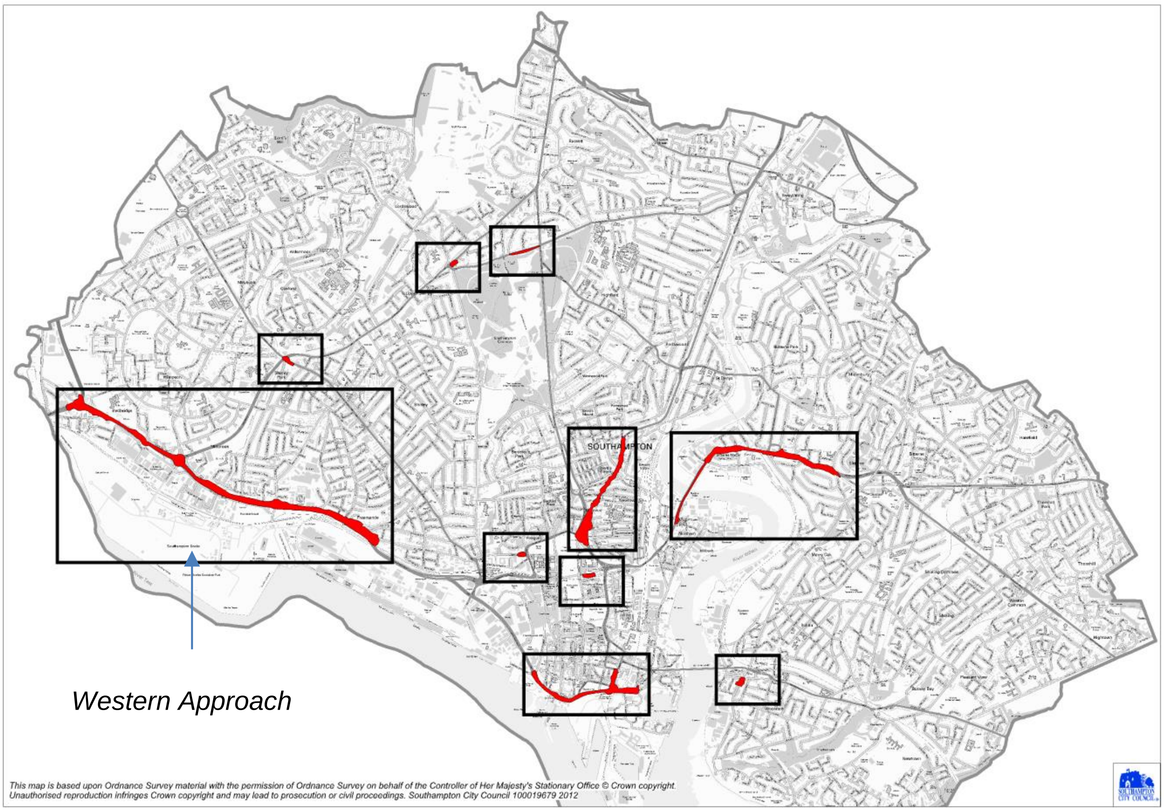
1 Introduction

Southampton, like many other urban areas, has elevated levels of Nitrogen Dioxide (NO_2) due mainly to road transport emissions. As such Southampton City Council (SCC) has designated 10 Air Quality Management Areas (AQMA) across the City, as shown in Figure 1 below, where concentrations of NO_2 breach Government, health-based air quality objectives and has undertaken reviews of current and predicted levels in the future, including assessments of measures to reduce pollution levels.

Figure 1 Southampton Air Quality Management Areas (AQMA)



In addition, Southampton was identified as one of the 5 cities in the UK where the EU Limit Value for NO_2 are not expected to be met by 2020 in DEFRA's 2015 Air Quality Plan. The key area identified by the DEFRA plan that will exceed in 2020 is the Western Approaches AQMA. The Plan also stated that each of the cities identified will be legally required to introduce a formal charging-based Clean Air Zone (CAZ), or equivalent, for specified classes of vehicles and European Vehicle Emission Standards (Euro Standards) as soon as practical but no later than 2020.

Subsequent work by DEFRA updated its air quality plan using more recent information on the expected real-world emission performance of vehicles. This later analysis identified an exceedance area in neighbouring New Forest District Council (NFDC) that would be expected to be beneficially impacted by a CAZ in Southampton. As such NFDC were instructed to work jointly with Southampton City Council to assess the impact of the CAZ options being developed on the New Forest exceedance area.

Following a sifting exercise and assessment of the AQ quality results for the 2020 baseline under business as usual conditions a list of the CAZ schemes was identified to take forward for detailed air quality modelling. The options that have been assessed are:

- Option 1 – a citywide Class B CAZ covering buses, taxis and HGVs;
- Option 1a – a city wide HGV charging scheme complemented by a bus traffic condition based on Euro VI for the city centre and incentives to upgrade taxis;
- Option 2 – a city centre Class A CAZ covering buses and taxis, complemented by bus retrofit grants, taxi upgrade incentives, an expansion of the freight consolidation centre and related DSP initiative and working with the port on promoting Euro VI HGVs;
- Option 3 – a non-charging CAZ comprising a bus traffic condition for Euro VI buses in the city centre supported by retrofit grants, taxi upgrade incentives and the freight measures from option 2.

This report sets out the details of these options, how they have been assessed and the air quality results for NO_2 in relation to the nationally modelled PCM road links and local monitoring locations. The results are provided for both the Southampton and New Forest modelling domains.

In addition to the option results an updated set of baseline results for 2020 are provided. This includes the baseline results for the New Forest modelling domain, which have not been reported before, and an update to the Southampton baseline which includes a correction to LGV emissions, the split of Euro 6 stages in the fleet in 2020 and an adjustment to the background maps that was discovered whilst running the CAZ options.

2 Options assessed and modelling assumptions

2.1 Description of options

The CAZ options have been developed for Southampton and though they do not cover specific measures in New Forest they will impact on New Forest in terms of changes in traffic flows and vehicle fleet composition. The CAZ options considered cover both formal charging-based CAZ schemes and non-charging measures. The boundaries for the charging CAZ schemes are illustrated in Figure 2 below. For the final options that were assessed only the city-wide boundary and the city centre boundary were considered.

Each of the CAZ schemes modelled are described in more detail below.

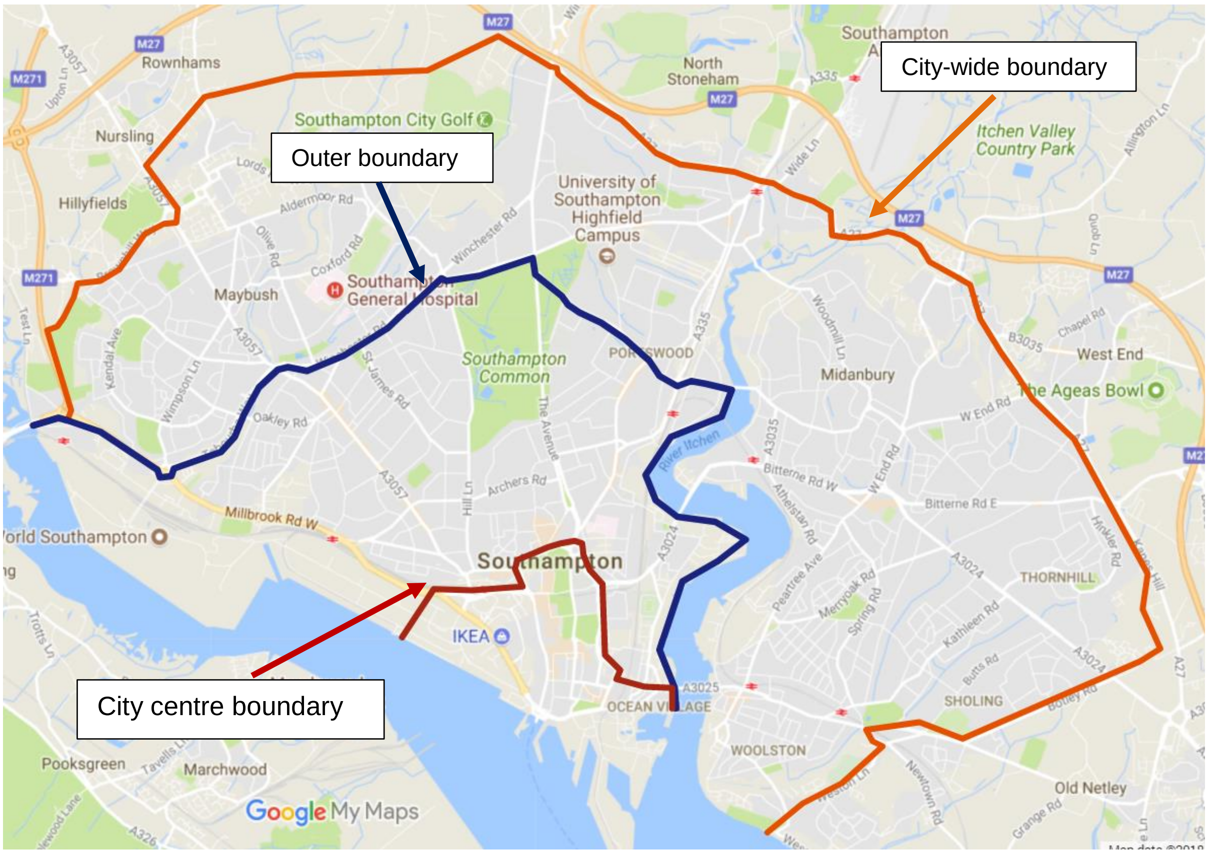
2.1.1 Option 1 – City wide CAZ B

The first option considered is a formal Class B charging CAZ with a boundary set covering the whole Southampton city area. The Class B CAZ covers buses (including coaches), taxis and HGVs, where vehicles not meeting the Euro 6/VI standard for diesel (or Euro 4 for Petrol) are charged for entering the city. Vehicles that are passing through the city would have the option of diverting around, which in this case is essentially a diversion around the M27.

The charge for assessment purposes has been set at the same level as the London ULEZ; £100/day for HGVs and buses, and £12.50 per day for taxis. This charge has been used as the modelling uses vehicle upgrade assumptions provided by JAQU and based on the evidence from the London ULEZ.

This option has been modelled in the transport model to assess potential diversionary or destination shifts as a result of the scheme. Within the transport model buses are fixed and taxis are not directly included (they have been estimated as a proportion of car traffic). As such the traffic response to the CAZ B is largely limited to changes in HGV traffic. However, this may have a knock-on effect to other vehicles classes if journey times change as a results of HGV behaviour and then affect route choices for other vehicle types. A description of the outcomes of the transport modelling of the city-wide CAZ B option is included in Appendix 2.

Figure 2 Illustrative CAZ boundaries



2.1.2 Option 1a – city-wide HGV charging scheme

This is a variant of the city-wide CAZ B option. In this scheme only HGV's are covered under the formal charging scheme, with buses (excluding coaches) and taxis influenced as follows:

- Buses would be subject to a traffic condition cover the city centre where they would be required to meet a Euro VI standard to operate in the area affected. This is consistent with the bus LEZ approach used in Oxford and Brighton. This traffic condition would be complemented by grants to support bus operators to upgrade their vehicles to meet the Euro VI standard.
- Taxis would not have a formal restriction applied to them but would have incentives to encourage them to upgrade including:
  - Less stringent vehicle age requirements for licencing CAZ compliant vehicles
  - Cash incentives to upgrade vehicles to CAZ standards
  - Priority access for CAZ compliant taxis to buses lanes and taxi ranks

This approach is designed to work more collaboratively with the bus and taxi industry. In relation to taxis this approach is a 'carrot' rather than a 'stick' approach and recognises the difficulty and high cost of upgrading an oldish taxi fleet in response to formal CAZ charges.

For the bus operators the scheme is intended to achieve high level of compliance with the Euro VI standard without having to use charges which could impact on fares and patronage of bus services. In addition, it recognises that there is a major bus depot within the city that serves many regional bus operations not directly operating though the city that could be viewed as being 'unfairly' impacted by a city-wide charging scheme.

Lastly it should be noted that this option would not impact on coach services which would be un-affected by the traffic condition. The impact of this is not considered in the transport and air quality modelling as coaches are not included, as they were not identified separately from any of the traffic count or ANPR data. That said, this was considered an appropriate approach as it is assumed that coaches undertake only a relatively small amount of vkm within the CAZ boundaries – hence any option impacting coaches would only have limited effect on emissions in Southampton. However, given the economic impacts are more in line with vehicles than kms affected, some consideration of coaches is being taking in the economic modelling comparing data on unique vehicles in the ANPR data with the registered local bus service vehicles.

2.1.3 Option 2 - City centre CAZ A plus additional HGV measures

This option focuses on reducing emissions from buses and taxis, while taking forward some additional HGV measures that were considered in Southampton's Low Emission Strategy (LES) study. The components of this scheme are then:

- A city centre charging CAZ A covering buses, coaches and taxis and limited to the city centre boundary illustrated in Figure 2;
- Complementing the CAZ A scheme with retrofit funding for buses and the upgrade funding for taxis;
- Taking forward the HGV measures from the Southampton LES covering:
    - Increased uptake of the city centre freight consolidation centre;
    - Further development of delivery and servicing plans (DSPs) for organisations in the city;
    - Working with the port, primarily through the HGV arrival booking system, to encourage CAZ compliant HGVs for accessing the port;
    - A city-wide freight EcoStars scheme to encourage efficient operation of freight fleets and newer vehicles;
    - Relaxing freight regulations to allow 24-hour delivery for CAZ compliant vehicles.

The key intention with this scheme option is to influence the majority of buses through a much smaller charging scheme, as most will operate through the city centre. This again recognises the issue of a city-wide scheme targeting all buses and its impact on a regional bus depot. This scheme would also impact on coaches that access the city centre. For the taxis the scheme uses a mixture of 'carrot' in terms of the upgrade grant and 'stick' in terms of charging those accessing the city centre if non-complaint.

With the HGVs the consolidation centre and DSP's are primarily designed to reduce HGV traffic movements in the city centre and surrounding area. These schemes will also potentially have an impact on the fleet composition through the use of CAZ complaint vehicles for the last leg of delivery for the consolidation centre and encouraging CAZ complaint vehicles for deliveries via the DSP. The work with the port would aim to increase the proportion of Euro VI complaint HGVs accessing the port, in particular the container port and car transport terminal.

2.1.4 Option 3 – Non-charging CAZ

The final option doesn't include any charging mechanism and is based around a bus-based traffic condition and incentives. The core elements of this option are:

- A bus traffic condition restricting buses operating in the city centre to Euro VI as described in option 1a
- A set of taxi incentives as described in option 1a
- The HGV measures described in option 2

This group of measures is designed more to encourage the uptake of CAZ compliant and low emission vehicles rather than use any formal regulations or charges. Again, no explicit measure affecting coaches is included.

2.2 Modelling assumptions

A summary of the assumptions used in modelling each of the options is provided in Table 1 below, with further details of the assumptions given in the following sections. Additional details on the full air quality modelling and transport modelling methods is given in the air quality and transport modelling methodology reports.

Table 1 Final list of options for assessment

Option	Components	Modelling approach
Option 1 City Wide CAZ B	City Wide CAZ B	City Wide CAZ B in transport model, feed into AQ model
	Bus grants	No additional assumption modelled as charge CAZ drives uptake
	Taxi incentives	No additional assumption modelled as charge CAZ drives uptake
Option 1A City Wide HGV charging	City wide CAZ for HGVs only	Using transport modelling for CAZ B but only update HGV fleet
	Bus traffic condition	Assume 100% buses in centre comply, 80% elsewhere comply - accounts for fact that most buses pass centre.
	Taxi incentives	Assume 20% of non-compliant vehicles upgrade, 1/3 of JAQU assumption
Option 2 City centre CAZ A Plus LES HGV	City centre Class A	Use base 2020 transport model results Buses- Assume 100% buses in centre comply, 80% elsewhere comply - accounts for fact that most buses pass centre Taxis - Assume JAQU compliance assumptions in centre (upgrade and VKM reduction), Assume 38% upgrade elsewhere (JAQU upgrade X ratio of city centre/rest of city Tax proportions)
	Bus grants	No additional assumption modelled as charge CAZ drives uptake
	Taxi incentives	No additional assumption modelled as charge CAZ drives uptake
	Freight DSP and consolidation	Assume 5% reduction of HGV and LGV traffic in centre, Assume 2.5% reduction in rest of city (reduced LES assumption, alternative is look at using transport model)
	Freight Eco, Port booking, 24hr	Assume 30% non-compliant HGVs upgrade (1/3 of JAQU assumption)
Option 3 Non-charging CAZ	Bus traffic condition plus grant	Use base 2020 transport model results Assume 100% buses in centre comply, 80% elsewhere comply - accounts for fact that most buses pass centre
	Taxi incentives	Assume 20% of non-compliant vehicles upgrade, 1/3 of JAQU assumption

	Freight DSP and consolidation	Assume 5% reduction of HGV and LGV traffic in centre, Assume 2.5% reduction in rest of city (reduced LES assumption, alternative is look at using transport model)
	Freight Eco, Port booking, 24hr	Assume 30% non-compliant HGVs upgrade (1/3 of JAQU assumption)

2.2.1 Option 1 – City-wide CAZ B

The CAZ B option is first modelled in the transport model to assess traffic responses to the scheme. In doing this the traffic model assesses the behaviour of both complaint vehicles (those that naturally meet the standard or are upgraded to do so) and non-complaint vehicles. The proportion of vkm that upgrade in response to the scheme is taken from guidance provided by JAQU as shown in Table 2 below. This upgrade response assumption is based on data developed for the London ULEZ with a charge of £100/day for the heavy-duty vehicles. This same charge is assumed in the traffic model to assess the response of non-compliant vehicles in terms of paying the charging, avoiding the zone or cancelling the trip. The details of the CAZ B transport modelling results are provided in Appendix 2.

Table 2 JAQU assumptions on behavioural response to the CAZ (vkm)

Proportions of non-compliant vehicle kilometres which react to the zone								
	Petrol Cars	Diesel Cars	Petrol LGVs	Diesel LGVs	RHGVs	AHGVs	Buses	Coaches
Pay charge – Continue into zone	7.1%	7.1%	20.3%	20.3%	8.7%	8.7%	0.0%	15.6%
Avoid Zone – Vkms removed, modelled elsewhere	21.4%	21.4%	10.0%	10.0%	0.0%	0.0%	0.0%	0.0%
Cancel journey – vkms removed completely	7.1%	7.1%	6.0%	6.0%	8.7%	8.7%	6.4%	12.5%
Replace Vehicle – vkms replaced with compliant vkms	**64.3%**	**64.3%**	**63.8%**	**63.8%**	**82.6%**	**82.6%**	**93.6%**	**71.9%**

Source: JAQU, CAZ Technical working group minutes – 15/2/17

This traffic data is then used in the air quality model to model the emissions from the vehicle fleet for both compliant and non-compliant vehicles. The detailed fleet split for compliant vehicles is generated from using the baseline 2020 vehicle fleet split and applying the JAQU upgrade assumption shown above. An additional upgrade assumption applied is that 75% of diesel vehicles that upgrade will switch to petrol (where possible – i.e. affecting cars, taxis and LGVs). The remaining vehicles then give the fleet split for the non-complaint vehicles. In the case of the Class B CAZ these assumptions are only applied to buses, HGVs and taxis which are affected by the scheme.

It is noted that one of the key assumptions in the modelling of the city-wide CAZ B scheme is the assumed upgrade % for non-compliant vehicles accessing the zone. The current assumption, as set out above, is based on data for London provided by JAQU. We recognise that the response locally may differ from this. To test the robustness of the CAZ B solution to achieve compliance we propose to do a sensitivity test as part of the final business.

The test proposed is a 50% reduction in response rate to represent a lower level of upgrade to the scheme. Only a reduction is being considered as the current assumption already shows compliance. This 50% reduction in response to upgrade would first be applied to the compliant/non-complaint split in the transport model and the model re-run. This would be expected to show a slightly higher level of diverting traffic and more non-compliant vehicles in the zone paying the charge. This updated traffic model run would them be put through the emissions and air quality model as was done for the original CAZ B assessment but accounting for the lower upgrade assumption in assessing the detailed fleet mix for the compliant and non-complaint fleets.

2.2.2 Option 1a – City-wide HGV charging scheme

In this case the same traffic data is used as for option 1 above. This is because the transport model is only modelling the impact of the CAZ B on HGVs (buses are fixed and taxis are not directly included). Within the air quality modelling the impact of the scheme on the fleet composition is as follows:

- HGV's – modelled exactly the same as the CAZ B as they see the same charge;
- Buses – we assume that 100% of bus vkm in the city centre meet the Euro VI standard, as this is the basis of the bus condition, and that 80% meet the standard elsewhere based on the assumption that not all buses will need to operate in the city centre.
- Taxis – we assume that 20% of non-complaint vehicles will upgrade as a result of the incentives, which is 1/3 of the JAQU assumption for in Table 2. This was based on judgement and agreed between the consultant and city. It was a pragmatic approach given the time and resources available, and reflecting the limited evidence available relating to behavioural responses, both locally and in general.

2.2.3 Option 2 – City Centre CAZ A plus HGV incentives

For this option the traffic data from the baseline 2020 traffic model run is used. This is because HGV's are not affected by the CAZ A scheme, buses are fixed and taxis are not included in the traffic model. The air quality modelling then applies the following impacts to each of the vehicle fleets:

- Buses – the same assumption is applied as for Option 1a with full compliance in the city centre and 80% compliance in the rest of the city. This impact is assumed to be generated by both the charge and the upgrade funding.
- Taxis – the JAQU upgrade % for cars is applied to taxis in the city centre, with a 38% upgrade applied to the rest of the city. The 38% assumption represents the product of JAQU upgrade percentage and the ratio of taxi traffic in the city centre and the rest of the city. This is designed to reflect the proportion of taxi vkm affected by the scheme outside the city centre. The taxi incentives are assumed to support this impact but have no additional impact.
- HGVs – the work with the port and the Ecostars scheme is assumed to increase the level of CAZ compliance in the HGV fleet. A simple assumption is made that 30% of non-compliant vehicles would upgrade, which is again about a 1/3 of the upgrade effect of a formal CAZ. This was based on judgement and agreed between the consultant and city. It was a pragmatic approach given the time and resources available, and reflecting the limited evidence available relating to behavioural responses, both locally and in general.

In addition to the impacts of the HGV measures on the fleet composition the consolidation centre and DSP measures are assumed to reduce HGV traffic in the city centre by 5% and the rest of the city by 2.5%. These assumptions are based on a review of such schemes carried out for the Southampton Low Emission Strategy study and taking a conservative view of how this would translate to Southampton.

2.2.4 Option 3 - Non-charging CAZ

Option 3 again uses the baseline 2020 traffic model traffic data and fleet assumptions from elements of the previous options as follows:

- Buses – the same assumption is applied as for Option 1a as it is the same bus traffic condition;
- Taxis – the same assumption as for Option 1a as it is the same set of incentives;
- HGVs – the same assumptions as for Option 2, including the vkm reductions.

3 Updated baseline results

This section provides an update to the baseline results for the Southampton Study area, which includes a correction to LGV emissions in 2020 that was discovered whilst running the CAZ options, and the new baseline results for the New Forest study area. For the New Forest study additional model verification work has been carried out which is reported in Appendix 1.

3.1 Comparison with PCM

For comparison with PCM model results, annual mean NO_2 concentrations at the roadside locations assessed in the national compliance PCM model have been extracted from the RapidAir dispersion model results; the results have been presented in both tabular form and using graduated colours on a map of the study area.

Roadside receptor locations in the PCM model are at a distance of 4m from the kerb and at 2m height. To represent this in our city scale modelling, a subset of the OS Mastermap GIS dataset provided spatially accurate polygons representing the road carriageway, receptor locations were then placed at 100m intervals along relevant road links using a 4m buffer around the carriageway polygons.

Each PCM link has a unique Census ID number and a grid reference assigned which is typically the co-ordinates describing the location of the DfT traffic count points on each link; this location may not however be where the highest roadside concentrations are occurring along the entire link length when using a more detailed local scale modelling method with observed average vehicle speeds on shorter road sections. The PCM links within our model domain range in length from approximately 120m to 3.25km; we have therefore reported the highest of the modelled concentrations from the city scale model receptors spaced at 100m intervals, 4m from the carriageway.

A full list of tabulated results comparing the PCM baseline results with the local modelled results from 2015 to 2020 is shown in Table 3. The table is in three sections:

- Section 1 is the main PCM links for Southampton council area;
- Section 2 is additional PCM links in the wider Southampton model domain;
- Section 3 is the PCM links in the New Forest model domain.

Mapped results are provided in Figures 3 and 4. They are provided for the 2015 base year and the 2020 target year, separately for the Southampton and New Forest modelled areas.

The 2020 results in the Southampton study area show a total of 9 links that are exceeding the limit value, of which 3 are in the Southampton City Council area and 6 in surrounding areas. The main areas of exceedance are on the motorway network around the city and into Eastleigh. The exceedance area not on the motorway network is on the Western Approach at Millbrook Road West on the A33 (census ID 56347). There are also some points along the Western Approaches, at the end of the M271 and the A33 around Dorset Street that are that are between 36 and 40 µg/m^3 so potentially at risk of exceeding within model error.

The results for New Forest show none of the PCM links as at risk of exceeding.

Table 3 Comparison of PCM and local NO2 Annual mean concentrations 2015 to 2020

CensusID	LA Name	Length (m)	PCM Baseline 2015	PCM Baseline 2017	PCM Baseline 2018	PCM Baseline 2019	PCM Baseline 2020	Local Baseline 2015	Local Baseline 2016	Local Baseline 2017	Local Baseline 2018	Local Baseline 2019	Local Baseline 2020
Southampton Links													
16340	Southampton Council	1,082	27.6	26.8	26.0	25.2	24.2	30.2	29.0	27.8	26.6	25.4	24.3
16891	Southampton Council	2,346	32.8	31.7	30.6	29.6	28.4	39.0	37.5	36.0	34.6	33.1	31.6
16892	Southampton Council	454	38.7	37.1	35.7	34.4	32.9	31.3	30.6	29.9	29.2	28.5	27.8
17531	Southampton Council	1,701	28.0	26.6	25.6	24.6	23.5	30.2	28.4	26.5	24.6	22.8	20.9
17532	Southampton Council	531	33.2	32.1	31.2	30.3	29.4	33.7	32.7	31.7	30.8	29.8	28.8
17974	Southampton Council	403	29.9	28.6	27.6	26.6	25.4	40.0	38.2	36.4	34.7	32.9	31.1
18113	Southampton Council	1,374	23.0	22.3	21.6	21.0	20.2	25.3	24.4	23.5	22.6	21.7	20.8
26062	Southampton Council	585	38.7	36.2	34.5	33.0	31.3	52.2	50.5	48.7	47.0	45.2	43.5
26296	Southampton Council	3,195	30.9	29.9	28.9	28.0	26.8	38.8	37.3	35.8	34.3	32.7	31.2
26351	Southampton Council	805	36.9	35.7	34.6	33.5	32.0	40.9	39.3	37.7	36.1	34.5	32.9
26371	Southampton Council	1,552	27.7	26.8	26.0	25.2	24.3	32.0	30.8	29.6	28.4	27.2	26.0
27635	Southampton Council	1,340	24.4	23.6	22.8	22.1	21.2	27.2	26.3	25.4	24.5	23.7	22.8
36987	Southampton Council	1,657	30.2	29.2	28.2	27.2	26.1	24.8	24.2	23.6	23.0	22.4	21.8
37658	Southampton Council	2,303	27.4	26.2	25.2	24.4	23.3	34.7	33.8	32.9	32.0	31.1	30.2
38212	Southampton Council	734	40.1	38.6	37.5	36.5	35.5	41.5	40.5	39.5	38.5	37.6	36.6
46375	Southampton Council	1,394	30.0	29.1	28.2	27.4	26.3	33.5	32.4	31.2	30.0	28.9	27.7
46963	Southampton Council	1,663	37.2	35.8	34.5	33.3	32.0	41.1	39.5	38.0	36.4	34.9	33.4
46964	Southampton Council	1,151	36.1	34.6	33.3	32.1	30.7	31.8	31.0	30.2	29.4	28.6	27.8
48317	Southampton Council	498	31.2	30.4	29.6	28.9	28.1	26.8	26.2	25.5	24.9	24.3	23.7
48456	Southampton Council	195	30.5	29.5	28.8	28.0	27.2	35.3	33.1	30.9	28.7	26.5	24.4
48513	Southampton Council	285	28.8	28.1	27.6	27.1	26.6	31.8	31.0	30.2	29.5	28.7	28.0
56347	Southampton Council	3,252	54.8	52.0	50.1	48.3	46.3	47.3	46.1	44.9	43.6	42.4	41.1
56374	Southampton Council	711	33.1	32.0	31.0	30.0	28.7	29.0	28.0	27.0	26.0	25.1	24.1
57434	Southampton Council	153	33.4	32.0	30.9	29.9	28.5	39.8	38.2	36.5	34.8	33.1	31.4
57672	Southampton Council	162	35.8	35.3	34.9	34.6	34.2	33.3	32.6	32.0	31.3	30.6	29.9
6292	Southampton Council	1,062	32.4	31.5	30.4	29.4	28.2	29.6	28.6	27.5	26.5	25.5	24.4

6349	Southampton Council	1,506	33.5	32.1	30.9	29.9	28.6	37.7	36.4	35.0	33.7	32.3	31.0
6367	Southampton Council	1,743	29.3	28.3	27.3	26.4	25.4	30.6	29.5	28.4	27.4	26.3	25.2
6368	Southampton Council	1,678	57.7	52.0	48.9	46.3	43.6	46.7	45.0	43.2	41.5	39.8	38.1
6933	Southampton Council	2,249	34.7	33.4	32.4	31.4	30.3	46.4	45.1	43.8	42.5	41.2	39.9
70064	Southampton Council	239	34.3	32.7	31.7	30.7	29.6	26.1	25.4	24.8	24.2	23.6	22.9
70066	Southampton Council	219	30.1	29.0	28.2	27.5	26.7	35.5	34.5	33.5	32.5	31.5	30.6
70108	Southampton Council	421	25.4	24.5	23.7	22.9	21.9	18.2	17.7	17.2	16.7	16.1	15.6
70109	Southampton Council	772	24.0	23.0	22.2	21.4	20.5	24.7	23.8	22.8	21.8	20.9	19.9
73605	Southampton Council	750	24.2	23.2	22.4	21.8	20.9	25.1	24.2	23.3	22.4	21.5	20.6
73613	Southampton Council	166	22.6	21.7	21.0	20.3	19.5	23.1	22.4	21.7	21.0	20.2	19.5
73615	Southampton Council	289	62.5	57.6	54.5	51.8	48.9	46.5	44.9	43.3	41.6	40.0	38.4
75250	Southampton Council	293	31.9	31.1	30.3	29.5	28.6	39.5	38.2	36.9	35.6	34.4	33.1
75251	Southampton Council	275	41.8	40.3	39.2	38.3	37.2	41.4	40.2	39.0	37.8	36.6	35.4
75252	Southampton Council	987	42.7	41.3	40.2	39.3	38.2	40.8	39.8	38.8	37.8	36.8	35.8
75253	Southampton Council	1,010	39.5	37.8	36.4	35.0	33.5	28.7	27.8	27.0	26.1	25.3	24.4
75258	Southampton Council	569	44.2	42.7	40.9	39.3	37.4	54.9	53.6	52.4	51.2	49.9	48.7
7569	Southampton Council	2,011	30.0	29.1	28.1	27.2	26.1	30.7	29.7	28.7	27.7	26.8	25.8
7580	Southampton Council	3,057	30.4	28.9	27.8	26.8	25.7	46.7	43.2	39.7	36.2	32.7	29.2
86003	Southampton Council	276	37.1	35.8	34.9	34.1	33.2	41.4	40.2	39.0	37.8	36.6	35.4
99871	Southampton Council	1,401	36.9	35.7	34.6	33.6	32.4	53.4	50.5	47.6	44.8	41.9	39.0
99872	Southampton Council	2,089	33.6	32.4	31.3	30.3	29.1	44.6	42.0	39.4	36.8	34.2	31.6
37658	Southampton Council	447	27.4	26.2	25.2	24.4	23.3	34.7	33.8	32.9	32.0	31.1	30.2
46963	Southampton Council	239	37.2	35.8	34.5	33.3	32.0	41.1	39.5	38.0	36.4	34.9	33.4
46964	Southampton Council	246	36.1	34.6	33.3	32.1	30.7	31.8	31.0	30.2	29.4	28.6	27.8
6292	Southampton Council	892	32.4	31.5	30.4	29.4	28.2	29.6	28.6	27.5	26.5	25.5	24.4
73613	Southampton Council	678	22.6	21.7	21.0	20.3	19.5	23.1	22.4	21.7	21.0	20.2	19.5
7569	Southampton Council	119	30.0	29.1	28.1	27.2	26.1	30.7	29.7	28.7	27.7	26.8	25.8
Other links in Southampton study area													
7988	Eastleigh Borough Council	264	27.4	26.5	25.7	24.8	23.9	27.9	26.4	24.9	23.4	21.9	20.4
7992	Eastleigh Borough Council	121	37.0	35.6	34.2	32.9	31.5	27.1	26.2	25.2	24.3	23.4	22.4

8129	Eastleigh Borough Council	58	24.2	23.2	22.4	21.8	20.9		21.2	20.5	19.8	19.2	18.5	17.9
8559	Eastleigh Borough Council	642	35.5	34.2	33.0	31.9	30.5		44.9	43.4	41.9	40.5	39.0	37.5
16269	Eastleigh Borough Council	126	23.3	22.6	21.9	21.2	20.4		25.5	24.6	23.7	22.9	22.0	21.1
16321	Eastleigh Borough Council	1211	35.5	33.8	32.4	31.0	29.5		47.4	46.3	45.2	44.1	43.0	41.9
17793	Test Valley Borough Council	876	44.9	43.3	41.5	39.7	37.8		82.1	77.9	73.7	69.5	65.3	61.1
28018	Test Valley Borough Council	387	52.6	50.1	47.8	45.6	43.3		44.3	41.9	39.5	37.2	34.8	32.5
29041	Test Valley Borough Council	579	31.5	30.8	29.7	28.6	27.3		41.5	40.0	38.4	36.8	35.2	33.6
36039	Eastleigh Borough Council	552	37.0	35.3	33.9	32.6	31.1		43.6	41.0	38.5	35.9	33.3	30.8
36293	Eastleigh Borough Council	647	26.0	25.3	24.6	23.9	22.9		25.7	24.7	23.8	22.9	21.9	21.0
38107	Test Valley Borough Council	140	55.0	53.5	51.1	48.9	46.5		59.7	58.0	56.4	54.7	53.1	51.4
47635	Test Valley Borough Council	62	25.2	24.3	23.4	22.5	21.5		24.1	23.3	22.5	21.7	20.9	20.1
48064	Eastleigh Borough Council	1212	40.9	39.9	38.5	37.1	35.4		84.8	82.9	81.1	79.3	77.4	75.6
56058	Test Valley Borough Council	327	46.6	43.9	41.7	39.7	37.6		39.5	38.3	37.1	35.9	34.7	33.5
56931	Eastleigh Borough Council	470	40.8	39.0	37.5	36.0	34.4		40.5	38.6	36.6	34.6	32.7	30.7
73606	Eastleigh Borough Council	285	27.8	26.3	25.3	24.3	23.2		30.4	28.9	27.5	26.0	24.5	23.0
73607	Eastleigh Borough Council	12	27.4	26.6	25.8	25.0	23.9		26.1	25.2	24.2	23.3	22.4	21.4
73609	Eastleigh Borough Council	343	40.2	38.8	37.4	36.0	34.5		69.5	67.0	64.6	62.1	59.7	57.2
73614	Test Valley Borough Council	476	44.0	41.7	39.8	38.1	36.2		26.5	25.5	24.6	23.7	22.7	21.8
75259	Test Valley Borough Council	704	51.7	50.3	48.1	46.1	43.8		78.4	74.3	70.3	66.2	62.1	58.0
New Forest links														
36375	New Forest District Council	30.625	57.3	52.9	50.1	47.7	45.0		44.1	42.0	39.9	37.8	35.8	33.7
56960	New Forest District Council	24.84	32.5	31.1	29.9	28.8	27.4		49.6	46.7	43.8	40.9	38.0	35.1
48475	New Forest District Council	224.51	24.2	23.5	22.8	22.1	21.2		29.2	28.0	26.8	25.5	24.3	23.1
16341	New Forest District Council	211.45	43.1	40.1	38.1	36.4	34.5		39.9	38.1	36.3	34.6	32.8	31.0
78316	New Forest District Council	993.25	30.0	28.3	27.1	26.0	24.6		19.0	18.4	17.8	17.2	16.6	16.0
28356	New Forest District Council	590.92	27.8	26.1	25.0	24.0	22.7		23.4	22.5	21.6	20.8	19.9	19.0
38492	New Forest District Council	163.64	35.0	33.3	32.0	30.7	29.2		32.2	30.6	29.0	27.4	25.8	24.2
74832	New Forest District Council	370.45	21.4	20.3	19.5	18.7	17.8		30.0	28.8	27.5	26.3	25.0	23.8

Figure 3 Local modelled annual NO_2 concentrations in Southampton in 2015

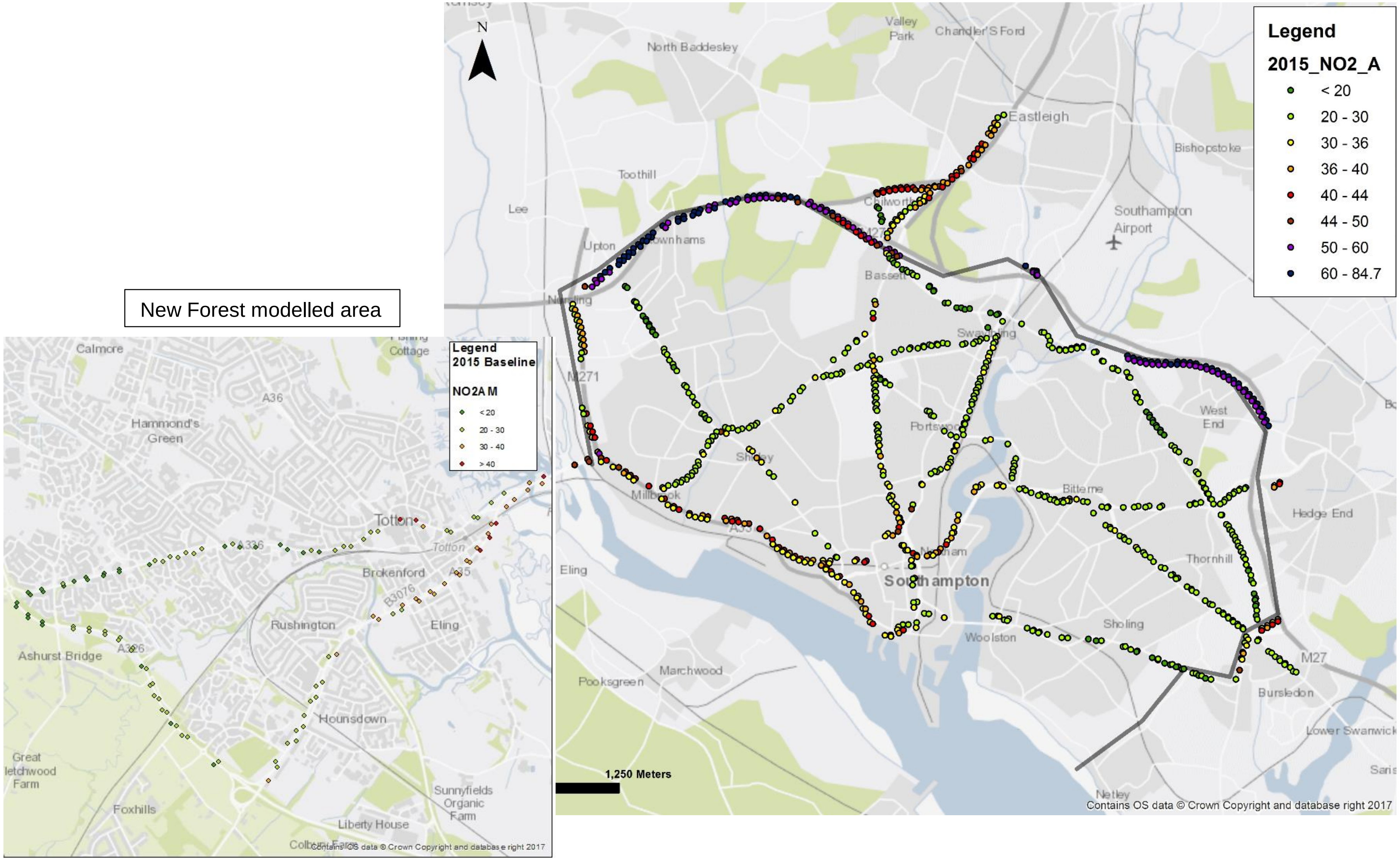


Figure 4 Local modelled annual NO_2 concentrations in 2020

3.2 Results at local monitoring points

The annual mean NO_2 concentrations measured in 2015 and modelled for 2015 and 2020 are shown in Table 4 below. The results for Southampton indicate that in 2020, compliance with the 40 µg.m^{-3} NO_2 annual mean objective will be achieved at all locations.

For the New Forest area all the measured and modelled results show compliance with the 40 µg.m^{-3} NO_2 annual mean objective

Table 4: Predicted NO_2 annual mean concentrations at monitoring site locations in 2015 and 2020

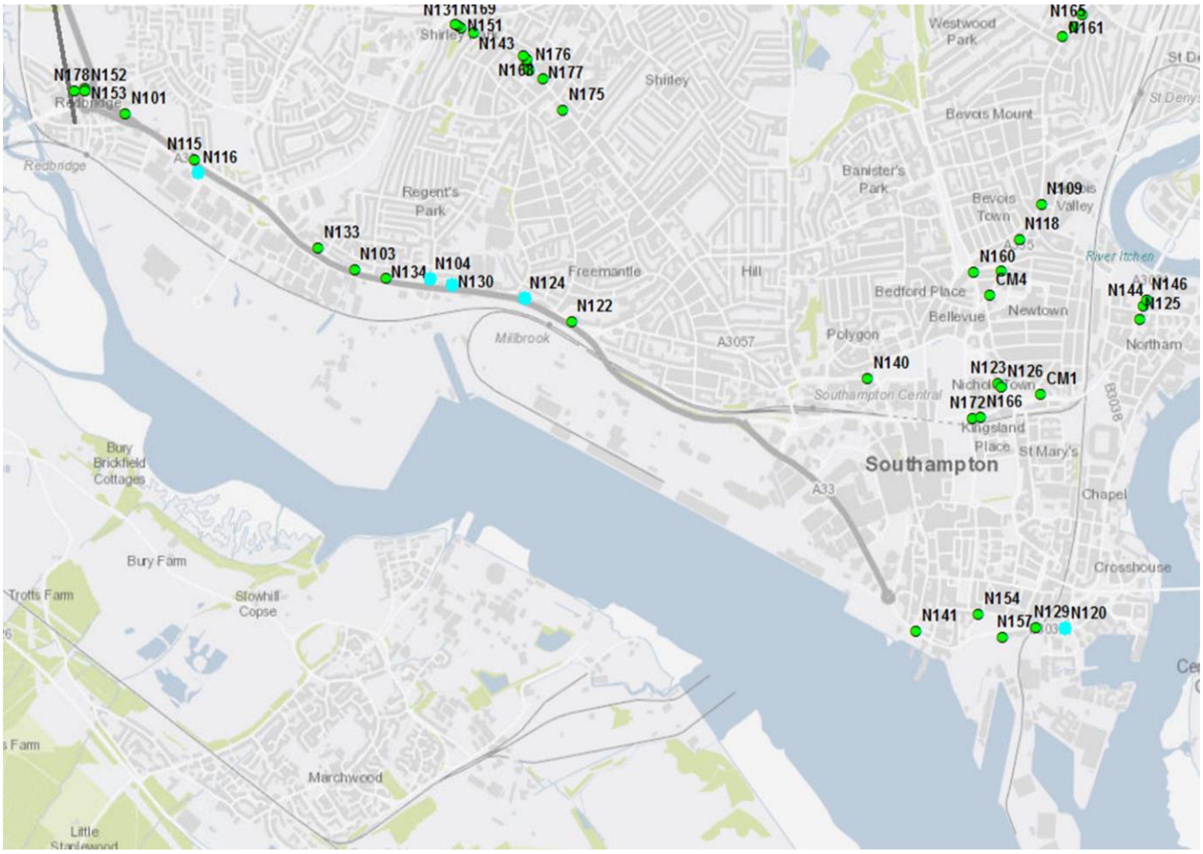
Monitoring site name	Site ID	Site type	NO_2 annual mean (µg.m^{-3})		
			Measured 2015	Modelled 2015	Modelled 2020
Southampton Monitoring Locations					
CM1 AURN Brintons Road	CM1	Urban Centre	32.0	35.3	29.0
CM4 Onslow Road	CM4	Roadside	42.0	40.6	34.6
CM6 Victoria Road	CM6	Roadside	42.0	22.3	19.1
Redbridge School Fence	N101	Roadside	44.7	40.3	31.4
64 Burgess Road	N102	Roadside	29.8	23.0	19.1
485 Millbrook Road	N103	Roadside	31.7	36.9	31.0
Regents Park Junction	N104	Roadside	38.4	36.7	31.5
2 Romsey Road	N106	Roadside	37.9	28.2	21.7
Cranbury Place	N107	Roadside	51.9	37.3	30.5
72 Bevois Valley Road	N109	Roadside	37.2	31.2	26.4
206 Bitterne Road	N113	Roadside	34.9	29.9	24.0
Bitterne Library, Bitterne Road	N114	Roadside	32.8	32.0	25.8
54 Redbridge Road	N115	Roadside	36.4	37.3	31.9
57 Redbridge Road	N116	Roadside	38.1	30.5	26.1
3 Rockstone Place	N118	Roadside	32.3	28.5	23.2
6-9 Canute Road	N120	Roadside	38.0	42.0	35.5
151 Paynes Road	N122	Roadside	31.5	39.6	33.8
102 St Andrews Road	N123	Roadside	32.8	30.2	27.1
305 Millbrook Road	N124	Roadside	37.3	41.3	35.8
Princes Court	N125	Roadside	35.3	37.4	29.9
107 St. Andrews Road	N126	Roadside	32.8	31.8	28.3
Canute Road	N129	Roadside	28.8	42.7	37.1
367A Millbrook Road	N130	Roadside	44.8	40.4	35.0
142 Romsey Road 1	N131	Roadside	37.9	46.7	29.3
539 Millbrook Road	N133	Roadside	30.7	28.9	24.1
433-435 Millbrook Road	N134	Roadside	37.6	36.1	31.0
24 Victoria Road	N135	Roadside	31.4	25.7	20.1
23 Victoria Road	N136	Roadside	31.1	25.6	20.1
66 Burgess Road 1	N138	Roadside	43.8	36.3	25.5
5 Commercial Road	N140	Roadside	44.8	40.1	29.1

Town Quay	N141	Kerbside	30.5	42.7	37.8
102 Romsey Road	N143	Roadside	34.4	36.9	25.7
208 Northam Road	N144	Roadside	31.8	39.2	31.9
222 Northam Road	N146	Roadside	28.7	35.1	28.6
44B Burgess Road	N149	Roadside	32.5	25.0	20.8
134 Romsey Road	N151	Roadside	37.4	41.5	26.3
M271	N152	Roadside	36.9	44.7	33.8
Coniston Road	N153	Roadside	31.2	34.3	28.1
Oceana Boulevard,	N154	Roadside	32.9	31.5	26.3
4 Platform Road	N157	Roadside	27.8	33.4	28.9
24 Portsmouth Road	N158	Roadside	36.8	23.4	20.4
35 Portsmouth Road	N159	Roadside	25.9	20.8	18.2
2 Dorset Street	N160	Roadside	32.6	33.4	28.6
30 Addis Square	N161	Roadside	32.5	25.5	19.0
263A Portswood Road	N162	Roadside	37.7	27.8	22.3
285 Portswood Road	N163	Roadside	27.8	23.8	19.8
168-174 Portswood Road	N164	Roadside	32.3	25.5	20.6
8 The Broadway	N165	Roadside	32.3	25.5	20.7
14 New Road	N166	Roadside	38.1	39.7	30.7
13 Romsey Road	N167	Roadside	33.5	29.8	22.6
23 Romsey Road	N168	Roadside	36.4	30.1	22.8
150 Romsey Road	N169	Roadside	40.6	46.7	29.3
4 New Road	N172	Roadside	42.9	41.6	32.1
19A Burgess Road	N173	Roadside	27.3	32.7	27.0
166A Bitterne Road	N174	Roadside	37.6	34.3	27.9
38 Shirley High Street	N175	Roadside	38.0	37.8	26.4
126 Shirley High Street	N176	Roadside	38.0	36.1	22.8
95 Shirley High Street	N177	Roadside	36.7	30.1	24.2
2 Gover Road	N178	Roadside	25.9	26.6	22.0
New Forest monitoring locations					
Junction Rd (analyser)	20	Roadside	23.89	22.37	19.11
30, Junction Rd	21	Kerbside	24.48	23.55	20.11
25, Junction Rd	22	Roadside	24.96	20.46	17.49
26, Rumbridge St.	23	Roadside	26.13	23.04	19.66
2, Eling Lane	24	Roadside	25.67	20.75	17.79
Elingfield Court, High St.	25	Roadside	22.97	23.98	19.81
55, High St.	26	Roadside	22.07	18.26	14.95
114, Commercial Rd	27	Kerbside	25.31	29.56	22.69
Commercial Rd	28	Roadside	23.31	28.61	22.05
Ringwood Rd / Maynard Rd rbt	29	Roadside	27.21	28.36	22.17
Asda rbt	30	Roadside	23.4	22.85	18.87
1, Rose Rd	31	Roadside	19.23	16.2	13.37

3.3 Source apportionment

For both the 2015 and 2020 base years we have conducted source apportionment for a number of monitoring locations to provide an indication of the key sources contributing to pollution levels. The locations are indicated in Figure 5 and are focused on the Western Approach, one of the key areas of concern, and alongside the port near the city centre. These areas have been selected to provide an understanding of the contribution of emissions associated with the Port to air quality levels.

Figure 5 Location of source apportionment results



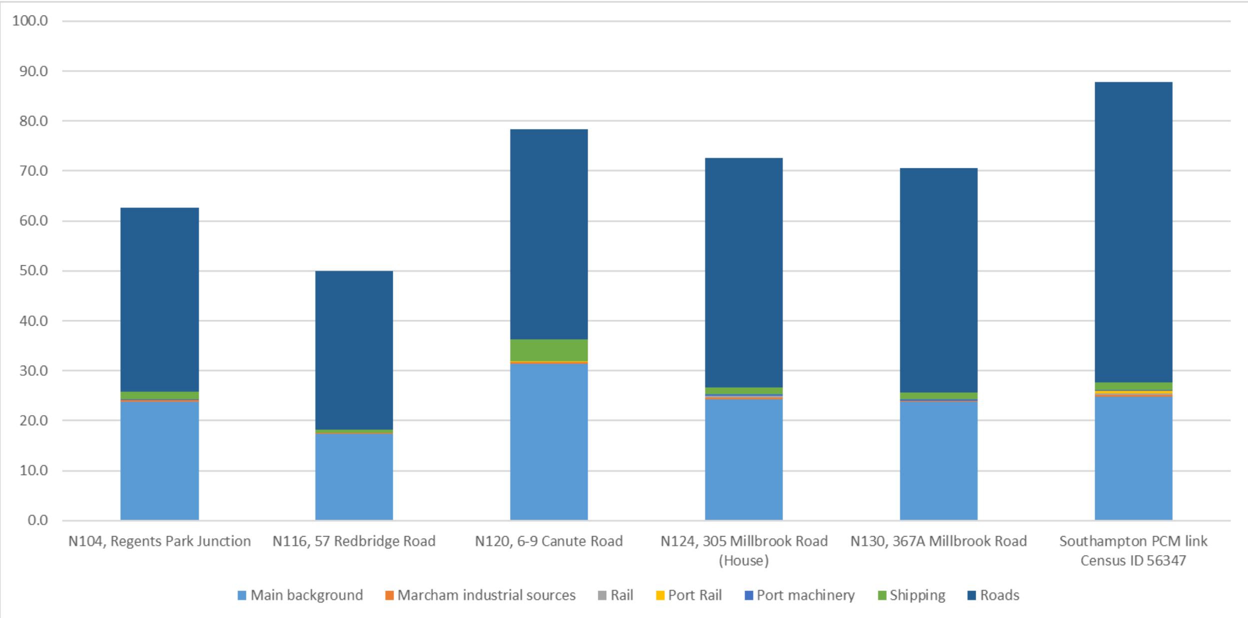
3.3.1 2015 baseline source apportionment

The source apportionment results for these locations are shown below in Table 5. The results are shown in terms of NOx concentrations. These show that the main source of air pollution is road traffic some 60-70%. The majority of the remaining contribution is general background, about 25-30%, comprising commercial and residential emissions. The activity on the port in terms of machinery and rail movements accounts for only about 0.5% of emissions, which is similar to the contribution associated with the emissions from the incinerator and power plant in Marcham. The contribution from ships at dock and accessing the port is somewhat larger at between 2 to 6%

Table 5 NOx concentrations in 2015 for each source modelled (µg/m^3)

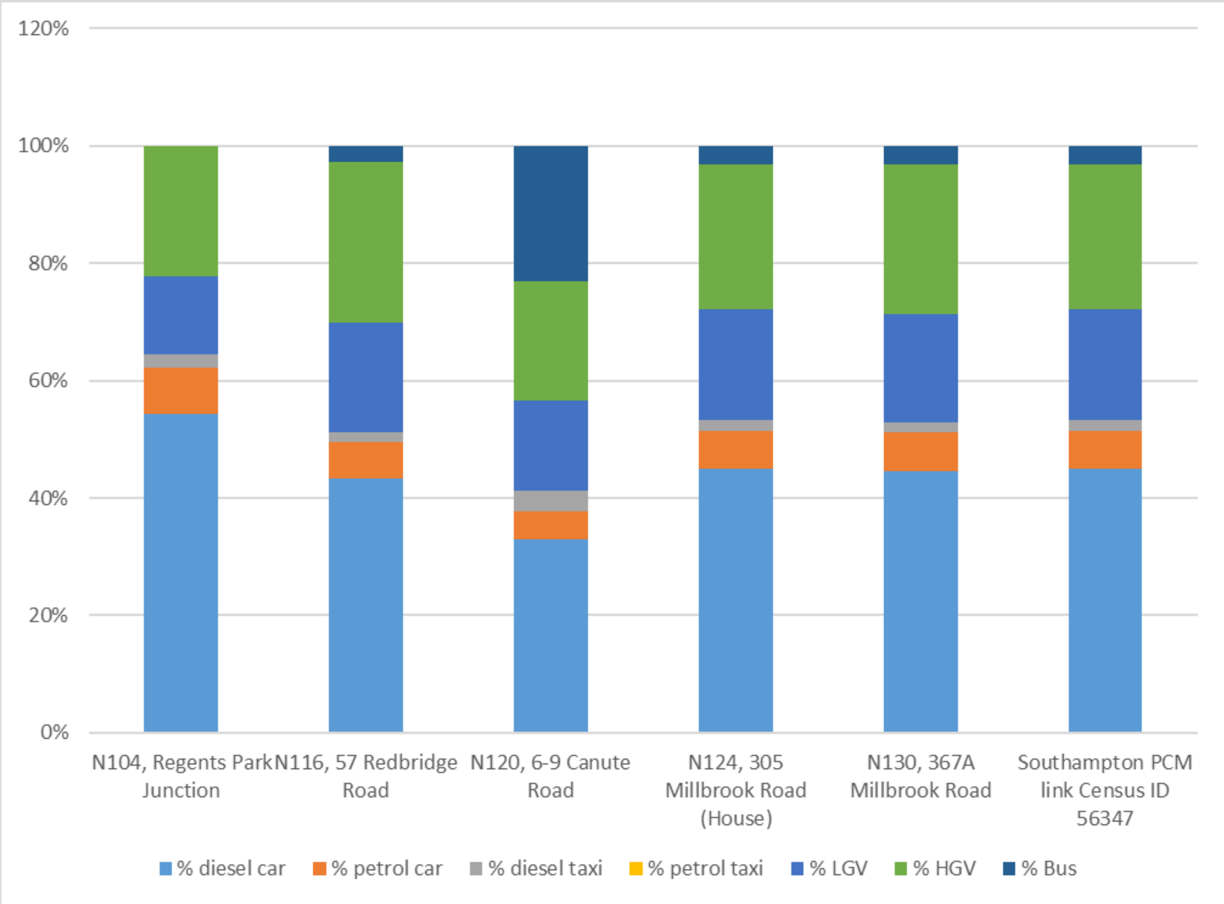
Location	Main background	Marcham industrial sources	Rail	Port Rail	Port machinery	Shipping	Roads	Total
N104, Regents Park Junction	23.9	0.2	0.0	0.0	0.2	1.5	36.8	62.6
N116, 57 Redbridge Road	17.4	0.1	0.0	0.0	0.1	0.7	31.6	49.9
N120, 6-9 Canute Road	31.4	0.3	0.0	0.2	0.1	4.4	42.0	78.3
N124, 305 Millbrook Road (House)	24.3	0.4	0.2	0.1	0.2	1.4	45.9	72.6
N130, 367A Millbrook Road	23.8	0.2	0.0	0.0	0.2	1.4	44.9	70.6
Southampton PCM link Census ID 56347	24.8	0.4	0.2	0.4	0.2	1.5	60.3	87.9

Figure 6 Breakdown of NOx concentrations by source type – 2015 baseline (µg.m^{-3})



The road contribution can be broken down further to show the contribution for each main vehicle type as illustrated in Figure 7. The break does vary across locations as would be expected. However, overall diesel cars are the main contributor followed by HGV and vans. Buses are only a small proportion along the Western Approaches, but at Canute Road near the city centre are much more significant. Taxis account for between 2% and 4% of the emissions, with the higher contribution again being at the city centre location.

Figure 7 Breakdown of road NOx contribution by vehicle type



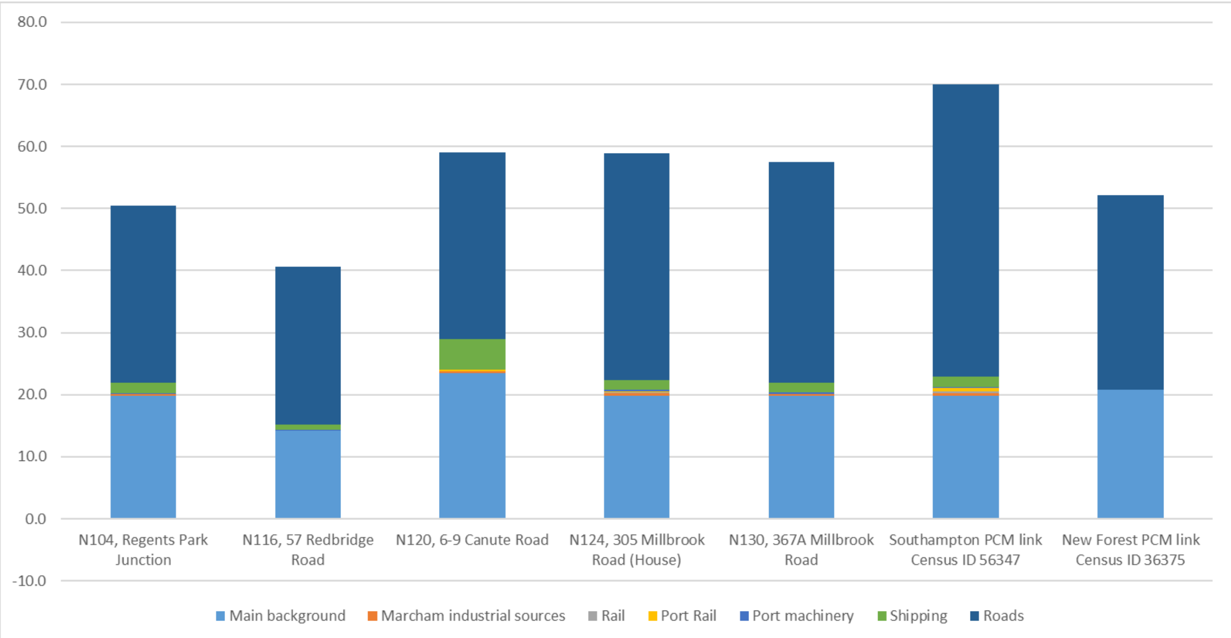
3.3.2 2020 baseline source apportionment

The 2020 source apportionment results are presented in Table 6 and Figure 8. These results are shown in terms of NOx concentrations. These show that the main source of air pollution in 2020 is still expected to be road traffic (60-70%). The majority of the remaining contribution will be general background (25-30%), comprising commercial and residential emissions. The activity on the port in terms of machinery and rail movements increases slightly when compared with 2015. The contribution from ships at dock and accessing the port also increases slightly when compared with 2015; this is attributable to projected increases in shipping activity.

Table 6 NOx concentrations in 2020 for each source modelled (μg/m^3)

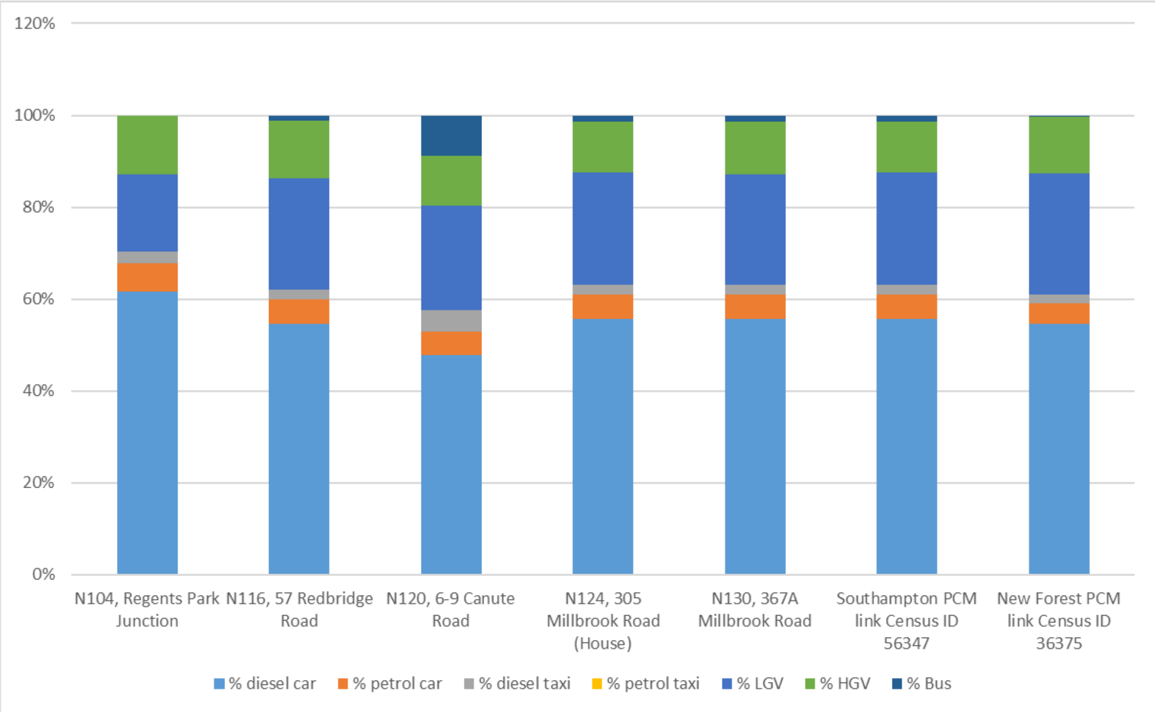
Location	Main background	Marcham industrial sources	Rail	Port Rail	Port machinery	Shipping	Roads	Total
N104, Regents Park Junction	19.8	0.2	0.0	0.0	0.2	1.7	28.5	50.5
N116, 57 Redbridge Road	14.2	0.1	0.0	0.0	0.1	0.8	25.4	40.6
N120, 6-9 Canute Road	23.5	0.3	0.0	0.2	0.1	4.9	30.1	59.1
N124, 305 Millbrook Road (House)	19.8	0.4	0.2	0.2	0.2	1.6	36.5	58.9
N130, 367A Millbrook Road	19.8	0.2	0.0	0.0	0.2	1.6	35.6	57.4
Southampton PCM link Census ID 56347	19.8	0.4	0.2	0.6	0.2	1.7	47.0	70.0
New Forest PCM link Census ID 36375	20.8						31.3	52.1

Figure 8: Breakdown of NOx concentrations by source type – 2020 baseline (μg.m^{-3})



The breakdown of projected NOx emissions from various vehicle categories in 2020 is presented in Figure 9. The 2020 source apportionment analysis shows similar results to 2015; whereby diesel cars are the main contributor followed by LGV. When compared with 2015, HGVs contribute a lower proportion of NOx emissions, LGV emissions now contribute a greater proportion. Buses still contribute only a small proportion along the Western Approach, but are much more significant in the city centre. The highest proportion of emissions form taxis is also in the city centre.

Figure 9 Breakdown of road NOx contribution by vehicle type



4 Options results

The four CAZ scheme options have been modelled for both the Southampton and New Forest model areas. The results have been extracted for both the PCM links and the local monitoring locations in the same way as for the baseline results in Section 3 above.

4.1 Comparison with PCM

A summary of the modelled annual mean NO_2 results for each of the options is shown in Table 7 with details provided in Table 8 below. The detailed results are broken down in the same way as the baseline results with three sections showing results for the PCM links in Southampton, PCM links in the wider Southampton modelled area and the PCM links in New Forest. The mapped results are shown in Figures 7 to 10.

Table 7 Summary of NO_2 results for the PCM links for options in 2020

Option	With SCC Boundary		Beyond SCC Boundary		Average Change in NO_2 (%) in SCC	Average Change in NO_2 (%) in NFDC
	PCM links > 40µ/m³	PCM links > 35µ/m³	PCM links > 40µ/m³	PCM links > 35µ/m³		
Baseline	3	11	6	7	N/a	N/a
Option 1	2	5	6	6	-6.5%	-1.8%
Option 1a	2	5	6	6	-6.5%	-2.0%
Option 2	3	7	6	7	-3.8%	-2.5%
Option 3	3	7	6	7	-3.6%	-2.0%

The impact of each option on the Southampton model area can be summarised as follows:

- Option 1 – City-wide CAZ B: on average this reduces concentrations of NO_2 by 6.5%, but this varies from link to link ranging from a 2% reduction up to 18% reduction. This is enough remove the exceedance on the Western Approach at Millbrook Road West, reducing the number of exceedances from 9 to 8. In addition, it reduces the number of PCM at risk of exceedance which were above 35µ/m³ from 18 to 11. This reduces the risk of these links potentially exceeding in the future.

- Option 1a – City-wide HGV charging: this option is very similar to Option 1 but using different mechanisms to affect buses and taxis. Its impact is also very similar to option 1 reducing average NO_2 concentrations by 6.5%, which again reduces the number of exceedance from 8 to 9 and reduces the number of links over 35µ/m³ from 18 to 11.

- Option 2 – city-centre CAZ A: this option has a similar impact on buses and taxis to option 1a, but has a lower impact on HGVs. Overall this measure reduces NO_2 concentration on average by 3.8%, about half that of Options 1 and 1a. However, this is not enough to reduce the number of exceedance but it does reduce the number of links over 35µ/m³ from 18 to 14, a little less than options 1 and 1a.

- Option 3 – non-charging CAZ package: this option has a very similar impact to Option 2 with an average 3.6% reduction in NO_2 concentrations and the number of links over 35µ/m³ from 18 to 14, a little less than options 1 and 1a.

The impact of all the schemes in New Forest is similar with an average reduction in NO_2 concentrations of about 2%. There are no exceedances in the baseline model for New Forest so there is no impact on reducing the number of exceedances from implementing the options.

Table 8 Annual mean NO2 for each PCM link in 2020 by option

CensusID	LA Name	Length (m)	Annual Mean NO2 in 2020				
			Baseline	Option 1	Option 1a	Option 2	Option 3
Southampton Links							
16340	Southampton Council	1082.4	24.3	22.1	22.1	23.2	23.2
16891	Southampton Council	2346.2	31.6	29.4	29.2	30.3	30.4
16892	Southampton Council	454.3	27.8	27.0	27.1	27.4	27.4
17531	Southampton Council	1700.7	20.9	18.8	18.8	19.7	19.7
17532	Southampton Council	530.8	28.8	27.4	27.4	28.0	28.0
17974	Southampton Council	403.3	31.1	27.2	27.1	29.2	29.2
18113	Southampton Council	1374.0	20.8	19.5	19.5	20.2	20.2
26062	Southampton Council	584.8	43.5	40.2	40.3	41.6	41.7
26296	Southampton Council	3194.8	31.2	28.5	28.5	29.8	29.9
26351	Southampton Council	804.7	32.9	29.7	29.7	31.3	31.3
26371	Southampton Council	1552.0	26.0	23.6	23.6	24.9	24.9
27635	Southampton Council	1340.1	22.8	21.3	21.3	22.0	22.0
36987	Southampton Council	1656.8	21.8	21.5	21.6	21.7	21.7
37658	Southampton Council	2303.4	30.2	28.4	28.0	28.4	28.6
38212	Southampton Council	734.2	36.6	34.8	34.9	35.2	35.4
46375	Southampton Council	1393.8	27.7	25.4	25.4	26.6	26.6
46963	Southampton Council	1662.6	33.4	30.9	30.7	32.0	32.0
46964	Southampton Council	1150.7	27.8	27.0	27.1	27.4	27.4
48317	Southampton Council	497.7	23.7	22.9	22.9	23.2	23.3
48456	Southampton Council	195.4	24.4	23.6	23.7	23.9	24.0
48513	Southampton Council	285.2	28.0	26.9	26.9	27.2	27.3
56347	Southampton Council	3251.6	41.1	37.6	37.7	40.2	40.2
56374	Southampton Council	711.3	24.1	22.6	22.6	23.4	23.4
57434	Southampton Council	152.7	31.4	27.6	27.5	29.5	29.5
57672	Southampton Council	161.7	29.9	27.7	27.7	28.8	28.9
6292	Southampton Council	1061.9	24.4	23.4	23.4	23.8	23.8
6349	Southampton Council	1506.1	31.0	28.4	28.3	29.6	29.7
6367	Southampton Council	1742.9	25.2	23.5	23.5	24.4	24.4
6368	Southampton Council	1678.0	38.1	35.1	35.1	36.9	37.0
6933	Southampton Council	2249.1	39.9	36.6	36.6	38.1	38.3
70064	Southampton Council	238.9	22.9	22.3	22.2	22.5	22.5
70066	Southampton Council	218.6	30.6	28.6	28.5	29.1	29.2
70108	Southampton Council	421.0	15.6	15.3	15.3	15.4	15.5
70109	Southampton Council	771.9	19.9	18.7	18.6	19.2	19.2
73605	Southampton Council	750.2	20.6	19.6	19.5	20.0	20.0
73613	Southampton Council	166.0	19.5	18.8	18.8	19.1	19.1
73615	Southampton Council	288.6	38.4	33.9	33.9	36.2	36.3
75250	Southampton Council	292.7	33.1	31.2	31.3	32.4	32.4
75251	Southampton Council	274.6	35.4	33.5	33.6	34.6	34.7
75252	Southampton Council	987.1	35.8	34.2	34.3	34.6	34.9
75253	Southampton Council	1009.8	24.4	23.4	23.4	23.9	24.0

75258	Southampton Council	568.7	48.7	42.6	42.7	46.6	46.7
7569	Southampton Council	2010.9	25.8	24.3	24.2	25.0	25.1
7580	Southampton Council	3056.8	29.2	26.4	26.4	26.6	26.6
86003	Southampton Council	275.9	35.4	32.8	32.3	33.1	33.3
99871	Southampton Council	1401.4	39.0	32.1	32.0	34.5	34.7
99872	Southampton Council	2089.2	31.6	29.4	29.4	30.6	30.6
37658	Southampton Council	446.8	30.2	28.4	28.0	28.4	28.6
46963	Southampton Council	238.9	33.4	30.9	30.7	32.0	32.0
46964	Southampton Council	245.5	27.8	27.0	27.1	27.4	27.4
6292	Southampton Council	891.9	24.4	23.4	23.4	23.8	23.8
73613	Southampton Council	678.0	19.5	18.8	18.8	19.1	19.1
7569	Southampton Council	119.3	25.8	24.3	24.2	25.0	25.1
Other links in Southampton Study area							
7988	Eastleigh Borough Council	263.7	20.4	19.0	19.0	19.5	19.5
7992	Eastleigh Borough Council	120.8	22.4	22.1	22.1	22.2	22.3
8129	Eastleigh Borough Council	57.5	17.9	17.2	17.2	17.5	17.5
8559	Eastleigh Borough Council	642.0	37.5	35.0	35.0	35.8	35.8
16269	Eastleigh Borough Council	126.2	21.1	20.0	20.1	20.5	20.5
16321	Eastleigh Borough Council	1211.5	41.9	41.6	41.7	41.5	41.6
17793	Test Valley Borough Council	875.8	61.1	55.4	55.6	56.6	56.7
28018	Test Valley Borough Council	387.2	32.5	30.3	30.4	30.5	30.5
29041	Test Valley Borough Council	578.5	33.6	33.2	33.3	32.8	32.8
36039	Eastleigh Borough Council	552.4	30.8	26.9	27.0	28.3	28.4
36293	Eastleigh Borough Council	646.7	21.0	20.2	20.3	20.5	20.5
38107	Test Valley Borough Council	140.0	51.4	44.4	44.5	48.7	48.8
47635	Test Valley Borough Council	61.7	20.1	19.0	19.0	19.5	19.5
48064	Eastleigh Borough Council	1211.8	75.6	68.4	68.6	72.2	72.4
56058	Test Valley Borough Council	327.1	33.5	31.9	32.0	32.3	32.4
56931	Eastleigh Borough Council	470.3	30.7	28.9	29.0	29.4	29.4
73606	Eastleigh Borough Council	284.7	23.0	21.3	21.3	22.1	22.1
73607	Eastleigh Borough Council	12.2	21.4	20.6	20.6	20.9	20.9
73609	Eastleigh Borough Council	342.6	57.2	52.2	52.3	54.7	54.8
73614	Test Valley Borough Council	476.2	21.8	20.7	20.8	21.1	21.1
75259	Test Valley Borough Council	704.1	58.0	56.4	56.5	53.8	53.9
New Forest links							
36375	New Forest District Council	30.6	33.7	32.7	32.7	32.7	32.8
56960	New Forest District Council	24.8	35.1	35.2	34.3	33.7	34.7
48475	New Forest District Council	224.5	23.1	22.6	22.6	22.6	22.6
16341	New Forest District Council	211.5	31.0	30.0	30.1	30.0	30.1
78316	New Forest District Council	993.3	16.0	15.9	15.9	15.8	15.8
28356	New Forest District Council	590.9	19.0	18.8	18.8	18.7	18.7
38492	New Forest District Council	163.6	24.2	23.8	23.8	23.7	23.7
74832	New Forest District Council	370.5	23.8	23.2	23.2	23.2	23.2

Figure 10 Annual mean NO_2 concentrations for Option 1 in 2020

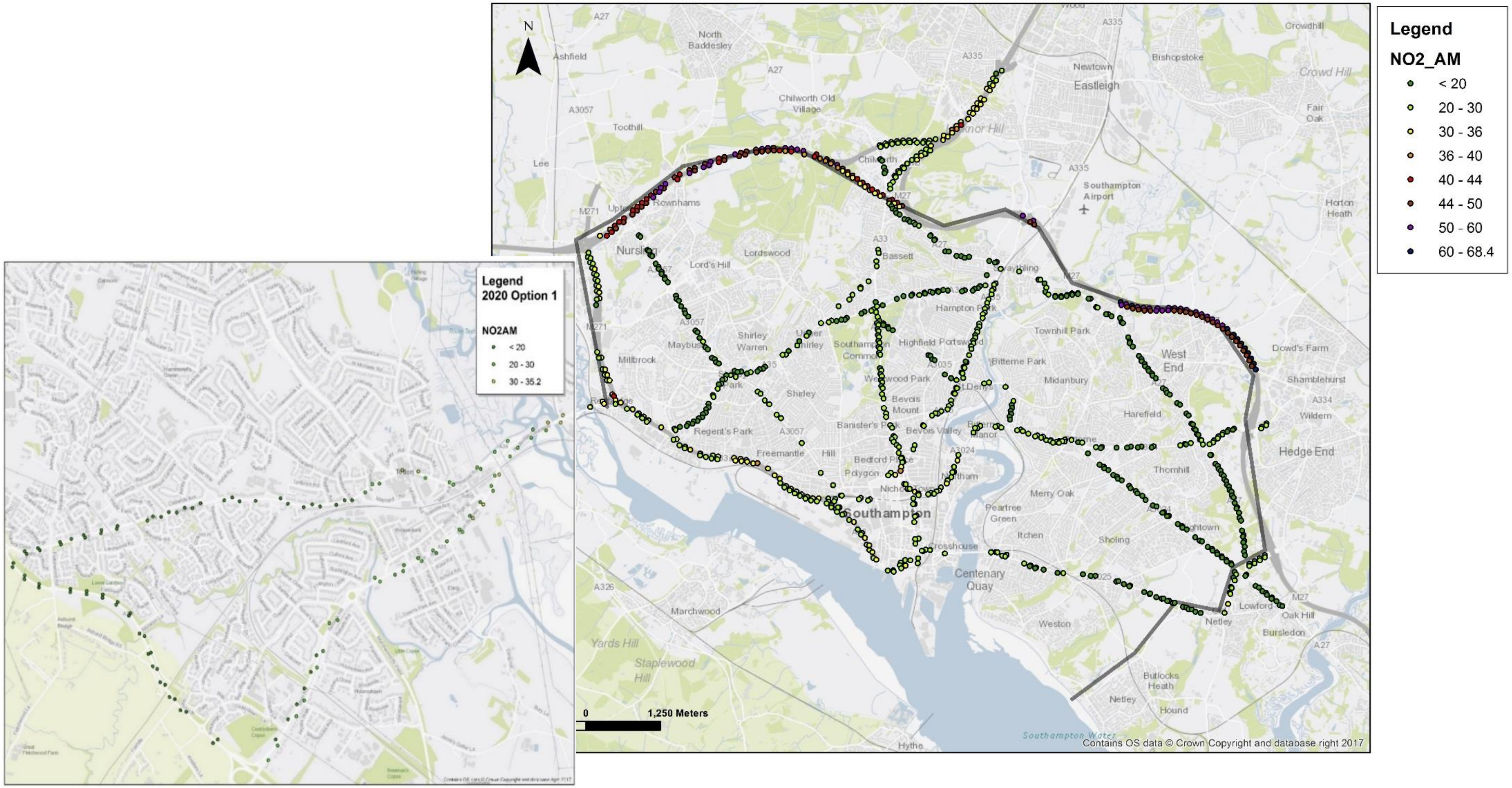


Figure 11 Annual mean NO_2 concentrations for Option 1a in 2020

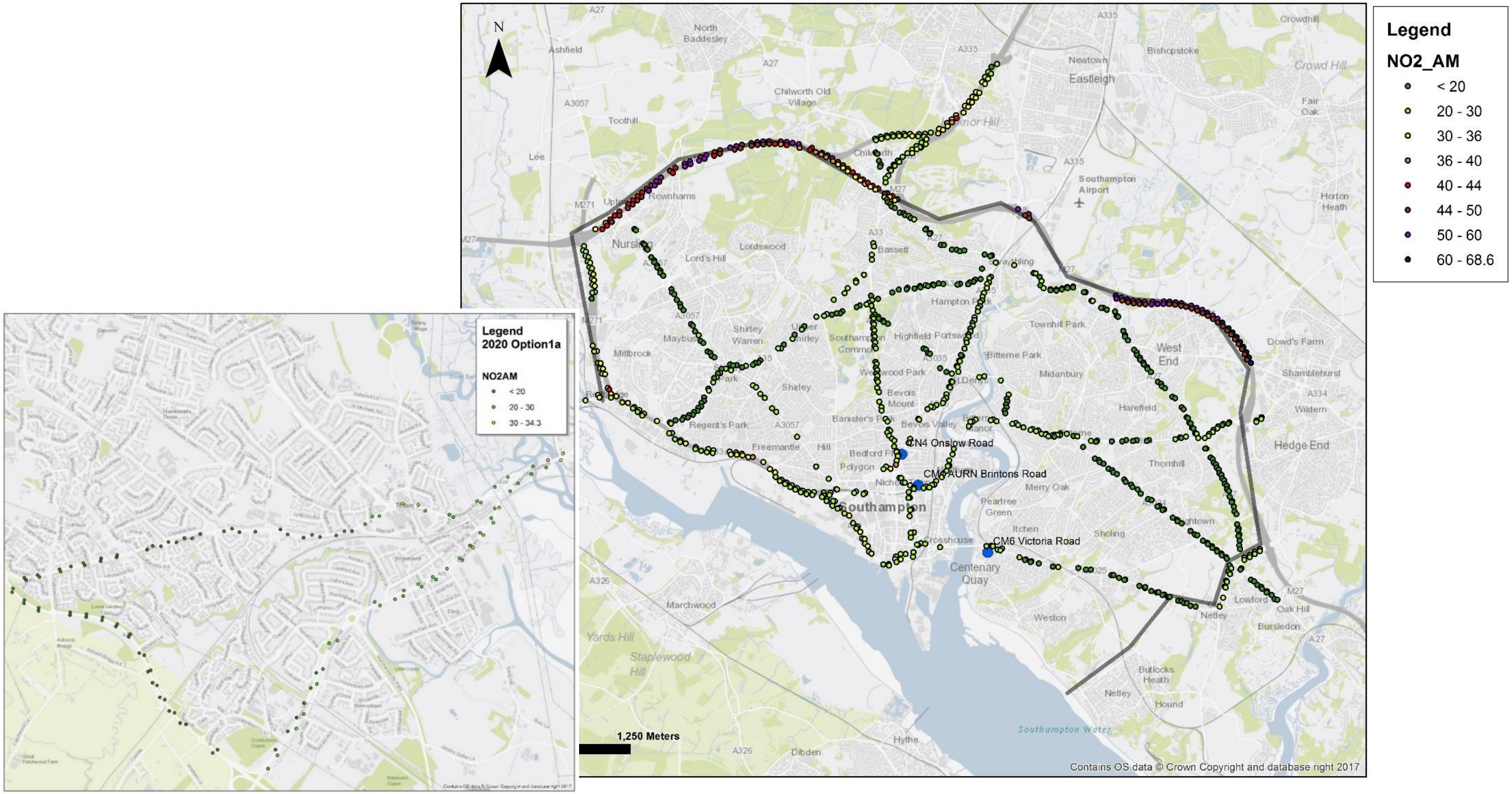
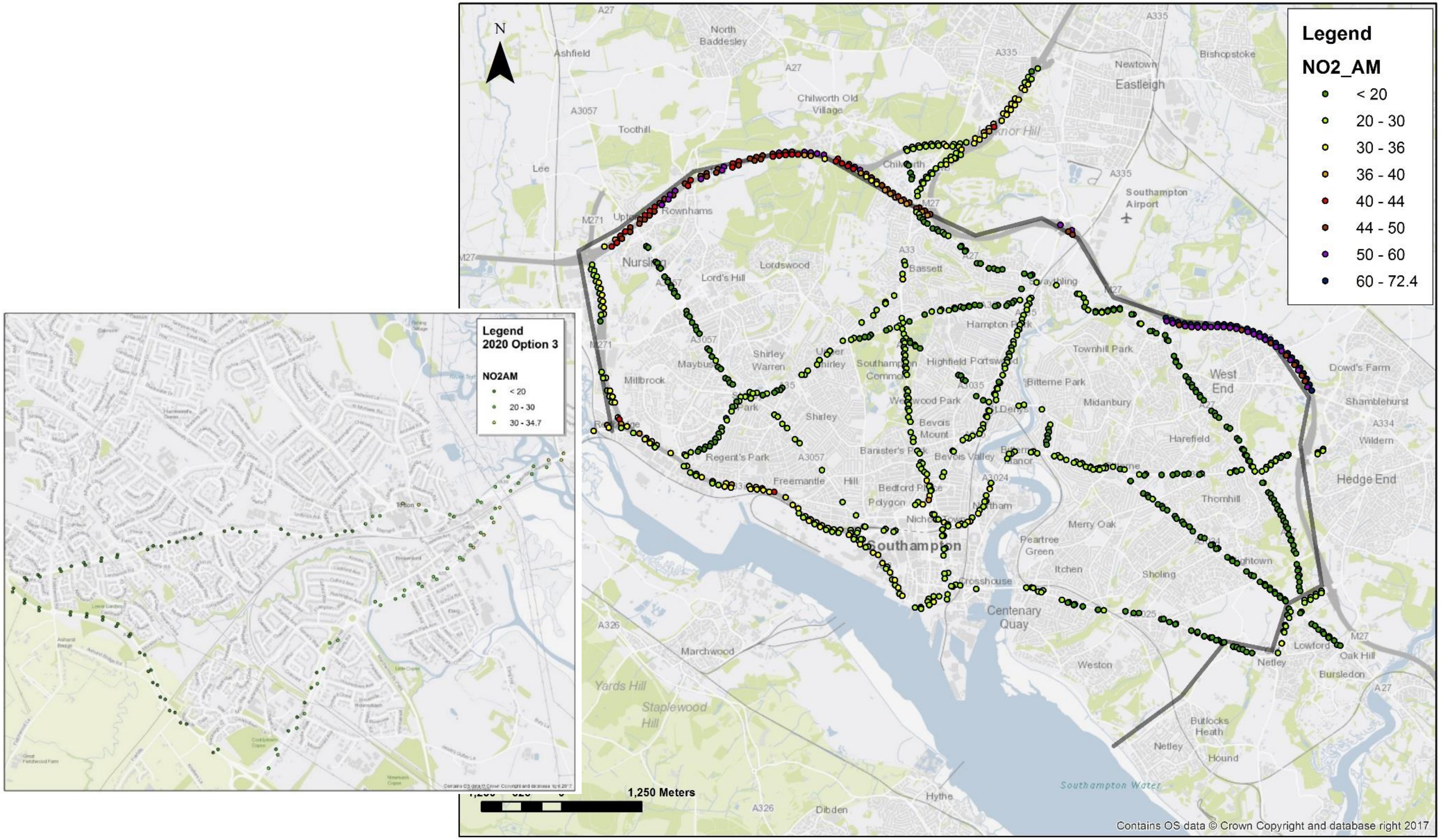


Figure 12 Annual mean NO_2 concentrations for Option 2 in 2020

Figure 13 Annual mean NO_2 concentrations for Option 3 in 2020



4.2 Results at local monitoring points

Modelled NO_2 results have also been extracted from the model for each of the monitoring locations in Southampton and New Forest. These results provide an indication of the impact of the options in relation to areas of concern in relation to local air quality management.

In both Southampton and New Forest all of the monitoring locations were below the 40 µg/m³ limit value in the baseline and remain so for all the options modelled.

Table 9: Predicted NO_2 annual mean concentrations at monitoring site locations in 2020

Monitoring site name	Site ID	Site type	NO_2 annual mean (µg.m^{-3})			
			Option 1	Option 1a	Option 2	Option 3
Southampton Monitoring Locations						
CM1 AURN Brintons Road	CM1	Urban Centre	27.0	26.8	27.9	28.0
CM4 Onslow Road	CM4	Roadside	32.2	32.0	33.3	33.4
CM6 Victoria Road	CM6	Roadside	18.6	18.5	18.8	18.8
Redbridge School Fence	N101	Roadside	29.0	29.0	30.6	30.7
64 Burgess Road	N102	Roadside	18.3	18.3	18.7	18.7
485 Millbrook Road	N103	Roadside	28.9	28.9	30.4	30.4
Regents Park Junction	N104	Roadside	28.7	28.7	30.8	30.8
2 Romsey Road	N106	Roadside	19.7	19.2	20.3	20.3
Cranbury Place	N107	Roadside	31.8	31.2	30.5	31.9
72 Bevois Valley Road	N109	Roadside	24.8	24.7	25.5	25.5
206 Bitterne Road	N113	Roadside	22.4	22.3	23.1	23.2
Library, Bitterne Road	N114	Roadside	23.6	23.5	24.7	24.8
54 Redbridge Road	N115	Roadside	28.6	28.6	31.1	31.2
57 Redbridge Road	N116	Roadside	23.6	23.7	25.5	25.5
3 Rockstone Place	N118	Roadside	23.4	22.9	22.7	23.6
6-9 Canute Road	N120	Roadside	32.8	32.3	33.1	33.3
151 Paynes Road	N122	Roadside	31.7	31.7	33.1	33.1
102 St Andrews Road	N123	Roadside	26.2	26.3	26.7	26.8
305 Millbrook Road	N124	Roadside	32.9	32.9	35.0	35.1
Princes Court	N125	Roadside	27.4	27.2	28.6	28.6
107 St. Andrews Road	N126	Roadside	27.1	27.1	27.6	27.7
Canute Road	N129	Roadside	34.7	34.4	35.0	35.2
367A Millbrook Road	N130	Roadside	31.8	31.8	34.2	34.3
142 Romsey Road 1	N131	Roadside	25.7	23.7	24.6	26.0
539 Millbrook Road	N133	Roadside	22.8	22.8	23.7	23.7
433-435 Millbrook Road	N134	Roadside	28.1	28.1	30.3	30.3
24 Victoria Road	N135	Roadside	20.6	20.2	20.2	20.6
23 Victoria Road	N136	Roadside	20.5	20.2	20.1	20.6
66 Burgess Road 1	N138	Roadside	25.1	24.5	23.6	25.2
5 Commercial Road	N140	Roadside	32.0	31.0	30.5	32.3

Town Quay	N141	Kerbside	35.9	36.0	36.3	36.6
102 Romsey Road	N143	Roadside	21.3	20.3	20.5	21.5
208 Northam Road	N144	Roadside	29.4	29.3	30.6	30.6
222 Northam Road	N146	Roadside	26.6	26.5	27.5	27.5
44B Burgess Road	N149	Roadside	19.8	19.9	20.3	20.3
134 Romsey Road	N151	Roadside	25.5	23.5	24.3	25.8
M271	N152	Roadside	31.2	31.3	32.5	32.5
Coniston Road	N153	Roadside	26.1	26.2	27.1	27.1
Oceana Boulevard,	N154	Roadside	24.6	24.3	25.0	25.0
4 Platform Road	N157	Roadside	26.6	26.4	27.4	27.5
24 Portsmouth Road	N158	Roadside	19.6	19.4	19.9	19.9
35 Portsmouth Road	N159	Roadside	17.9	17.8	18.0	18.0
2 Dorset Street	N160	Roadside	27.1	27.1	27.9	28.0
30 Addis Square	N161	Roadside	18.8	17.9	18.6	19.1
263A Portswood Road	N162	Roadside	21.0	20.4	20.5	21.2
285 Portswood Road	N163	Roadside	19.4	18.7	18.8	19.4
168-174 Portswood Road	N164	Roadside	20.5	19.3	20.1	20.7
8 The Broadway	N165	Roadside	20.5	19.3	20.1	20.7
14 New Road	N166	Roadside	27.7	27.2	28.4	28.5
13 Romsey Road	N167	Roadside	20.0	19.4	20.8	20.9
23 Romsey Road	N168	Roadside	20.1	19.5	21.0	21.0
150 Romsey Road	N169	Roadside	25.7	23.7	24.6	26.0
4 New Road	N172	Roadside	28.7	28.2	29.7	29.7
19A Burgess Road	N173	Roadside	25.3	25.3	26.1	26.2
166A Bitterne Road	N174	Roadside	26.2	26.0	26.9	27.0
38 Shirley High Street	N175	Roadside	26.4	24.9	25.2	26.5
126 Shirley High Street	N176	Roadside	23.5	23.0	23.0	23.8
95 Shirley High Street	N177	Roadside	23.1	21.5	22.6	23.4
2 Gover Road	N178	Roadside	20.5	20.5	21.3	21.3
New Forest monitoring locations						
Junction Rd (analyser)	20	Roadside	19.06	19.06	18.96	18.98
30, Junction Rd	21	Kerbside	20.04	20.05	19.93	19.95
25, Junction Rd	22	Roadside	17.45	17.45	17.37	17.39
26, Rumbridge St.	23	Roadside	19.86	19.6	19.41	19.61
2, Eling Lane	24	Roadside	17.72	17.72	17.64	17.66
Elingfield Court, High St.	25	Roadside	19.61	19.47	19.45	19.5
55, High St.	26	Roadside	14.7	14.71	14.73	14.74
114, Commercial Rd	27	Kerbside	22.02	22	22.06	22.1
Commercial Rd	28	Roadside	21.44	21.42	21.48	21.51
Ringwood Rd / Maynard Rd rbt	29	Roadside	21.65	21.65	21.58	21.61
Asda rbt	30	Roadside	18.67	18.68	18.59	18.61
1, Rose Rd	31	Roadside	13.22	13.23	13.23	13.23

5 Conclusions

This report has provided an overview of the air quality results, in terms of NO_2 concentrations, for the Southampton and New Forest CAZ study areas covering the 2015 base year, 2020 baseline and 4 CAZ options in 2020. The results have been provided for the national air quality model (PCM) links and locl monitoring locations.

The baseline results for 2020 indicate the following:

- There are 3 exceedances of the 40µ/m^3 limit with in the Southampton City Council area, one is on the Western Approach at Millbrook Road West, but the other two relate to Highways England roads on the motorway network;
- There are a further 6 exceedances on the motorway network around Southampton falling into other districts (Eastleigh and Test Valley);
- No exceedances were identified in the New Forest modelled area in the 2020 baseline;
- All of the monitoring locations in both Southampton and New Forest were estimated to be under the 40µ/m^3 limit by 2020.

The impact of the options can be summaries as follows:

- Options 1 (Citywide CAZ B) and Option 1a (Citywide HGV charging scheme) show very similar impacts in Southampton with an average reduction in NO_2 concentrations of 6.5%. This is enough remove the exceedance on the Western Approach at Millbrook Road West, reducing the number of exceedances from 9 to 8. In addition, it reduces the number of PCM at risk of exceedance which were above 35µ/m^3 from 18 to 11.
- Options 2 (City centre CAZ A) and 3 (non-charging measures) both have a similar impact in Southampton which is about half that of options 1 and 1a with an average reduction in NO_2 concentrations of 3.6%. However, this is not enough to reduce the number of exceedance but it does reduce the number of links over 35µ/m^3 from 18 to 14, a little less than options 1 and 1a.
- All options have a similar impact on New Forest with an average reduction in NO_2 concentrations of around 2%.

Overall this suggests that from an air quality point of view either option 1 or 1a would provide the most benefits.

Appendices

Appendix 1: Southampton updated air quality model verification and adjustment

Appendix 2: New Forest air quality model verification and adjustment

Appendix 3: Transport model results for the city-wide CAZ B option

Appendix 1: Southampton updated air quality model verification and adjustment

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations; this helps to identify how the model is performing and if any adjustments should be applied. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. This can be followed by adjustment of the modelled results if required. The LAQM.TG(16) guidance recommends making the adjustment to the road contribution of the pollutant only and not the background concentration these are combined with.

The approach outlined in LAQM.TG(16) section 7.508 – 7.534 (also in Box 7.14 and 7.15) has been used in this case. All roadside automatic and diffusion tube NO_2 measurement sites in Southampton have been used for model verification. A single road NOx adjustment factor was derived and used to calculate:

- Citywide modelling results at receptor points adjacent to relevant PCM road links
- Citywide 1m resolution NO_2 annual mean concentration rasters providing a continuous representation of the spatial variation in modelled concentrations.

The use of a zonal model verification approach was also considered during our analysis of modelled vs measured Road NOx; we concluded:

- There was no clear pattern in the value of road NOx adjustment factors across different zones of the city; allocating zones would therefore have been a subjective process.
- There could be various factors contributing to variable model agreement at individual measurement sites across the domain, these include uncertainties or omissions in the modelled traffic activity data, uncertainties in estimates of background concentrations, and omission of other nearby sources that have not been explicitly modelled e.g. bus stops, car parks etc. When modelling at the local scale, we typically model with a consistent background concentration across the model domain; and the impact of other sources such as car parks and bus stops can be modelled. Including this amount of detail is not however practical when modelling at city scale.
- Using a zonal approach could be considered relevant when the intention of the modelling is to focus on evidence relevant to specific areas or hotspots within the wider model domain e.g. small AQMA's. Whereby applying a zone specific road NOx adjustment factor may reduce the overall average error between measured and modelled concentrations at that location and hence increase confidence in the model results and associated conclusions. However, when generating evidence relevant to citywide impacts, applying different road NOx adjustment factors across the domain may create sudden step changes in modelled concentrations at the edge of each zone. For the Southampton CAZ assessment this would mean we were unable to produce a continuous NO_2 annual mean concentration raster for use in the distributional analysis aspect of the economics modelling. It may also have led to inconsistencies in the modelled concentrations at receptor points adjacent to relevant PCM road links where these were at the edge of a (subjectively allocated) verification zone.
- We have also presented results for future year scenarios using road NOx adjustment factors specific to each monitoring site, which could be considered as a zonal verification approach. This aims to provide an indication of when it is likely that compliance will be achieved at each measurement site even if the required Road NOx adjustment factor is higher than the slope of the best fit line across all sites.

It is appropriate to verify the performance of the RapidAir model in terms of primary pollutant emissions of nitrogen oxides ($NOx = NO + NO_2$). To verify the model, the predicted annual mean Road NOx concentrations were compared with concentrations measured at the various monitoring sites during 2015. The model output of Road NOx (the total NOx originating from road traffic) was compared with measured Road NOx, where the measured Road NOx contribution is calculated as the difference between the total NOx and the background NOx value. Total measured NOx for each diffusion tube was calculated from the measured NO_2 concentration using the latest version of the Defra NOx/NO_2 calculator issued for use in the CAZ cities (v5.3).

The initial comparison of the modelled vs measured Road NOx identified that the model was under-predicting the Road NOx contribution at most locations. Refinements were subsequently made to the model inputs to improve model performance where possible.

The gradient of the best fit line for the modelled Road NOx contribution vs. measured Road NOx contribution was then determined using linear regression and used as a global/domain wide Road NOx adjustment factor. This factor was then applied to the modelled Road NOx concentration at each discretely modelled receptor point to provide adjusted modelled Road NOx concentrations. A linear regression plot comparing modelled and monitored Road NOx concentrations before and after adjustment is presented in Figure A3.1.

The total annual mean NO_2 concentrations were then determined using the NOx/NO_2 calculator to combine background and adjusted road contribution concentrations.

Some clear outliers were apparent during the model verification process, whereby we unable to refine the model inputs sufficiently to achieve acceptable model performance at these locations. There are a number of reasons why this could be the case e.g.

- A site located next to a large car park, bus stop, petrol station, or taxi rank that has not been explicitly modelled due to unknown activity data.
- Sites located underneath trees or vegetation i.e. unsuitable locations for diffusion tubes to measure NO_2 concentrations effectively
- No traffic model road link included where the NO_2 sampler is located, or not all road links included e.g. at a junction.
- Uncertainties in the traffic model outputs.
- Uncertainties in the background maps, and the uncertainties introduced by modelling background concentrations over such a wide area at 1km resolution i.e. the mapped background concentrations change very suddenly at the edges of each 1km background map square. In reality annual average background concentrations would change gradually over an urban area. A possible solution to this issue wold be to interpolate the 1km background maps to a finer resolution e.g. 200m; this would have the effect of smoothing out the sudden changes in background concentrations at the 1km square edges of the background maps

However, in this case, excluding all of these outliers from the verification process would lead to a lower road NOx adjustment factor than that calculated using all sites. Therefore, to present a conservative approach to adjusting future year predictions of road NOx concentrations, a primary NOx adjustment factor (PAdj) of **2.1593** based on model verification using all of the 2015 NO_2 measurements was applied to all modelled Road NOx data prior to calculating an NO_2 annual mean.

A plot comparing modelled and monitored NO_2 concentrations before and after adjustment during 2015 is presented in Figure A3.2.

Figure A3.1 Comparison of modelled Road NO_x Vs Measured Road NO_x before and after adjustment (all sites)

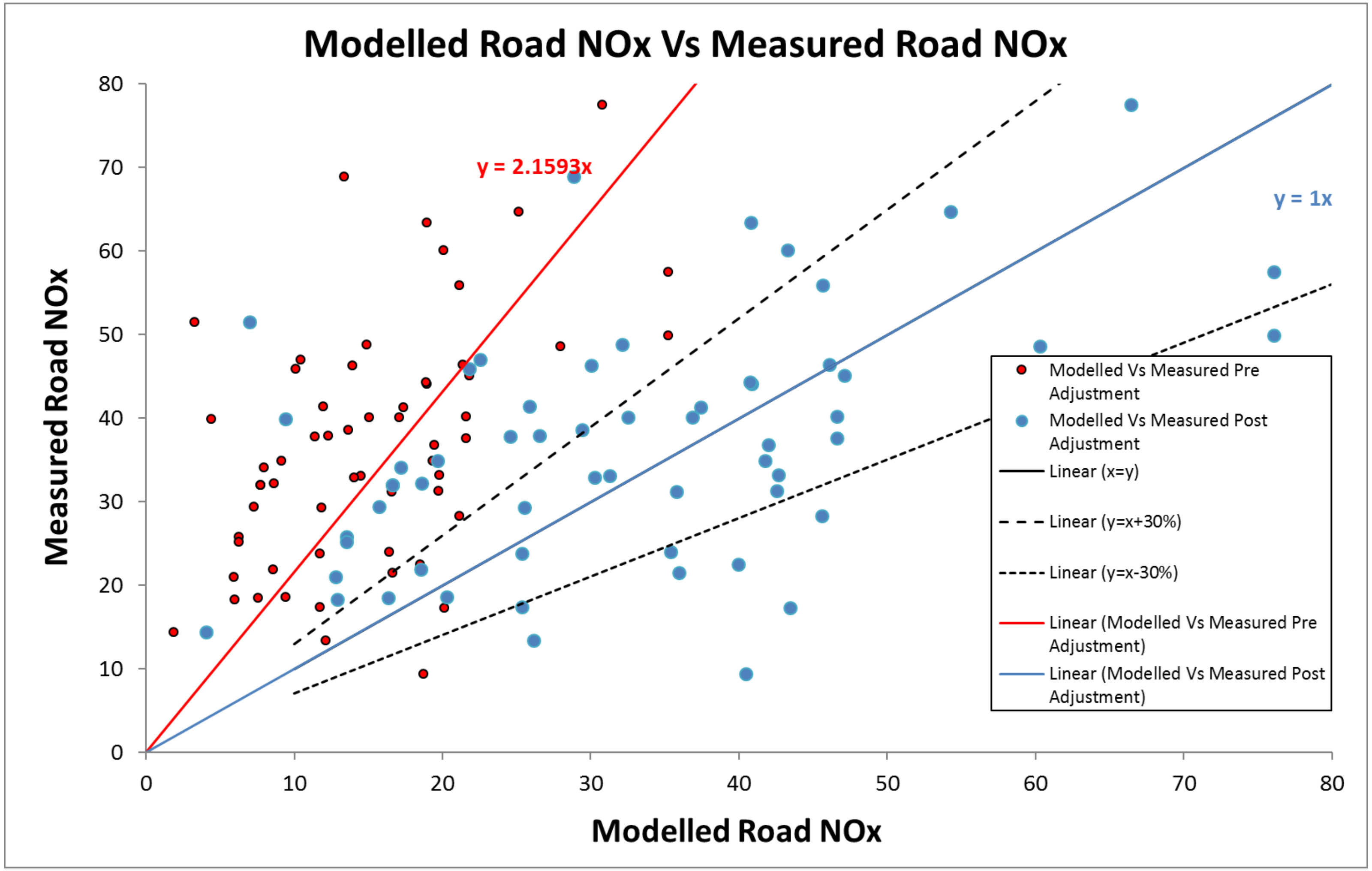
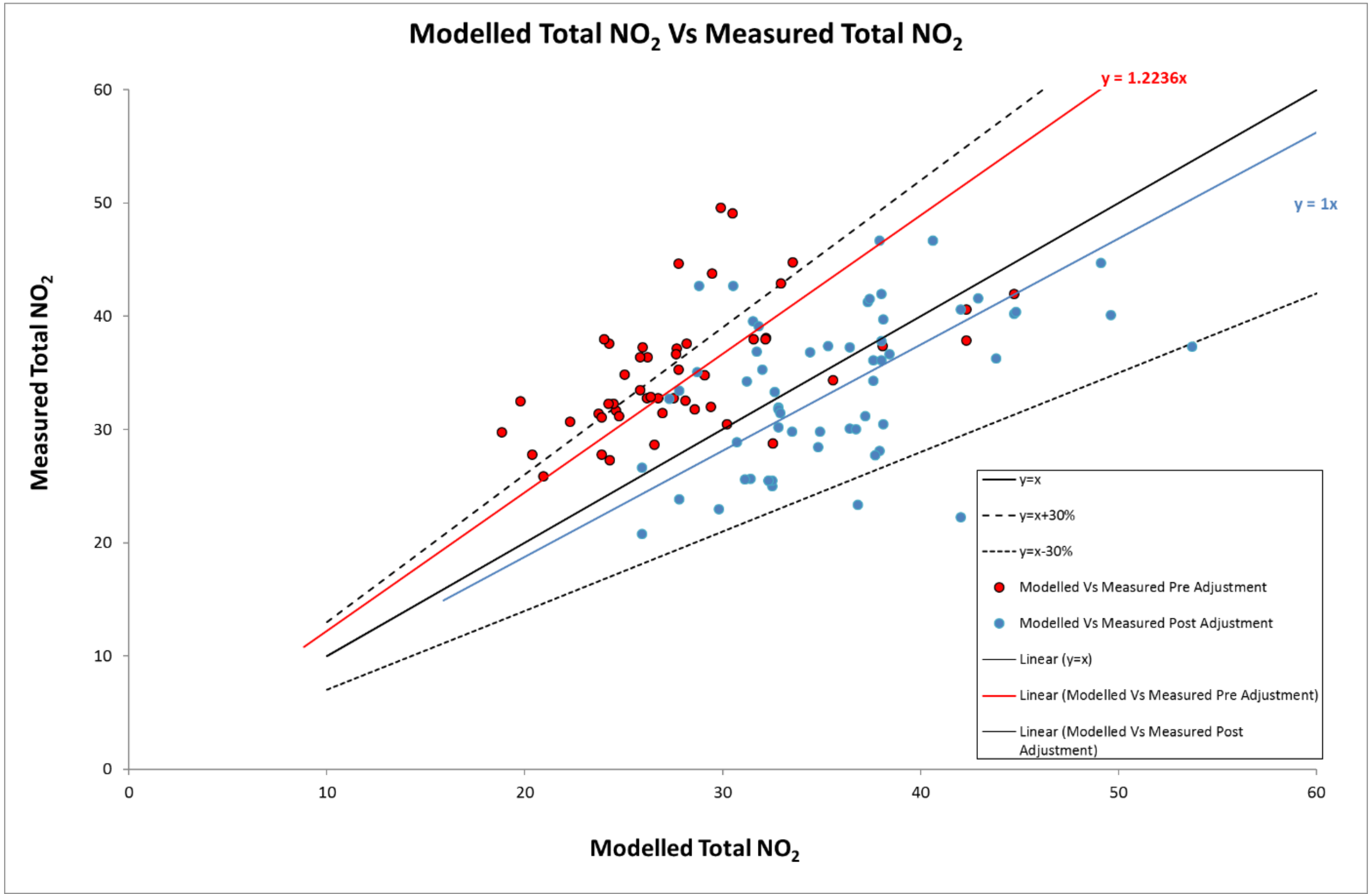


Figure A3.2: Modelled vs. measured NO_2 annual mean 2015



Model performance

To evaluate the model performance and uncertainty, the Root Mean Square Error (RMSE) for the observed vs predicted NO_2 annual mean concentrations was calculated, as detailed in Technical Guidance LAQM.TG(16). The calculated RMSE is presented in Table A3.1.

In this case the RMSE was calculated at 6.7 µg.m^{-3}. An RMSE was also calculated when clear outliers were excluded which reduced the average model error to 5.3 µg.m^{-3}.

Table A3.1: Root mean square error

NO_2 monitoring site	Measured NO_2 annual mean concentration 2015 (µg.m^{-3})	Modelled NO_2 annual mean concentration 2015 (µg.m^{-3})
CM1	32.0	35.3
CM4	42.0	40.6
CM6	42.0	22.3
N101	44.7	40.3
N102	29.8	23.0
N103	31.7	36.9
N104	38.4	36.7
N106	37.9	28.2
N107	53.7	37.3
N109	37.2	31.2
N113	34.9	29.9
N114	32.8	32.0
N115	36.4	37.3
N116	38.1	30.5
N118	34.8	28.5
N120	38.0	42.0
N122	31.5	39.6
N123	32.8	30.2
N124	37.3	41.3
N125	35.3	37.4
N126	32.8	31.8
N129	28.8	42.7
N130	44.8	40.4
N131	37.9	46.7
N133	30.7	28.9
N134	37.6	36.1
N135	31.4	25.7
N136	31.1	25.6
N138	43.8	36.3
N140	49.6	40.1
N141	30.5	42.7
N143	34.4	36.9
N144	31.8	39.2

NO_2 monitoring site	Measured NO_2 annual mean concentration 2015 ($\mu g.m^{-3}$)	Modelled NO_2 annual mean concentration 2015 ($\mu g.m^{-3}$)
N146	28.7	35.1
N149	32.5	25.0
N151	37.4	41.5
N152	49.1	44.7
N153	31.2	34.3
N154	32.9	31.5
N157	27.8	33.4
N158	36.8	23.4
N159	25.9	20.8
N160	32.6	33.4
N161	32.5	25.5
N162	37.7	27.8
N163	27.8	23.8
N164	32.3	25.5
N165	32.3	25.5
N166	38.1	39.7
N167	33.5	29.8
N168	36.4	30.1
N169	40.6	46.7
N172	42.9	41.6
N173	27.3	32.7
N174	37.6	34.3
N175	38.0	37.8
N176	38.0	36.1
N177	36.7	30.1
N178	25.9	26.6
	RMSE (all sites)	**6.7**
	RMSE (excluding clear outliers)	**5.1**

Appendix 2 – New Forest air quality model verification and adjustment

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations; this helps to identify how the model is performing and if any adjustments should be applied. The verification process involves checking and refining the model input data to try and reduce uncertainties and produce model outputs that are in better agreement with the monitoring results. This can be followed by adjustment of the modelled results if required. The LAQM.TG(16) guidance recommends making the adjustment to the road contribution of the pollutant only and not the background concentration these are combined with.

The approach outlined in LAQM.TG(16) section 7.508 – 7.534 (also in Box 7.14 and 7.15) has been used in this case. All roadside diffusion tube NO_2 measurement sites in New Forest study area have been used for model verification.

It is appropriate to verify the performance of the RapidAir model in terms of primary pollutant emissions of nitrogen oxides ($NOx = NO + NO_2$). To verify the model, the predicted annual mean Road NOx concentrations were compared with concentrations measured at the various monitoring sites during 2015.

The model output of Road NOx (the total NOx originating from road traffic) was compared with measured Road NOx, where the measured Road NOx contribution is calculated as the difference between the total NOx and the background NOx value. Total measured NOx for each diffusion tube was calculated from the measured NO_2 concentration using the latest version of the Defra NOx/NO_2 calculator issued for use in the CAZ cities (v5.3).

The initial comparison of the modelled vs measured Road NOx identified that the model was under-predicting the Road NOx contribution at most locations. Refinements were subsequently made to the model inputs to improve model performance where possible.

The gradient of the best fit line for the modelled Road NOx contribution vs. measured Road NOx contribution was then determined using linear regression and used as a global/domain wide Road NOx adjustment factor. This factor was then applied to the modelled Road NOx concentration at each discretely modelled receptor point to provide adjusted modelled Road NOx concentrations. A linear regression plot comparing modelled and monitored Road NOx concentrations before and after adjustment is presented in Figure A1.1.

The total annual mean NO_2 concentrations were then determined using the NOx/NO_2 calculator to combine background and adjusted road contribution concentrations.

Some clear outliers were apparent during the model verification process, whereby we unable to refine the model inputs sufficiently to achieve acceptable model performance at these locations. There are a number of reasons why this could be the case e.g.

- A site located next to a large car park, bus stop, petrol station, or taxi rank that has not been explicitly modelled due to unknown activity data.
- Sites located underneath trees or vegetation i.e. unsuitable locations for diffusion tubes to measure NO_2 concentrations effectively
- No traffic model road link included where the NO_2 sampler is located, or not all road links included e.g. at a junction.
- Uncertainties in the traffic model outputs.

- Uncertainties in the background maps, and the uncertainties introduced by modelling background concentrations over such a wide area at 1km resolution i.e. the mapped background concentrations change very suddenly at the edges of each 1km background map square. In reality annual average background concentrations would change gradually over an urban area. A possible solution to this issue wold be to interpolate the 1km background maps to a finer resolution e.g. 200m; this would have the effect of smoothing out the sudden changes in background concentrations at the 1km square edges of the background maps

However, in this case, excluding all of these outliers from the verification process would lead to a lower road NOx adjustment factor than that calculated using all sites. Therefore, to present a conservative approach to adjusting future year predictions of road NOx concentrations, a primary NOx adjustment factor (PAdj) of **1.7456** based on model verification using all of the 2015 NO_2 measurements was applied to all modelled Road NOx data prior to calculating an NO_2 annual mean.

A plot comparing modelled and monitored NO_2 concentrations before and after adjustment during 2015 is presented in Figure A1.2.

Figure A1.1 Comparison of modelled Road NO_x Vs Measured Road NO_x before and after adjustment (all sites)

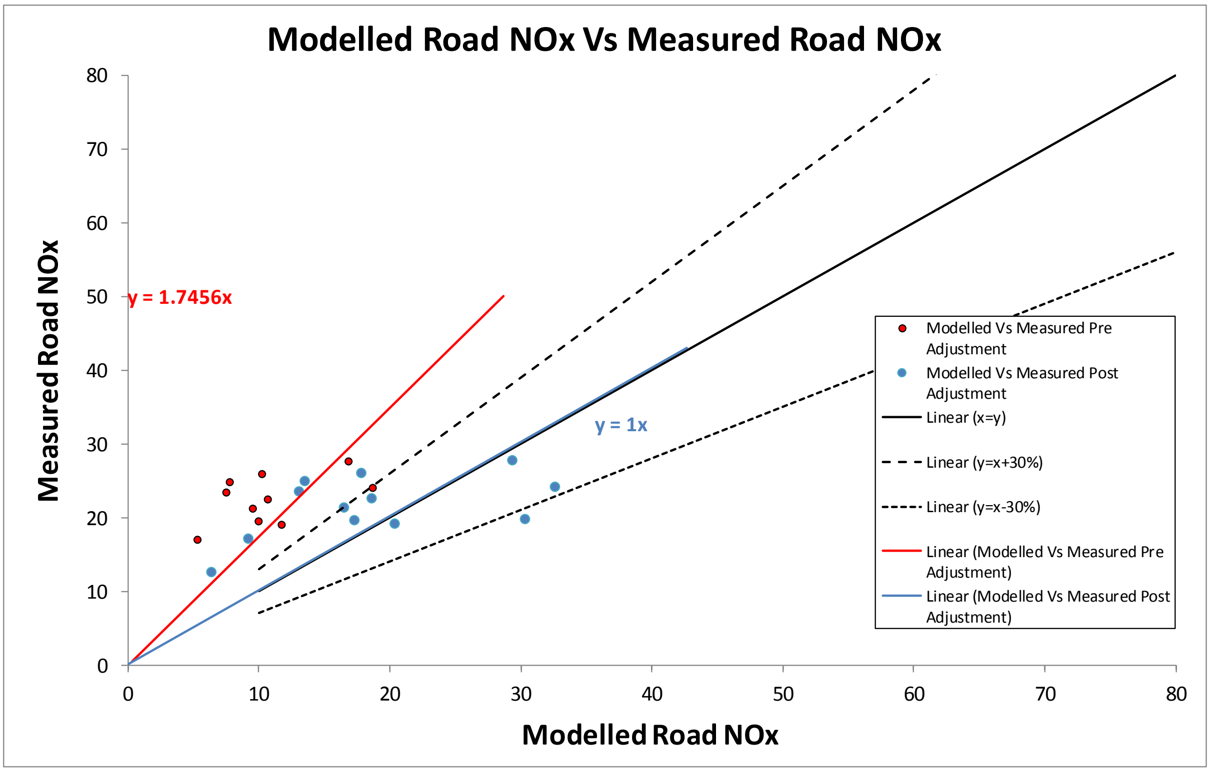
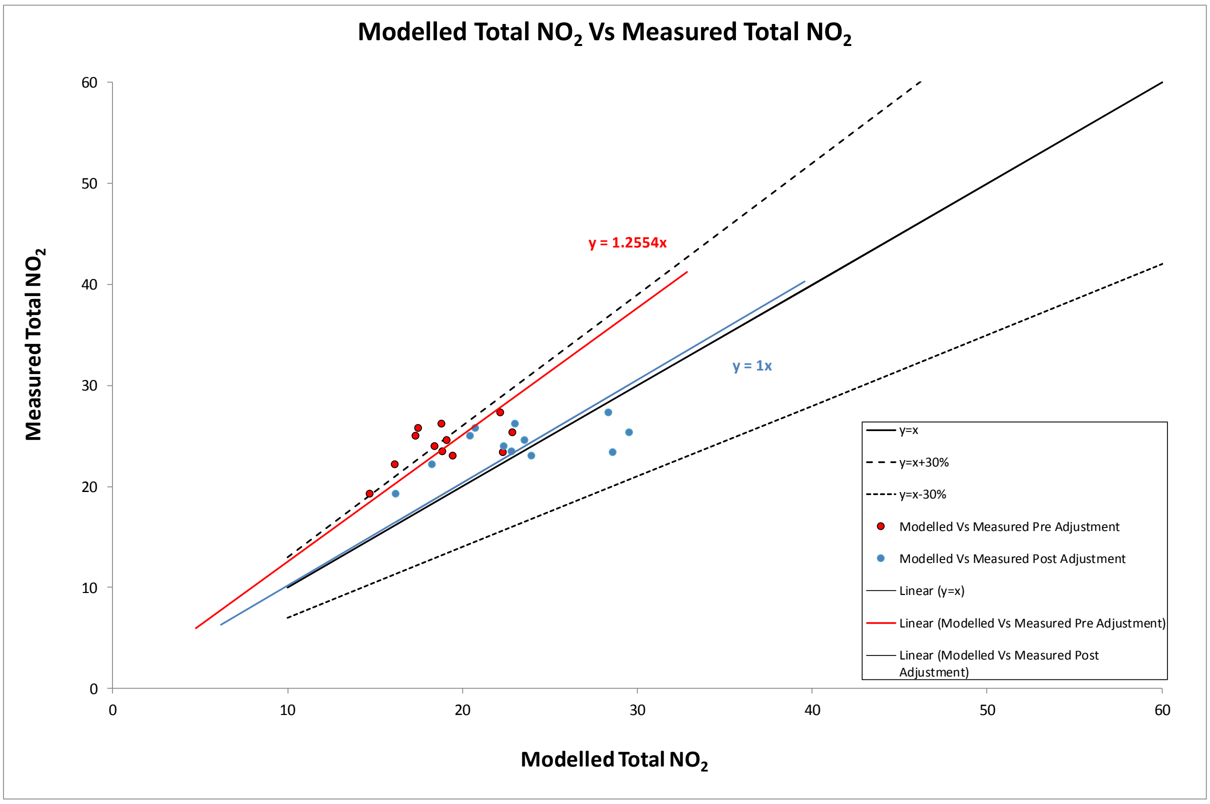


Figure A1.2: Modelled vs. measured NO_2 annual mean 2015



Model performance

To evaluate the model performance and uncertainty, the Root Mean Square Error (RMSE) for the observed vs predicted NO_2 annual mean concentrations was calculated, as detailed in Technical Guidance LAQM.TG(16). The calculated RMSE is presented in Table A1.1.

In this case the RMSE was calculated at 3.3 $\mu g.m^{-3}$. An RMSE was also calculated when clear outliers were excluded, however the RMSE remained at 3.3 $\mu g.m^{-3}$.

Table A1.1: Root mean square error

NO_2 monitoring site	Measured NO_2 annual mean concentration 2015 ($\mu g.m^{-3}$)	Modelled NO_2 annual mean concentration 2015 ($\mu g.m^{-3}$)
20 - Junction Rd (analyser)	23.9	22.4
21 - 30 Junction Rd	24.5	23.6
22 - 25 Junction Rd	25.0	20.5
23 - 26 Rumbridge St.	26.1	23.0
24 - 2 Eling Lane	25.7	20.8
25 - Elingfield Court, High St.	23.0	24.0
26 - 55 High St.	22.1	18.3
27 - 114 Commercial Rd	25.3	29.6
28 - Commercial Rd	23.3	28.6
29 - Ringwood Rd / Maynard Rd roundabout	27.2	28.4
30 - Asda roundabout	23.4	22.9
31 - 1 Rose Rd	19.2	16.2
	RMSE (all sites)	**3.3**
	RMSE (excluding clear outliers)	**3.3**

Appendix 3 – Transport model results for the city-wide CAZ B option

This is attached as a separate PDF report.

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