Ricardo
Energy & Environment

Three Rivers Detailed Assessment

Junction 18, M25

Report for Three Rivers District Council
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Executive summary

Ricardo Energy & Environment have been commissioned by Three Rivers District Council to undertake a Detailed Assessment of Nitrogen Dioxide (NO_2) and Particulate Matter 10 micrometres or less in diameter (PM_{10}) within Chorleywood. This Detailed Assessment will allow Three Rivers District Council to decide if the current Air Quality Management Area around Junction 18 of the M25 can be revoked.

This modelling study, which has used the most recently available traffic, monitoring and meteorological data for Rickmansworth indicates that there are no exceedances of the NO_2 or PM_{10} annual mean objective at locations with relevant exposure in the area surrounding Junction 18 of the M25.

The results do however indicate that annual mean NO_2 concentrations are close to their air quality objective of 40 µg.m^{-3} at locations where relevant exposure may be present. **It is therefore recommended that Three Rivers District Council continue to measure NO_2 and PM_{10} and do not revoke the Air Quality Management Area. Three Rivers District Council intend to expand their monitoring network to cover the locations highlighted within the modelling as close to the objective in order to inform further their decision on the revocation of the J18 Chorleywood Air Quality Management Area.**

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1 Introduction

Ricardo Energy & Environment have been commissioned by Three Rivers District Council to undertake a Detailed Assessment of Nitrogen Dioxide (NO_2) and Particulate Matter 10 micrometres or less in diameter (PM_{10}) within Chorleywood. This assessment has been undertaken to investigate the potential scale and extent of exceedances of the Air Quality Objectives in the study area. This Detailed Assessment will allow Three Rivers District Council to decide if the current Air Quality Management Area around Junction 18 of the M25 can be revoked.

1.1 Policy Background

The Environmental Act 1995 placed a responsibility on the UK Government to prepare an Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland. The most recent version of this strategy (2007) sets out the current UK framework for air quality management and includes a number of air quality objectives for specific pollutants.

1.2 Air Quality Objectives

The 1995 Act sets out the requirements for Local Authorities to "Review and Assess" air quality in their areas following a prescribed timetable. The Review and Assessment process is intended to locate and spatially define an Air Quality Management Area (AQMA), carry out a Detailed Assessment of Air Quality, and develop an Air Quality Action Plan (AQAP) which should include measures to improve air quality so that the objectives may be achieved in the future. The timetables and methodologies for carrying out Review and Assessment studies are prescribed in Defra's Technical Guidance – LAQM.TG(16)[1].

Table 1 lists the objectives relevant to this assessment that are included in the Air Quality Regulations 2000 and (Amendment) Regulations 2002 for the purposes of Local Air Quality Management (LAQM). This assessment focuses on NO_2 and PM_{10} concentrations.

Table 1: NO_2 and PM_{10} Objectives included in the Air Quality Regulations

Pollutant	Air Quality Objective Concentration	Measured as
Nitrogen Dioxide (NO_2)	200 $\mu g.m^{-3}$ not to be exceeded more than 18 times a year	1-hour mean
	40 $\mu g.m^{-3}$	Annual mean
Particulate Matter (PM_{10})	50 $\mu g.m^{-3}$ not to be exceeded more than 35 times a year	24-hour mean
	40 $\mu g.m^{-3}$	Annual mean

1.2.1 Locations where Air Quality Objectives apply

When carrying out the review and assessment of air quality it is only necessary to focus on areas where relevant public exposure is present. Table 2 summarises examples of where the air quality objectives for NO_2 and PM_{10} should and should not apply.

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[1] https://laqm.defra.gov.uk/technical-guidance/

Table 2: Examples of where the NO_2 Air Quality Objectives should and should not apply

Averaging Period	Pollutant	Objectives should apply at …	Objectives should not generally apply at …
Annual mean	NO_2, PM_{10}	All locations where members of the public might be regularly exposed. Building facades of residential properties, schools, hospitals, care homes 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 façade), or any other location where public exposure is expected to be short term.
1 hour mean	NO_2	All locations where the annual mean and 24 and 8-hour mean objectives apply. Kerbside sites (for example, pavements of busy shopping streets). Those parts of car parks, bus stations etc. which are not fully enclosed, where members of the public might reasonably be expected to spend one hour or longer.	Kerbside sites where the public would not be expected to have regular access.
24 hour mean	PM_{10}	All locations where the annual mean objective would apply, together with hotels. Gardens of residential properties.	Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.

1.3 Purpose of this Detailed Assessment

This Detailed Assessment aims to assess the magnitude and spatial extent of any exceedances of the NO_2 and PM_{10} air quality objectives at locations where relevant human exposure may be present in Rickmansworth. The assessment will determine if an AQMA should be declared at these locations.

1.4 Overview of Detailed Assessment

The general approach taken in this Detailed Assessment was:

- Collect and interpret data from previous LAQM Review and Assessment reports;
- Collect and analyse recent traffic, monitoring and meteorological and background concentration data before use in the dispersion model;
- Use dispersion modelling to produce contour plots of NO_2 and PM_{10} concentrations at points of relevant exposure;
- Recommend if Three Rivers District Council should revoke the AQMA within Chorleywood.

The modelling methodologies provided for Detailed Assessment outlined in the Defra Technical Guidance LAQM.TG(16) were used throughout this study.

1.5 Previous Review and Assessments

1.5.1 2018 Annual Status Report (ASR)

The 2018 ASR reported that the main source of pollution in the district is from road transportation within Rickmansworth. Nitrogen dioxide (NO_2) and Particulate Matter (PM_{10}) are the pollutants of concern within Three Rivers and is monitored throughout the district using a network of diffusion tubes and AQMesh monitors. The majority of Rickmansworth meets the Air Quality Objectives for nitrogen dioxide (NO_2) and particulate matter (PM_{10}). However, in several locations within the district, concentrations of NO_2 and PM_{10} exceed the 40 $\mu g.m^{-3}$ annual mean objective.

NO_2 annual mean concentrations in excess of the 40 $\mu g.m^{-3}$ objective were measured at three of the thirteen diffusion tube sites in Three Rivers during 2017. The triplicate diffusion tubes at Belfry House Uxbridge Road (Mill End 1) measured 53.1, 53.2 and 48.5 $\mu g.m^{-3}$ respectively. Further details on NO_2 monitoring within Rickmansworth is presented in Section 4.

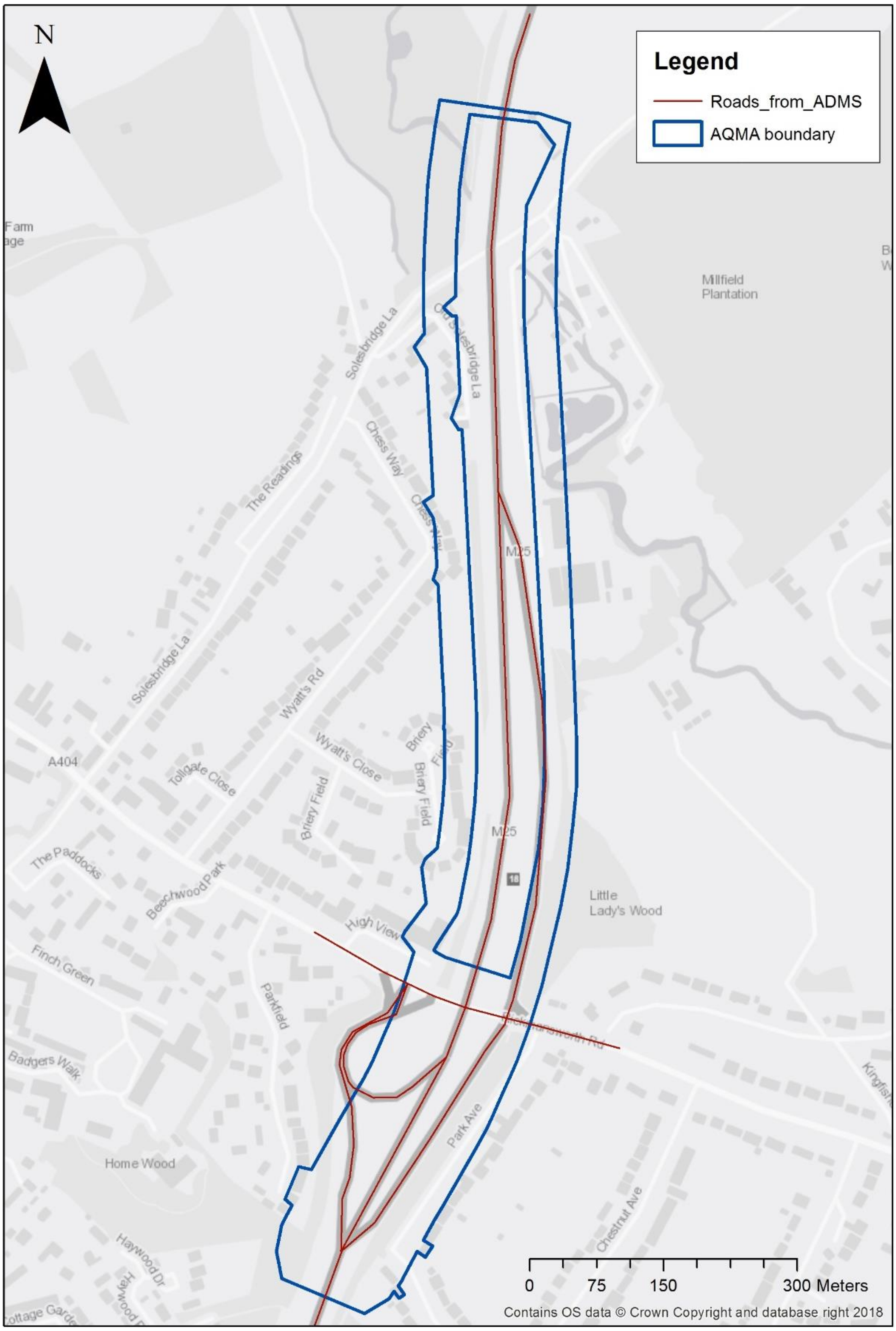
Based on the measured exceedances of the NO_2 and PM_{10} annual mean objective in 2017, the ASR concluded that a Detailed Assessment was required.

2 Detailed Assessment Study Area

Three Rivers District Council is a sub-urban district authority in south-west Hertfordshire, covering an area of approximately 88.8 square kilometres. It borders Watford and Hertsmere boroughs to the east, Buckinghamshire County (Chiltern and South Bucks Districts) to the west, St Albans City & District and Dacorum Borough to the north, and the London Boroughs of Hillingdon and Harrow are to the south. The main traffic routes are the M1 and M25 motorways which are significant sources of local air pollution emissions.

Rickmansworth is a small town in south-west Hertfordshire. The town is mainly to the north of the Grand Union Canal and the River Colne. The largest town is Watford, approximately 5 miles to the east. The study area is located within Chorleywood, around Junction 18 of the M25. The study area is presented in Figure 1.

Figure 1: Detailed assessment study area, including the location of the Chorleywood AQMA.



3 Information used to support this assessment

3.1 Mapping

Ordnance Survey based GIS data of the model domain and a road centreline GIS dataset were used in this assessment. This enabled accurate road widths and the distance of the housing to the kerb to be determined in GIS.

3.2 Road Traffic Data

3.2.1 Average flow, speed and fleet split

Publicly available Department for Transport (DfT)[2] count datasets were used in this detailed assessment to assign traffic flows to the roads in the study area. 2017 annual average daily traffic (AADT) counts at Rickmansworth Road, Chorleywood Road and the M25 either side of Junction 18 were used. These counts included a breakdown of typical vehicle fleet split data into Car, LGV, HGV, Bus, Rigid HGV, Artic HGV and motorcycle.

The speed on free-flowing road links was assumed to be equal to the speed limit on the road. Free-flowing road links were identified following examination of the typical traffic layer on Google maps[3] captured during normal working weekdays. The Google traffic data can be considered reliable given that it is derived from many on board vehicle GPS measurements that are collected in real time to enable the web interface to be updated with the latest conditions. To account for speed reductions during peak traffic periods, assumed average speeds were reduced at road sections where slow moving traffic was observed to occur regularly e.g. at locations approaching busy junctions. A summary of the traffic data used is presented in Appendix 3

It should be noted that traffic patterns in urban locations are complex and it is not possible to fully represent these in atmospheric dispersion models. By attempting to describe these complex traffic patterns using quite simple metrics (AADT, average speed and basic vehicle split composition) a degree of uncertainty is introduced into the modelling.

3.2.2 Vehicle Emission Factors

3.2.2.1 COPERT Version 5.0

COPERT is a software tool used world-wide to calculate air pollutant and greenhouse gas emissions from road transport. The development of COPERT is coordinated by the European Environment Agency (EEA), in the framework of the activities of the European Topic Centre for Air Pollution and Climate Change Mitigation. The European Commission's Joint Research Centre manages the scientific development of the model. COPERT has been developed for official road transport emission inventory preparation in EEA member countries. However, it is applicable to all relevant research, scientific and academic applications[4].

[2] DfT (2018) http://www.dft.gov.uk/traffic-counts/
[3] Google (2018) https://www.google.co.uk/maps
[4] EMISIA (2018) http://emisia.com/products/copert (accessed Sept 2018)

The COPERT methodology is part of the EMEP/EEA air pollutant emission inventory guidebook for the calculation of air pollutant emissions and is consistent with the 2006 IPCC Guidelines for the calculation of greenhouse gas emissions. The use of a software tool to calculate road transport emissions allows for a transparent and standardized, hence consistent and comparable data collecting and emissions reporting procedure, in accordance with the requirements of international conventions and protocols and EU legislation. The latest published vehicle NO_x emission factors use the functions provided in COPERT version 5.

3.2.2.2 Emissions calculations

Typically, the latest version of the Emissions Factors Toolkit (EFT Version 8) is used for this type of assessment. Parameters such as traffic volume, speed and fleet composition are entered into the EFT, and an emissions factor in grams of NO_x/second/kilometre is generated for input into the dispersion model.

Ricardo Energy & Environment have developed our own in-house vehicle emissions calculator which uses the latest COPERT5 emissions functions. Using COPERT5 emission functions therefore represents the latest available published European evidence base on typical current and future year vehicle NO_x emissions.

All vehicle emissions for this Detailed Assessment have been calculated using the COPERT5 emission functions. An additional benefit of the in-house emissions calculator is its ability to model the impact of road gradient effects on vehicle emissions. Calculation of gradients follows the process and equations outlined in LAQM.TG(16) section 7. The equations used to calculate uphill and downhill gradients are outlined in paragraph 7.253 and 7.254 respectively.

3.3 Ambient Monitoring

NO_2 concentrations are monitored using diffusion tubes at 13 locations within Rickmansworth, while PM_{10} is monitored using AQMesh sensor systems. Details of the type, locations and concentrations recorded by the diffusion tubes are presented in Section 4.

3.4 Meteorological Data

Hourly sequential meteorological data (wind speed, direction etc.) for 2017 measured at the Northolt site was used for the modelling assessment. The meteorological measurement site is located approximately 13.6 km South East of the study area. Some filling of cloud cover from the Heathrow Airport meteorological measurement site was required to maximise the number of useable hourly measurements in the 2017 dataset.

Meteorological measurements are subject to their own uncertainty which will unavoidably carry forward into this assessment. A wind rose representing the Northolt 2017 meteorological dataset is presented in Appendix 2.

3.5 Background Concentrations

Background NO_x annual mean concentrations for a dispersion modelling study can be accessed from either local monitoring data conducted at a representative background site or from the background maps produced by Defra[5]. The background maps are the outputs of a national scale dispersion model provided at a 1 km x 1 km resolution and are therefore subject to a degree of uncertainty.

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[5] https://uk-air.defra.gov.uk/data/laqm-background-home

There are no urban background diffusion tube monitoring sites in Rickmansworth, the mapped background NO_x concentrations for the relevant 1 km x 1 km grid squares were therefore used for the Detailed Assessment. The sector contributions from road traffic emissions on A Class Roads and Motorways were subtracted from the total background NO_x concentrations to avoid double counting of the road contribution when explicitly modelling road traffic emissions. The mapped annual mean background NO_x and PM_{10} concentrations for the 1km grid squares covering Rickmansworth are presented in Table 3.

Table 3: Mapped Background NO_x concentrations in Chorleywood 2017

Easting	Northing	Total NO_x background ($\mu g.m^{-3}$)	Total NO_x minus A Roads and Motorway ($\mu g.m^{-3}$)	Total PM_{10} background ($\mu g.m^{-3}$)	Total PM_{10} minus A Roads, Motorway and Break/tyre abrasion ($\mu g.m^{-3}$)
504162	196286	28.6	16.9	15.1	14.5

4 Monitoring Data

Three Rivers District Council measured NO_2 annual mean concentrations at 13 diffusion tubes in Rickmansworth during 2017. Details of QA/QC for the diffusion tube measurements are presented in the Three Rivers District Council 2017 LAQM Annual Status Report. The NO_2 annual mean concentrations in excess of the 40 $\mu g.m^{-3}$ objective were measured at one triplicate diffusion tube site in Rickmansworth during 2017.

The monitoring locations and results form 2016 and 2017 are presented in Table 4. A map showing the location of the monitoring sites used in the study is presented in Figure 2. Triplicate measurements are made at the monitoring site located within the study area – the average NO_2 concentration of these three sites has been used for model verification purposes (see Section 5.1.3).

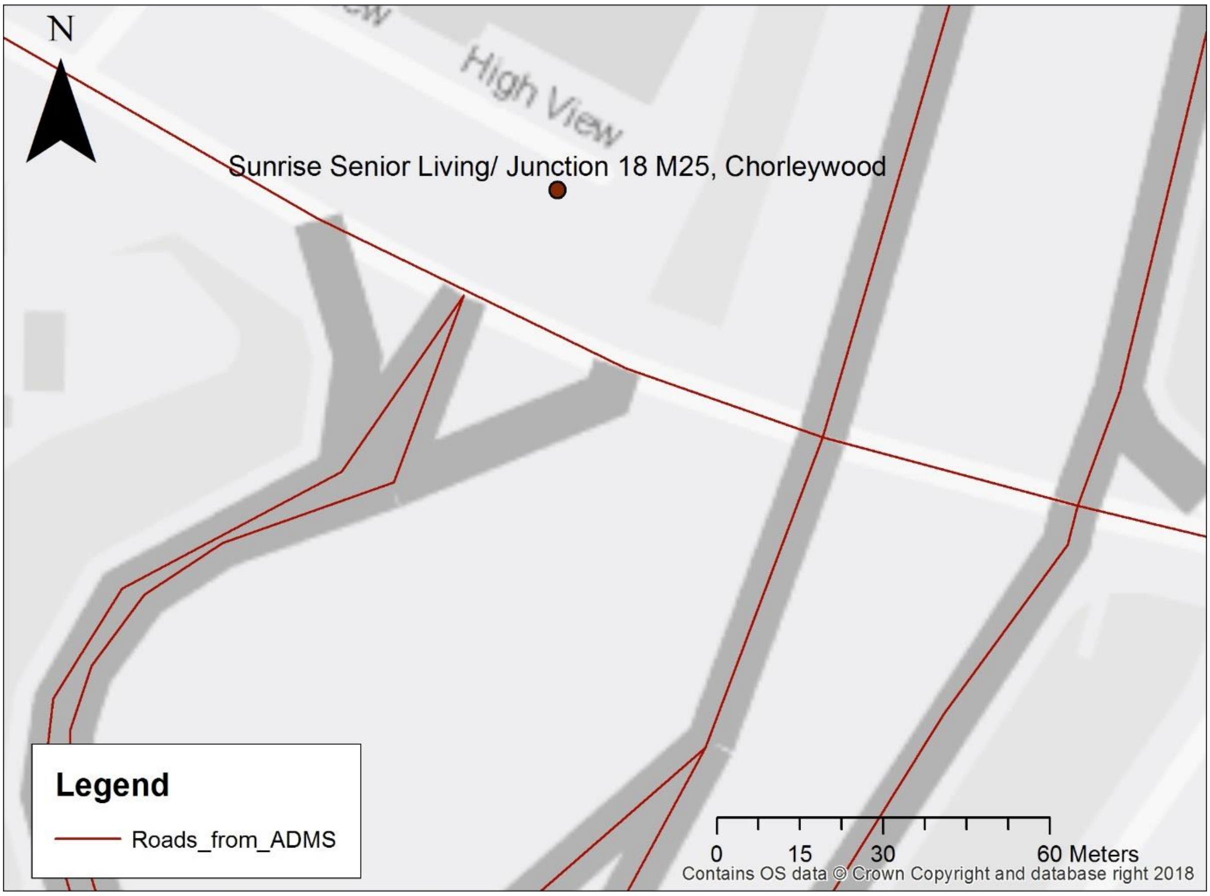
Table 4: NO_2 Monitoring Results

Site		Type	X	Y	2017 Data Capture (%)	2016 ($\mu g.m^{-3}$)	2017 ($\mu g.m^{-3}$)
S1 (NA)	Watford Road, Croxley Green	Roadside	507134	195283	100	25.9	27.3
S2 (NA)	Chandlers Cross	Roadside	506430	198590	100	26.1	24.6
S3 (NA)	The Retreat Kings Langley	Suburban	508100	201800	100	30.1	27.1
S4 (NA)	Sunrise Senior Living/ Junction 18 M25, Chorleywood	Roadside	504162	196286	100	30	32.5
S5 (NA)	Sunrise Senior Living/ Junction 18 M25, Chorleywood	Roadside	504162	196286	100	34.4	33.1
S6 (NA)	Sunrise Senior Living/ Junction 18 M25, Chorleywood	Roadside	504162	196286	92	34.5	34.1

Site		Type	X	Y	2017 Data Capture (%)	2016 (µg.m^{-3})	2017 (µg.m^{-3})
S7 (NA)	Rickmansworth Fire Station, Rectory Road	Roadside	505500	194400	100	28.2	27.1
S1 (NB)	Belfry House Uxbridge Road (Mill End 1)	Kerbside	505264	194251	67	N/A	53.1
S2 (NB)	Belfry House Uxbridge Road (Mill End 1)	Kerbside	505264	194251	67	N/A	53.2
S3 (NB)	Belfry House Uxbridge Road (Mill End 1)	Kerbside	505264	194251	67	N/A	48.5
S4 (NB)	A412 Long Lane (Mill End 2)	Kerbside	504104	193684	75	N/A	28.7
S5 (NB)	A412 Long Lane (Mill End 2)	Kerbside	504104	193684	75	N/A	29.7
S6 (NB)	A412 Long Lane (Mill End 2)	Kerbside	504104	193684	75	N/A	30

Kerbside monitoring location – within 1m of the kerb of a busy road.
Roadside monitoring location – within 1m-5m of a busy road.
Suburban monitoring location – a location situated in a residential area on the outskirts of a town or city

Figure 2: Diffusion tube monitoring locations



Three Rivers District Council have a AQMesh pod deployed at Junction 18, at the same location as the passive diffusion tube measurement (Table 5), measuring PM_{10} and $PM_{2.5}$. The annual average PM_{10} concentration measured at this site was 46.9 µg/m^3 (data capture: 43.4 %).

Table 5: AQ Mesh PM monitoring results

Site	Address	X	Y	2017 Data Capture (%)	PM_{10} (µg.m^{-3})	$PM_{2.5}$ (µg.m^{-3})
AQMesh1	Junction 18 (M25), Chorleywood	504161	196285	43.4	46.9	11.4

5 Modelling

5.1 Modelling Methodology

Annual mean concentrations of NO_2 during 2017 have been modelled within the study area using the atmospheric dispersion model ADMS Roads Extra (Version 4.1). Terrain effects were captured by gradient adjusting the emissions data and therefore the terrain was modelled as flat in ADMS.

The model was verified by comparing the modelled predictions of road NO_x with local monitoring results. The relevant 2017 broadside monitoring site measurements within the study area (described in Section 4 above) were used to verify the annual mean road NO_x model predications.

The data collected by the AQMesh pod is treated as an indicative data source, as the instruments do not undergo the robust QA and QC procedures as the automatic monitoring stations that make up the UK monitoring network. Similarly to diffusion tubes, co-location studies can be carried out to establish the relationship between AQMesh measurements and those from the automatic network allowing a bias adjustment factors to be developed. This co-location study has not been undertaken for the AQMesh in Chorleywood and therefore the instrument can provide an indication of temporal trends in pollution concentrations however the error in the absolute concentration cannot be quantified. This, in combination with the low data capture for the year (43 %), has led to the decision to use the NOx adjustment factor to the PM_{10} concentrations during model verification. LAQM.TG(16) guidance states that NOx adjustment factors can be applied to PM_{10} modelling in the absence of PM_{10} data (paragraph 7.528).

Following initial comparison of the modelled concentrations with the available monitoring data, refinements were made to the model input to achieve the best possible agreement with the measurements. Further information on model verification is provided in Section 5.1.3 and Appendix 1.

A surface roughness of 0.5 m was used at the dispersion site to represent the parkland, open suburbia conditions present within the modelled domain. A limit for the Monin-Obukhov length of 10 m was applied to represent a small town. For the meteorological measurement site, a roughness value of 0.5 m was used.

5.1.1 Treatment of Modelled NO_x

It is necessary to convert the modelled NO_x concentrations to NO_2 for comparison with the relevant objectives. The latest version of the Defra NO_x/NO_2 model[6] (v6.1) was used to calculate NO_2 concentrations from the NO_x concentrations predicted by ADMS-Roads. The model requires input of the background NO_x, the modelled road contribution and accounts for the proportion of NO_x released as primary NO_2. For the purposes of the assessment we have assumed that 27% of NO_x is released as primary NO_2, the value associated with the “All other urban UK Traffic” option for the Rickmansworth area in the model.

5.1.2 Validation of ADMS Roads

In simple terms, validation of the model is the process by which the model outputs are tested against monitoring results at a range of locations and the model is judged to be suitable for use in specific applications. CERC have carried out extensive validation of ADMS applications by comparing modelled results with standard field, laboratory and numerical data sets; participating in EU workshops on short range dispersion models; comparing data between UK motorway field monitoring data; carrying out inter-comparison studies alongside other modelling solutions such as DMRB and CALINE4; and carrying out comparison studies with monitoring data collected in cities throughout the UK using the extensive number of studies carried out on behalf of local authorities and Defra.

5.1.3 Verification of the model

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. Dispersion models of this nature carry a degree of uncertainty for the reasons explained in the previous sections, so it is important to check their performance against measurements and adjust their outputs accordingly. A full description of the model verification procedure for the baseline models is presented in Appendix 1.

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[6] NOx to NO_2 https://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html#NOxNO2calc

LAQM.TG(16) recommends making the adjustment to the road contribution of the pollutant only and not the background concentrations these are combined with. The modelled Road NO_x concentrations were verified using the available 2017 diffusion tube locations within the study area. Measured Road NO_x concentrations were calculated from the diffusion tube measurements using the NO_x/NO_2 calculator. As stated above, triplicate measurements were made at the monitoring location in the study area, and the average concentration of these was used for model verification.

The initial comparison of the modelled vs measured Road NO_x identified that the model under predicts the NOx concentrations at the measurement site. Where possible, refinements were made to the model input to improve the overall model performance.

Verifying modelling data with diffusion tube data will always be subject to uncertainty due to the inherent limitations in such monitoring data. Following initial refinements to the model input parameters, a primary NO_x adjustment factor (PAdj) of 1.3163 was applied to all modelled Road NO_x data prior to calculating an NO_2 annual mean. The adjustment factor was applied to all Road NO_x concentrations predicted by the model; the adjusted total NO_2 concentrations were then calculated using the Defra NO_x/NO_2 calculator.

Technical Guidance LAQM.TG(16) details calculations that can be carried out to establish model performance and uncertainty. However, due to the individual measurement site within the study area, these statistics could not be calculated.

5.2 Model Results

5.2.1 Pollutant contour plots

Annual mean NO_2 concentrations have been predicted across a grid of points covering the study area. The grid resolution of the domain across the entire study area was approximately 4 m east-west and 15 m north-south.

The source-oriented grid option was enabled in ADMS-Roads, this option provides finer resolution of predicted pollutant concentrations at locations in close proximity to the roadside, with a wider grid being used to represent concentrations further away from the road. The resolution is dependent upon the total size of the domain being modelled. The predicted concentrations were interpolated to derive values between the grid points using the Spatial Analyst tool in GIS software ArcMap 10.5. This allows contours showing the predicted spatial variation of pollutant concentrations across the modelling study domain. The grid height was modelled at both 1.5 m to represent human exposure at ground level; and at 4 m to represent exposure at 1st floor level.

A contour plot showing the modelled spatial variation in the NO_2 annual mean concentrations during 2017 at ground level is presented in Figure 3. The contour plot at 4 m, representing annual mean NO_2 concentrations at 1st floor height NO_2 is presented in Figure 4. Similar plots for ground and first floor PM_{10} concentrations are shown in Figure 5 and Figure 6 respectively. The contour plots indicate that there are areas with concentrations greater than the annual mean objective for NO_2 of 40 µg.m^{-3}, however these do not occur at locations where relevant human exposure is present.

Figure 3: Modelled NO_2 annual mean concentrations at 1.5 m height (µg.m-3)

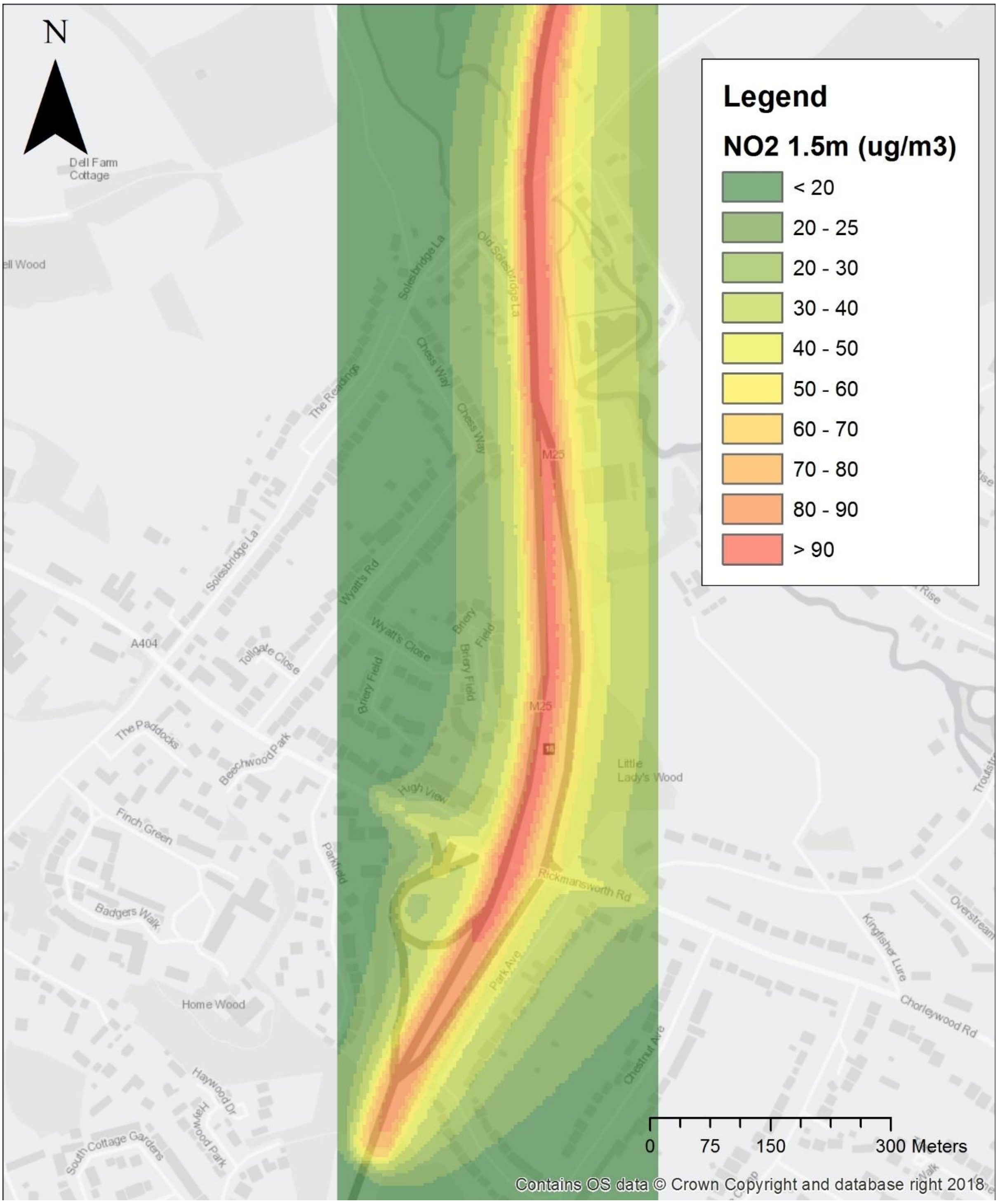


Figure 4: Modelled NO_2 annual mean concentrations at 4 m height (µg.m^{-3})

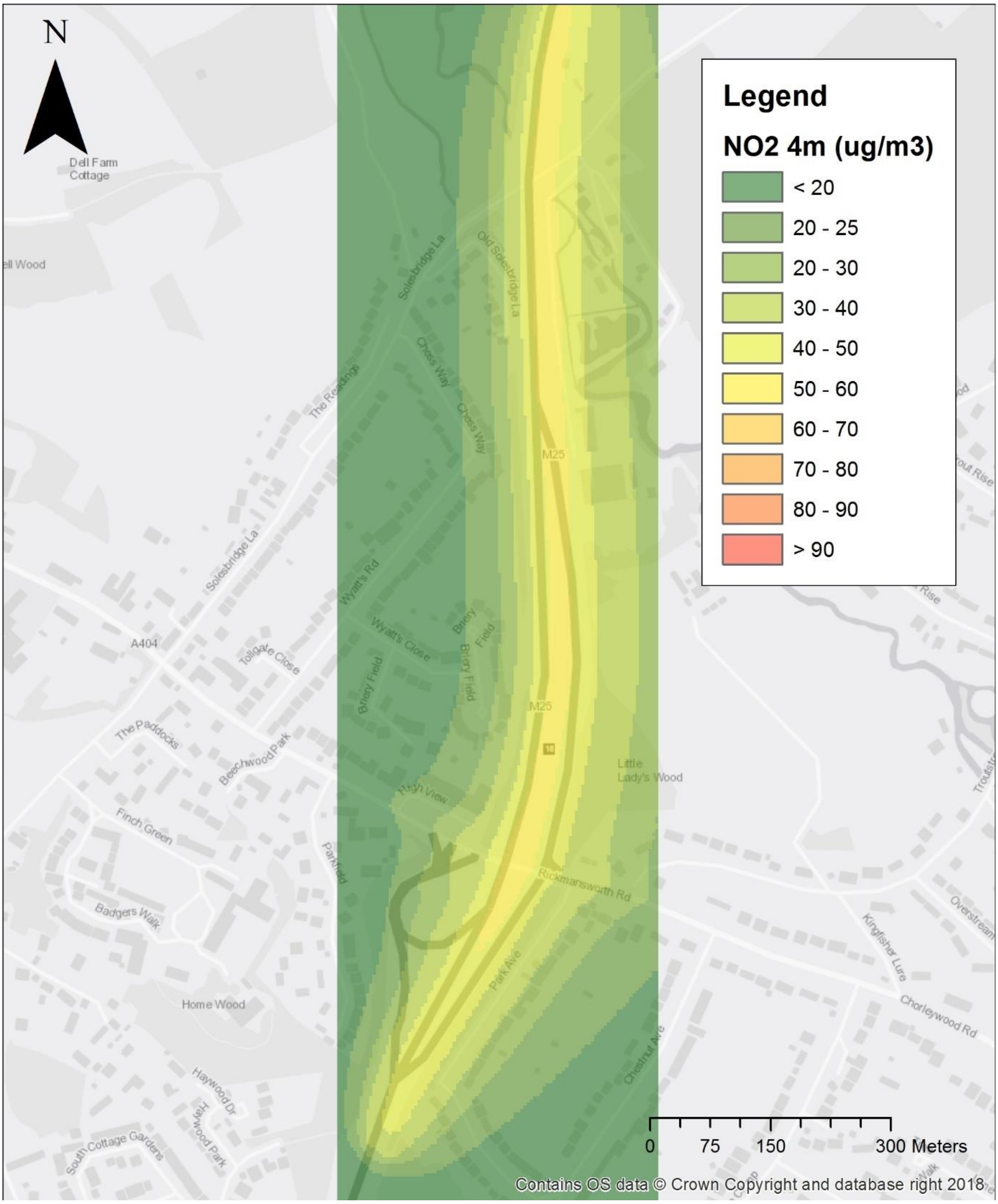


Figure 5: Modelled PM_{10} annual mean concentrations at 1.5 m height ($\mu g.m^{-3}$)

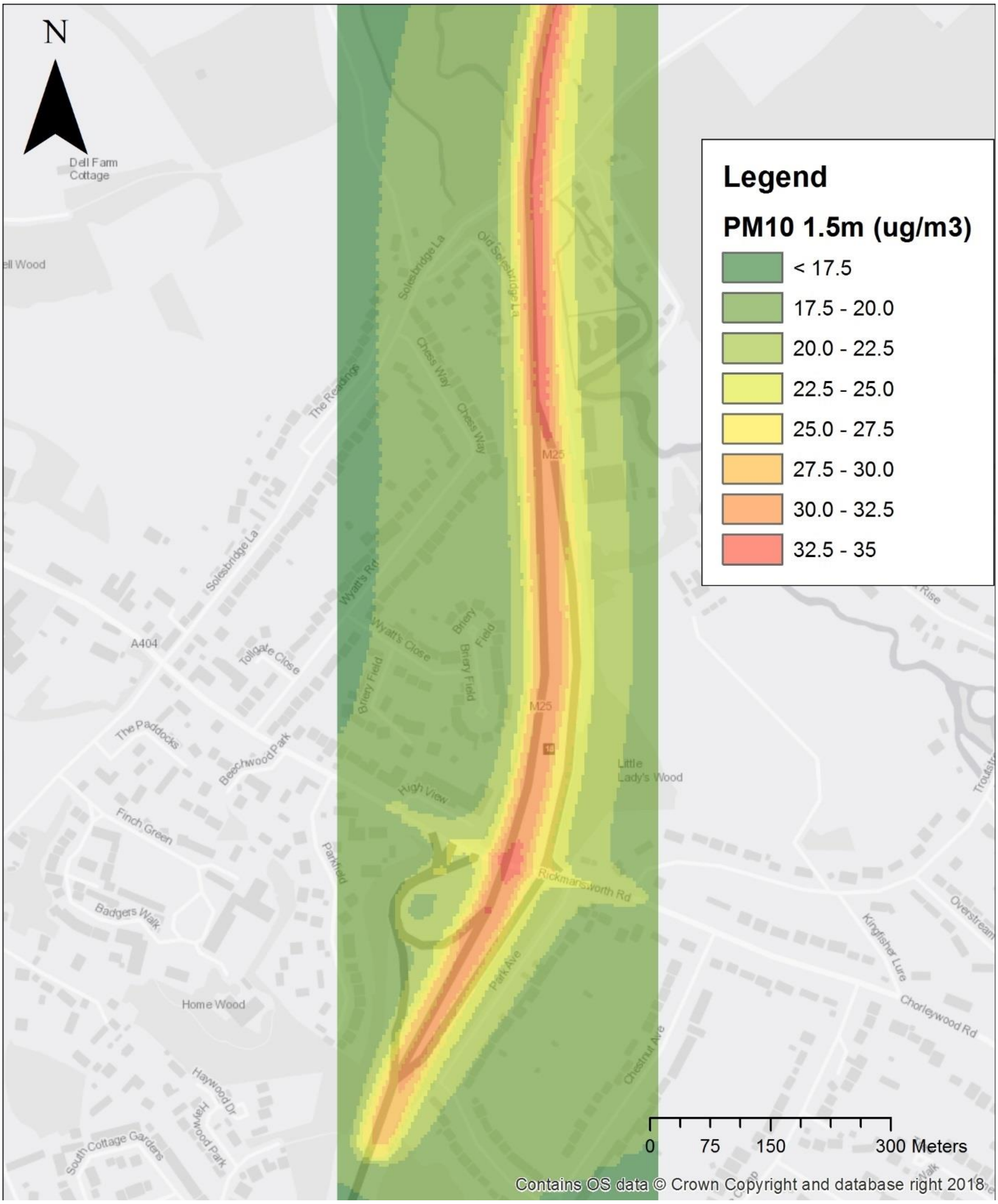


Figure 6: Modelled PM_{10} annual mean concentrations at 4 m height ($\mu g.m^{-3}$)

5.2.2 Model results at discrete receptor locations

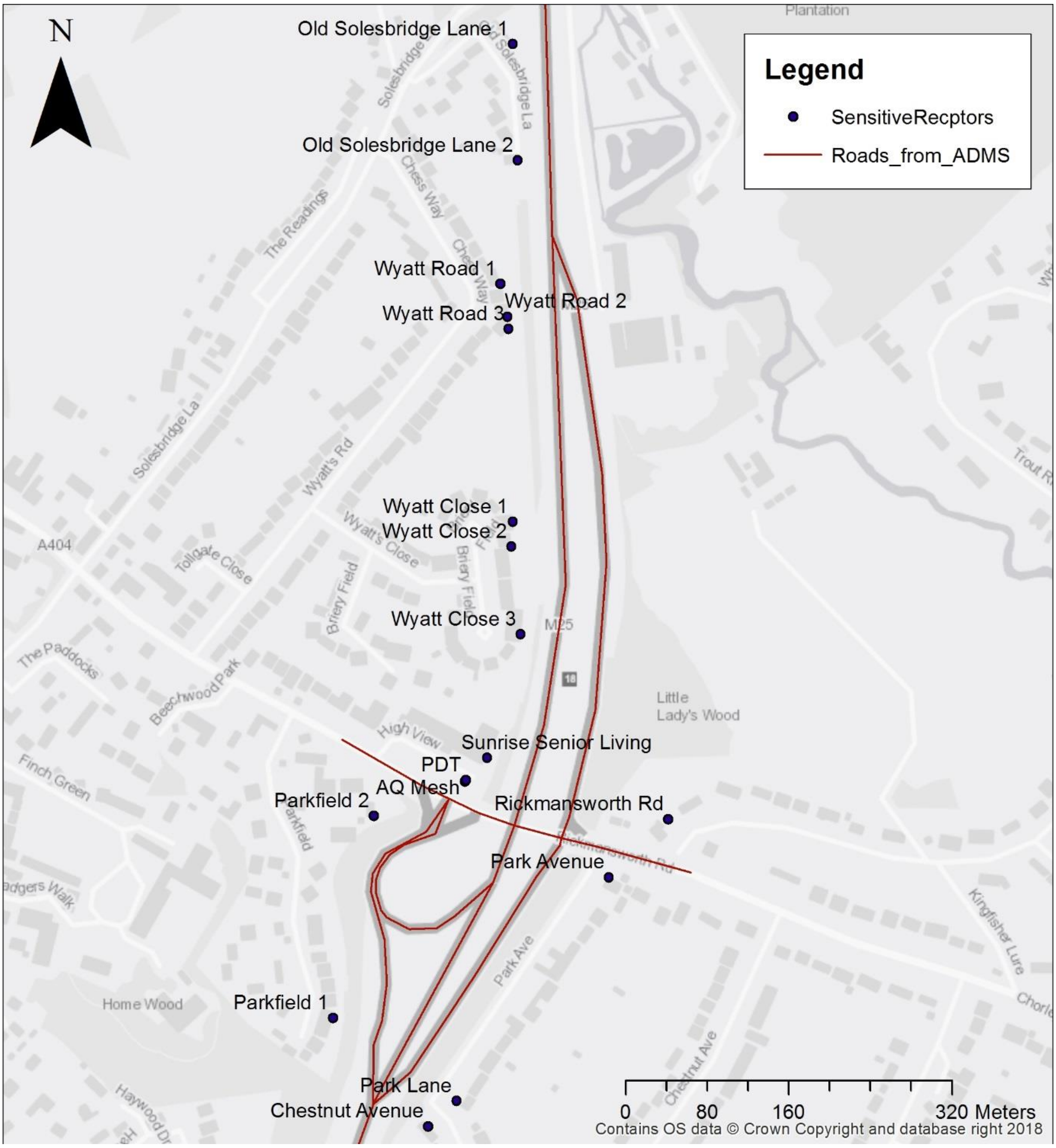
The adjusted model has been used to predict NO_2 concentrations for a selection of discrete receptors within the study area. The receptors are located at the façade of buildings in the model domain where relevant exposure exists within the pollution hotspots identified from the modelled contour plots.

The receptors have been modelled at heights of 1.5 m and 4 m to represent human exposure at ground floor and first floor height where pollutant concentrations attribute to road traffic emissions are likely to be at a maximum. Details of the selected receptors are presented in Table 6 and the locations presented in Figure 7.

Table 6: Receptor Locations and Descriptions

Receptor	Easting	Northing	Height Modelled (m)
Old Solesbridge Lane 1	504208	197007	1.5, 4
Old Solesbridge Lane 2	504213	196893	1.5, 4
Wyatt Road 1	504196	196772	1.5, 4
Wyatt Road 2	504203	196740	1.5, 4
Wyatt Road 3	504204	196728	1.5, 4
Wyatt Close 1	504208	196539	1.5, 4
Wyatt Close 2	504207	196515	1.5, 4
Wyatt Close 3	504216	196429	1.5, 4
Sunrise Senior Living	504183	196308	1.5, 4, 6.5
Parkfield 1	504032	196053	1.5
Chestnut Avenue	504125	195947	1.5, 4
Park Lane	504153	195972	1.5
Parkfield 2	504072	196251	1.5, 4
Rickmansworth Rd	504360	196248	1.5, 4
Park Avenue	504302	196191	1.5, 4

Figure 7: Modelled receptor locations



The adjusted modelled annual mean concentrations for NO_2 and PM_{10} for each of the specified receptor locations are presented in Table 7. The results indicate that concentrations in excess of 40 µg.m^{-3} NO_2 annual mean objective are not occurring at any of the modelled receptor locations within the hotspots identified in the pollutant contour plots. As stated in the modelling methodology section, the roads have been modelled on flat-earth accounting for impacts of gradients on emissions. In reality, the sensitive receptors with the greatest modelled concentrations (Old Solesbridge Lane and Chestnut Avenue) are separated from the motorway by vegetation and are located elevated from the carriageway. The flat-earth approach is a conservative approach to estimate the concentrations at these sensitive locations resulting from the M25. For PM_{10}, none of the concentrations modelled at the sensitive receptors exceed the 40 µg/m^3 PM_{10} annual mean objective.

Table 7: Predicted annual mean NO_2 concentrations at specified receptors 2017

Receptor	NO_2 Annual Mean (µg.m^{-3})	PM_{10} Annual Mean (µg.m^{-3})	Height Modelled (m)
Old Solesbridge Lane 1	37	18.1	1.5
	30	17.1	4
Old Solesbridge Lane 2	39	18.4	1.5
	31	17.2	4
Wyatt Road 1	28	16.8	1.5
	25	16.4	4
Wyatt Road 2	30	17.1	1.5
	26	16.5	4
Wyatt Road 3	30	17.1	1.5
	26	16.5	4
Wyatt Close 1	29	17.0	1.5
	26	16.5	4
Wyatt Close 2	29	17.0	1.5
	26	16.5	4
Wyatt Close 3	36	18.1	1.5
	30	17.2	4
Sunrise Senior Living	35	18.1	1.5
	30	17.4	4
	35	16.5	6.5
Parkfield 1	22	15.9	1.5
Chestnut Avenue	38	18.3	1.5
	33	17.5	4
Park Lane	34	17.7	1.5
Parkfield 2	21	15.9	1.5
	20	15.7	4
Rickmansworth Rd	29	17.2	1.5
	28	16.9	4
Park Avenue	33	17.8	1.5
	30	17.3	4

5.2.3 Predicted NO_2 concentrations in comparison with the 1-hour short-term objective

It is difficult to accurately predict if the NO_2 1-hour mean objective is being exceeded using dispersion modelling. TG(16) states that if an annual mean NO_2 concentration in excess of 60 µg.m^{-3} is measured, an exceedance of the 1-hour mean objective may be occurring.

Annual mean concentrations in excess of 60 µg.m^{-3} are not predicted at any locations where anyone is likely to spend an hour or more within the study area in Rickmansworth; it is therefore considered very unlikely that the short term NO_2 objective is being exceeded at locations where there is relevant exposure.

6 Conclusions

This modelling study, which has used the most recently available traffic, monitoring and meteorological data for Rickmansworth indicates that there are no exceedances of the NO_2 or PM_{10} annual mean objective at locations with relevant exposure in the area surrounding Junction 18 of the M25.

The modelled PM_{10} concentrations are lower than the 40 µg/m^3 annual mean limit value (maximum modelled PM_{10} concentration at the discrete receptors was 18.4 µg/m^3. The results do however indicate that annual mean NO_2 concentrations are close to their air quality objective of 40 µg.m^{-3} at locations where relevant exposure may be present. **It is therefore recommended that Three Rivers District Council continue to measure NO_2 and PM_{10} and do not revoke the Air Quality Management Area. Three Rivers District Council intend to expand their monitoring network to cover the locations highlighted within the modelling as close to the objective in order to inform further their decision on the revocation of the J18 Chorleywood Air Quality Management Area.**

It is important to consider that although we have attempted to minimise uncertainty in this dispersion modelling study as much as possible, there will be some uncertainty in the modelled pollutant concentrations. For example, traffic count information for the slip roads at junction 18 were not available, and the traffic movements on these links were estimated. Three Rivers District Council should consider making more detailed traffic counts within the Chorleywood AQMA which could be used in future assessments.

Appendices

Appendix 1 – Model Verification

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 at the various monitoring locations. 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. LAQM.TG(16) recommends making the adjustment to the road contribution only and not the background concentration these are combined with.

It is appropriate to verify the performance of the ADMS Roads model in terms of primary pollutant emissions of nitrogen oxides ($NO_x = NO + NO_2$). The model has been run to predict annual mean Road NO_x concentrations during the 2017 calendar year at all appropriate diffusion tube monitoring locations within Rickmansworth.

The model output of Road NO_x (the total NO_x originating from road traffic) has been compared with the measured Road NO_x, where the measured Road NO_x contribution is calculated as the difference between the total NO_x and the background NO_x value. Total measured NO_x for each diffusion tube was calculated from the measured NO_2 concentration using the Defra NO_x/NO_2 calculator.

The initial comparison of the modelled vs measured Road NO_x identified that the model was under-predicting the Road NO_x contribution at most locations. Where possible, refinements were made to the model input to improve the overall model performance.

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

The background NO_x concentration was then added to determine the adjusted total modelled NO_x concentrations. The total annual mean NO_2 concentrations were then determined using the NO_x/NO_2 calculator.

A primary NO_x adjustment factor (PAdj) of **1.3163** has been applied to all modelled Road NO_x data prior to calculating an NO_2 annual mean. A plot comparing modelled and monitored NO_2 concentrations before and after adjustment during 2017 is presented in Figure A1.2.

Figure A1.1: Comparison of modelled Road NO_x Vs Measured Road NO_x 2017 before and after adjustment

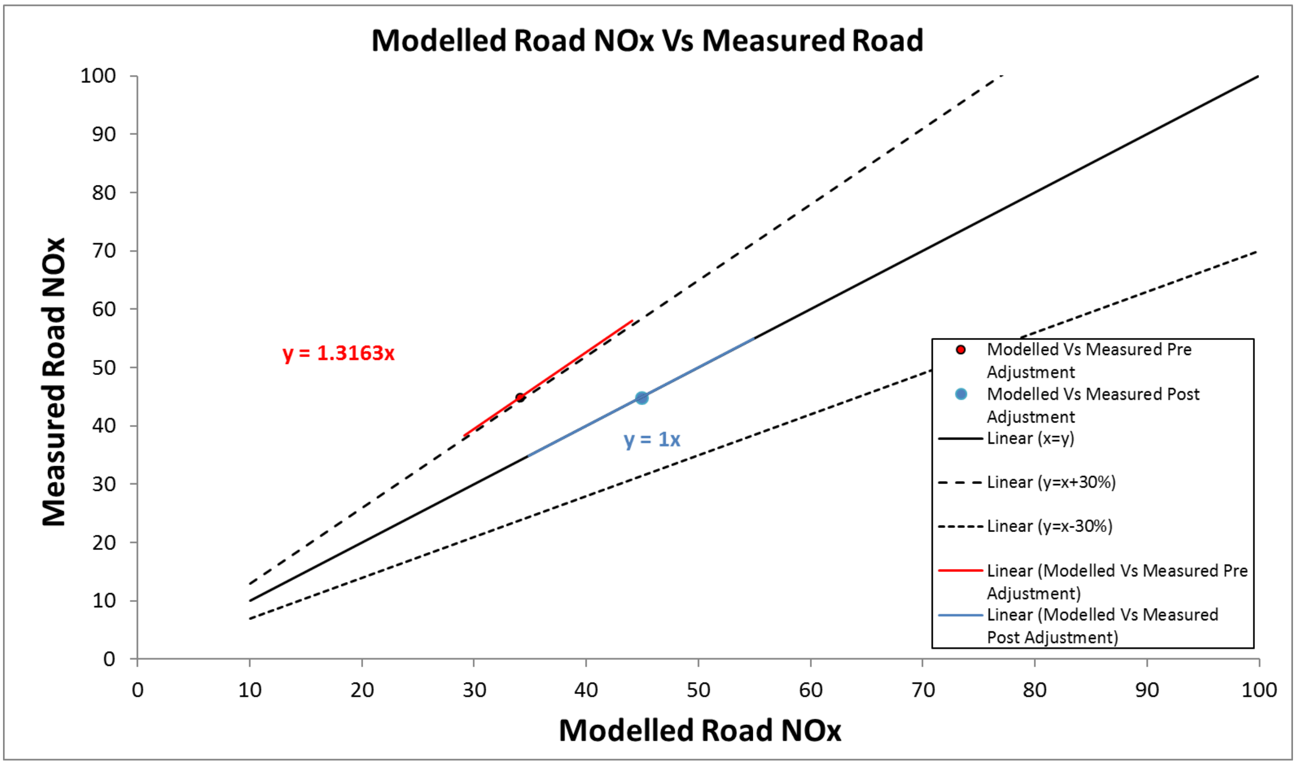
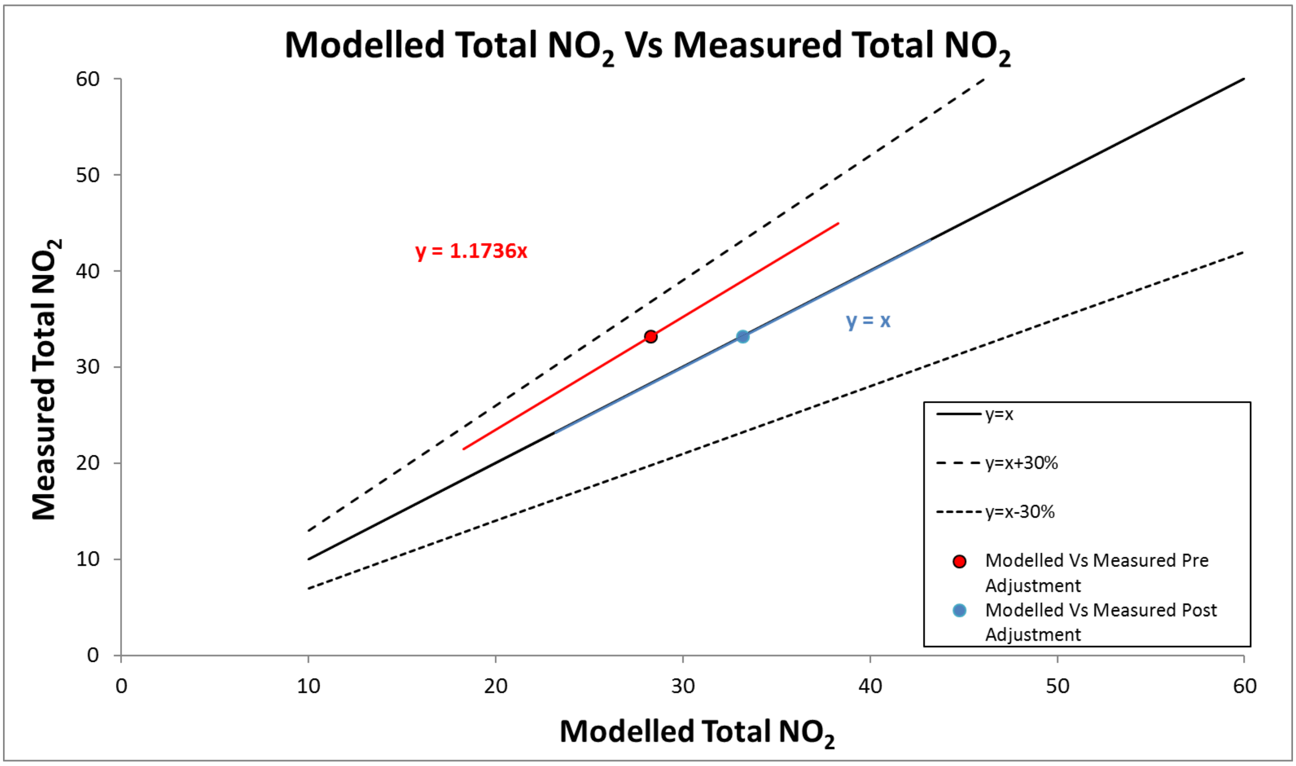
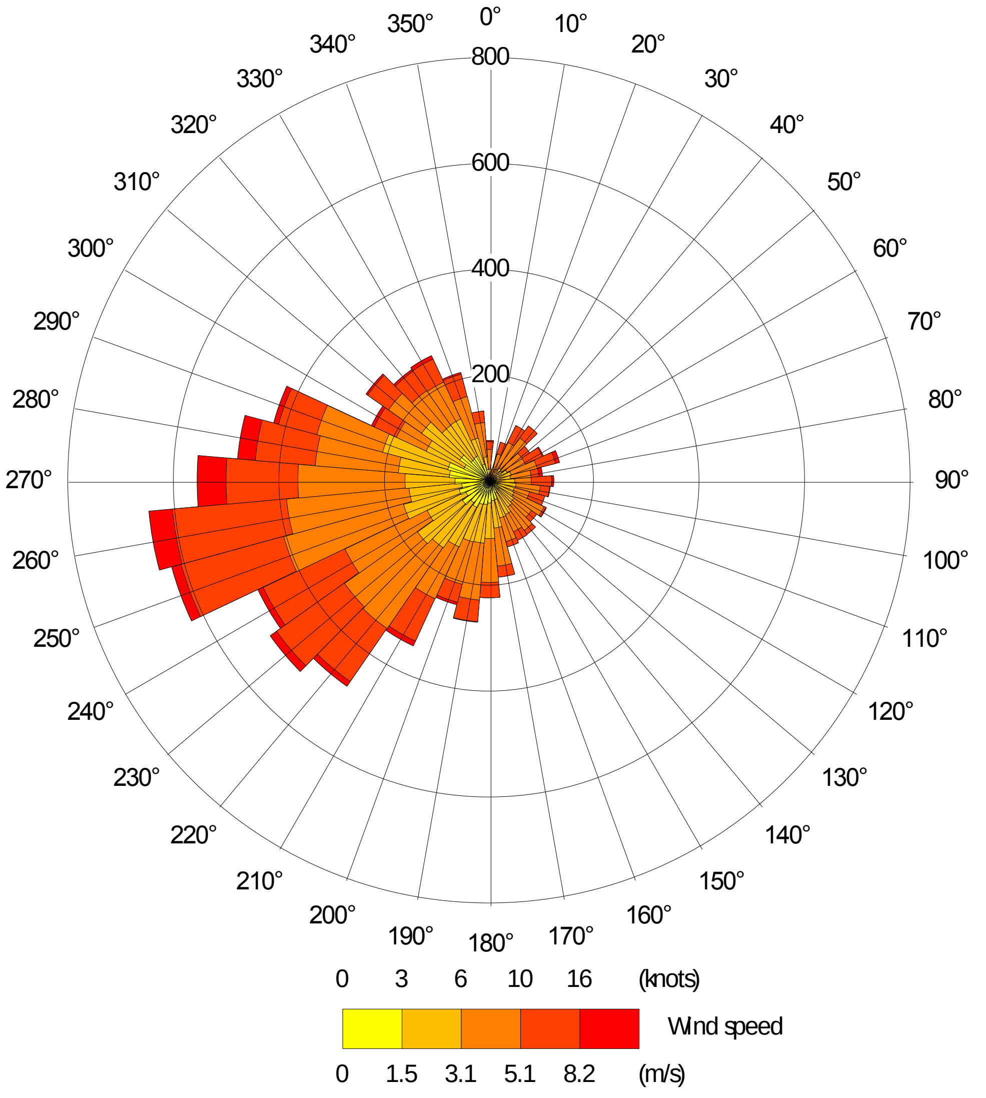


Figure A1.2: Linear regression analysis of modelled vs. monitored NO_2 annual mean 2017



Appendix 2 – Meteorological Dataset Wind Rose



Meteorological variable	Data Capture (%)
Wind Speed	100.0
Wind Direction	100.0
Cloud Cover	98.7
Temperature	100.0

Appendix 3 – Traffic Data

A summary of the traffic data used within the assessment is presented in Table A3.1. Traffic data was obtained from DfT national counts for 2017. The proportion of cars that are petrol and diesel was taken from the NAEI 2017 projections[7] – motorway splits were applied to the counts located on the motorway, while the urban split was applied to the remaining count points.

Table A3.1: Summary of traffic data used for the assessment

Road	DfT Count Point	AADT	% Motor cycles	% Car	Car Diesel	Car Petrol	% LGV	% Rigid HGV	% Artic HGV	% Bus
M25	7054	156432	0.4	74.7	46.2	28.5	15.6	3.1	6.0	0.3
M25	27085	179645	0.3	76.2	47.1	29.1	14.9	3.0	5.4	0.2
Chorleywood Road	27080	18507	0.5	79.5	35.7	43.8	17.4	1.8	0.4	0.4
Rickmansworth Road	73175	20683	0.6	83.4	37.4	46.0	13.3	1.9	0.3	0.4

The traffic diurnal profile for the local area was developed from the detailed local traffic counts available on the A404 Chorleywood Road and Rickmansworth Road. The profiles were similar for both count locations and therefore the average profile for the two sites was used in the model:

Table A3.2: Diurnal profile applied for the assessment

Hour	Weekday profile	Saturday	Sunday
1	0.113	0.255	0.347
2	0.057	0.132	0.176
3	0.036	0.071	0.104
4	0.039	0.073	0.069
5	0.080	0.092	0.073
6	0.249	0.137	0.135
7	0.775	0.333	0.425
8	1.870	0.812	0.736
9	1.517	1.374	1.053
10	1.637	1.686	1.490
11	1.480	1.952	1.866
12	1.485	1.927	1.914
13	1.493	1.627	1.910
14	1.397	1.586	1.950
15	1.473	1.687	1.787
16	1.633	1.738	1.766
17	1.830	1.669	1.785

[7] Vehicle fleet composition projections (Base 2016). Available from: http://naei.beis.gov.uk/data/ef-transport

Hour	Weekday profile	Saturday	Sunday
18	1.814	1.579	1.721
19	1.701	1.327	1.467
20	1.240	1.162	1.114
21	0.786	0.955	0.932
22	0.589	0.675	0.572
23	0.460	0.652	0.396
24	0.245	0.498	0.212

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