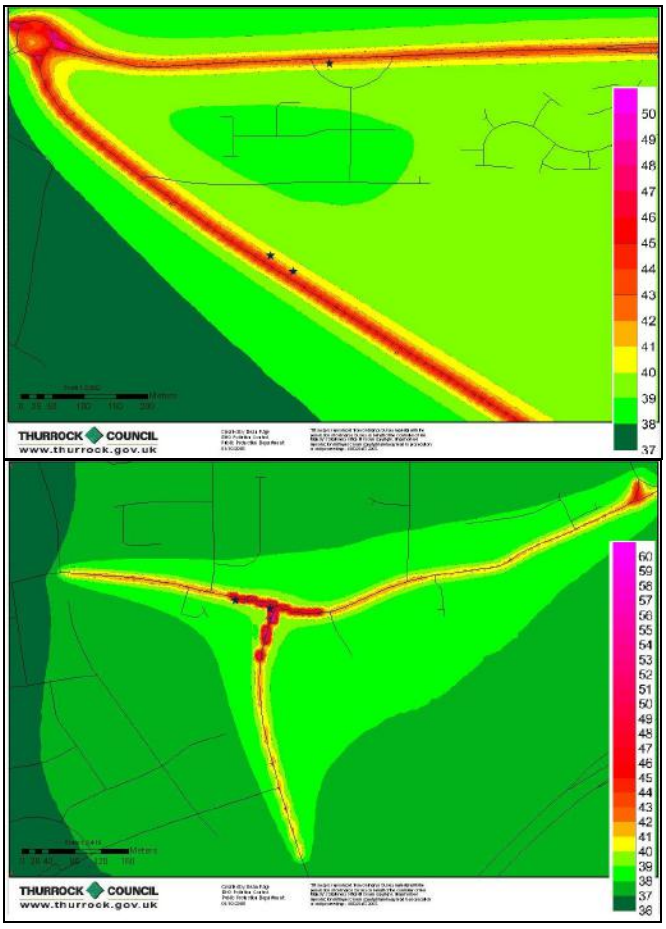
2014 Air Quality Detailed Assessment Report for NO_2
Thurrock Council

In fulfillment of Part IV of the Environment Act 1995
Local Air Quality Management



Executive Summary

This is the 2014 Detailed Assessment for NO_2. This assessment fulfils the Council's next step of the Local Air Quality Management (LAQM) process and is required as a result of the findings of the Council's 2013 Air Quality Progress Report. The report examines the pollutant nitrogen dioxide (NO_2) which is summarised below.

Nitrogen dioxide

The Previous 2013 Air Quality Progress Report showed there to be an exceedence of the annual mean objective for NO_2, within two areas. The first is along the Purfleet By-pass Road, Purfleet, and the second is along Aveley High Street / Ship Lane, Aveley, from the Council's own NO_2 diffusion tube network results. The purpose of this Detailed Assessment Report is to have a more in depth approach in investigating if there is a likely exceedence of the annual mean air quality objective for NO_2, by means of using monitoring data within these locations, and also by use of modelling of the area, which is verified with the monitoring data, to assess the extent of the exceedence.

New monitoring results have been used in this report. The report thus meets the requirements of the technical guidance LAQM. TG (09) produced by the Department of Environment, Food and Rural Affairs (Defra). The monitoring confirms that NO_2 is exceeding the annual mean air quality objective of 40 $\mu g\ m^{-3}$, at both locations within Aveley and Purfleet.

In addition comprehensive and detailed dispersion modelling has been undertaken by use of Cambridge Environmental Research Consultants (CERC's) Advanced Dispersion Model (ADMS-Roads) to assess the extent of these exceedences of the annual mean air quality objective for NO_2 in areas where there is relevant public exposure. The modelling has been verified with the monitoring data to ensure that the modelling is accurate and representative. The modelling confirms that there are areas of exceedence at a number of locations along Aveley High Street and Ship Lane. There are also locations along the Purfleet By-pass Road that exceeding the objective for NO_2.

The Council will from the finding of this report, declare an Air Quality Management Area (AQMA) for breaching the annual mean objective for NO_2 along part of Aveley High Street and Ship Lane, Aveley. The Council will also declare an AQMA for breaching the annual mean objective for NO_2 along part of the Purfleet By-pass, Purfleet.

The Council will continue to investigate further using non-continuous monitoring at the same locations as well as periodically re-model future years to determine whether the objective will continue to be breached to assess whether concentrations of NO_2 will change and also to trace long-term trends.

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1 Introduction to Detailed Assessment

This is the Detailed Assessment of air quality for Thurrock Council for NO_2. It is specifically looking at two areas within Thurrock which were first identified within the Council's 2013 Air Quality Progress Report as being above the annual mean air quality objective for NO_2. These two areas are located firstly along the Purfleet By-pass, Purfleet and secondly along Aveley High Street/ Ship Lane, Aveley (details of these locations can be found in Figures 2-4). This assessment fulfils the Council's next step of the Local Air Quality Management (LAQM). The report examines only the pollutant nitrogen dioxide (NO_2).

Technical Guidance (LAQM.TG09) was produced by Defra to aid local authorities with their duties. This guidance replaces an earlier version produced in 2003 (LAQM.TG03). The revised guidance is designed to support local authorities in carrying out their duties under the Environment Act 1995. It confirms that LAQM forms a key part of the government's strategies to achieve the air quality objectives.

The guidance provides advice to local authorities for the purposes of undertaking their statutory review and assessments and on factors that need to be taken into account when assessing exposure. The standards from which the objectives derive are based on a potential risk to health, thus a single exposure of an individual above the standards is to be avoided. The objectives however also allow a number of occurrences where the standards might be exceeded for reasons of feasibility and practicality.

This report considers that only the long-term objective for NO_2 or annual mean objective is relevant when considering public exposure in these two locations, as the measured annual mean concentrations at these two locations are below 60 $\mu g\ m^{-3}$, which is the threshold level identified within TG(09), it states is not likely to breach the short-term 1-hour objective of 200 $\mu g\ m^{-3}$, not to be exceeded more than 18 times per calendar year, if the annual mean is below 60 $\mu g\ m^{-3}$. Supplementary evidence is included in this report for 1-hour NO_2 objective which rules out any further consideration.

The aim of the detailed assessment is thus to identify with reasonable certainty whether or not a likely exceedence of an AQS objective will arise. The assumptions used need to be considered in depth and the data used should be of a high standard. This is to ensure confidence in the decisions that need to be made. Where a likely exceedence is identified the detailed assessment shall provide detail of both its magnitude and geographical extent.

The Council is also required to confirm that there is the likelihood of relevant public exposure in the identified area(s). The Air Quality (England) Regulations as amended, refer to "the quality of air at locations which are situated outside of buildings or other natural or man made structures, above or below ground, and where members of the public are regularly present."

2 Introduction for nitrogen dioxide (NO_2)

2.1 Overview to Detailed Assessment of Nitrogen Dioxide

This section provides the Detailed Assessment for Thurrock Council, which fulfils the statutory requirement for this, the Council's next step, of the Local Air Quality Management (LAQM) process for nitrogen dioxide (NO_2). The main purpose of this section is to assess whether or not the Council needs to declare a new Air Quality Management Area (AQMA).

2.2 Background

Local air quality management forms a key part of the Government's strategies to achieve the air quality objectives under the Air Quality (England) Regulations 2000 and 2002. As part of its duties the Council completed its Updating and Screening Assessment of the seven LAQM pollutants. The conclusion for NO_2 was that the Council needed to undertake a Detailed Assessment for one area only, specifically the area where monitoring has indicated that the annual mean objective (see Table 1) will not be met. The opportunity is taken in this report to formally prove the need to declare another AQMA(s) for NO_2.

Table 1 Air Quality Objectives for nitrogen dioxide (NO_2)

Pollutant	Objective		Date to be achieved by
	Concentration	Measured as	
Nitrogen Dioxide	200 µg m^{-3} not to be exceeded more than 18 times a year	1 hour mean	31 Dec 2005
	40 µg m^{-3}	Annual Mean	31 Dec 2005

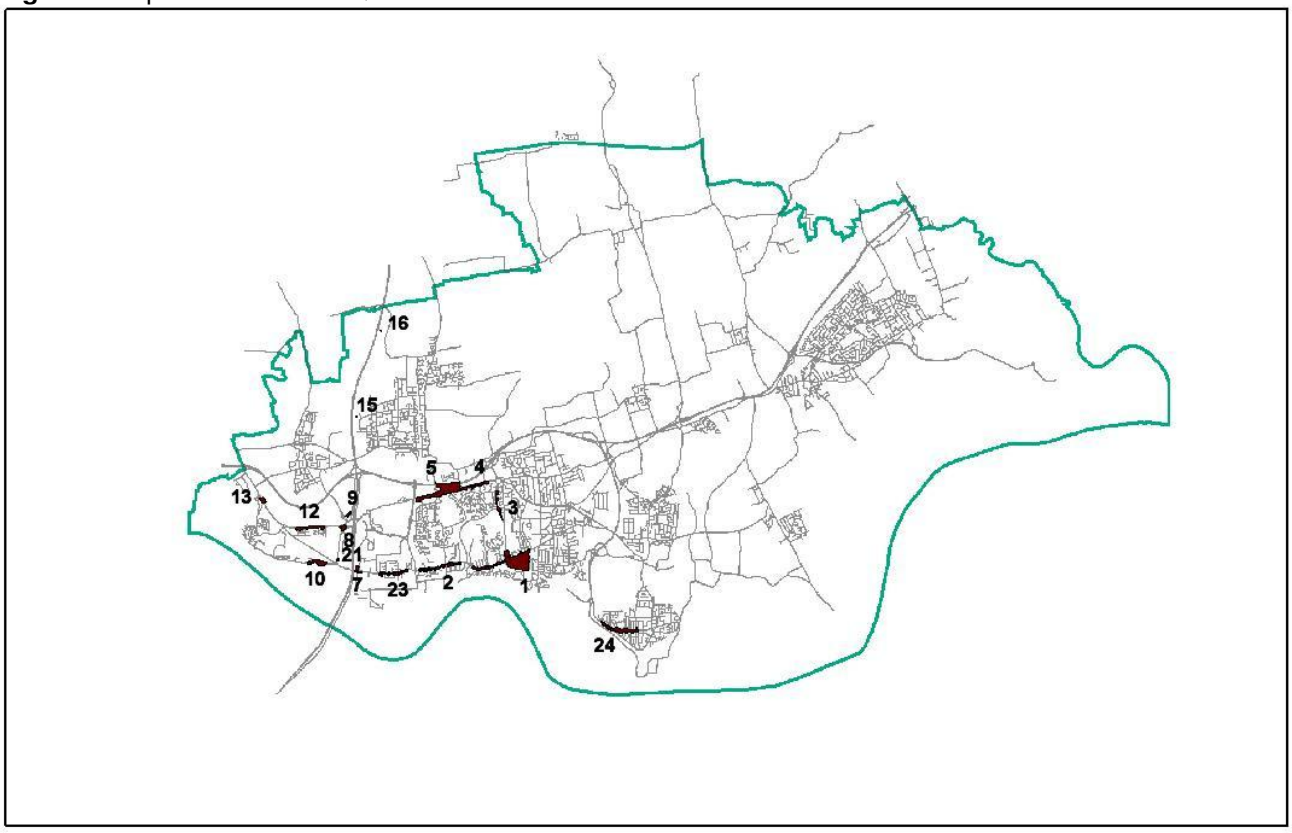
(It should be noted that the 1-hour mean (which is less stringent than the annual mean objective) does not need to be assessed further in this report) as in accordance with the TG(09) Guidance any annual mean concentration measured below 60 µg m^{-3} is not likely to exceed the 1-hour objective for NO_2. The monitored diffusion tube results at both, the Purfleet By-pass and Aveley High Street/ Ship Lane are all below 60 µg m^{-3}, thus it is unlikely that these locations breach the 1-hour objective.

The Council's current AQMA's are listed in Table 2 and shown in Figure 1 below

Table 2 Summary of existing Thurrock AQMA's

AQMA No.	Pollutant	Description of Air Quality Management Area
1	NO_2	Grays town centre and London Road Grays
2	NO_2	London Road South Stifford and adjoining roads
3	NO_2	East side of Hogg Lane and Elizabeth Road
4	NO_2	West of Chafford Hundred Visitor Centre
5	NO_2 and PM10	Warren Terrace, A13 and A1306
7	NO_2 and PM10	Hotels next to M25
8	NO_2 and PM10	Hotel next to Junction 31 of the M25
9	NO_2	Hotel next to Junction 31 of the M25
10	NO_2 and PM10	London Road Purfleet near to Jarrah Cottages
12	NO_2	Watts Wood estate next to A1306
13	NO_2	London Road Aveley next to A1306
15	NO_2	Near to M25 on edge of Irvine Gardens, South Ockendon
16	NO_2	Next to M25 off Dennis Road
21	NO_2	Hotel on Stonehouse Lane
23	NO_2	London Road West Thurrock
24	NO_2	Tilbury Calcutta Road & Dock Road

Figure 1 Map of Thurrock's AQMA's



2.3 Monitoring of NO_2

Thurrock Council operates both an automatic "continuous monitoring" network with detailed and high quality temporal resolution as well as a passive monitoring network using NO_2 diffusion tube samplers, which are less sophisticated and only representative against long term air quality objectives.

2.3.1 Continuous Monitoring

The Council currently has four continuous monitoring stations located within the borough. Three of them are classified as roadside (R) monitoring stations and one is classified as an Urban Background (UB) station. (Details are outlined below)

Table 3 Details of Thurrock's Continuous Monitoring Stations

Site ID	Site Name	Site Type	X OS Grid Reference	Y OS Grid Reference	Inlet Height (m)	Pollutants Monitored	In AQMA?	Monitoring Technique	Relevant Exposure? (Y/N with distance (m) from monitoring site to relevant exposure)	Distance to Kerb of Nearest Road (m) (N/A if not applicable)	Does this Location Represent Worst-Case Exposure?
TK1	Thurrock Grays AURN	Urban Background	561066	177894	3.5	PM_{10} NO_2 SO_2 O_3	No	FDMS Chemiluminescent Fluorescent Photometry	No	38	No
TK8 & Formerly (TK2)	Purfleet,London Road	Roadside	556701 (556737)	177937 (177928)	1.5	PM_{10} NO_2	Yes	BAM Chemiluminescent	No	2.6	Yes
TK3	Stanford-le-Hope, Manorway	Roadside	569358	182736	2.75	PM_{10} $PM_{2.5}$ NO_2 SO_2	No	FDMS FDMS Chemiluminescent Fluorescent	No	3	No
TK4	Tilbury, Calcutta Road	Roadside	563901	176282	1.5	NO_2	To be Declared	Chemiluminescent	Yes (2m)	5.5	No

Table 4 Details of Thurrock's Non-Continuous Monitoring Stations which are relevant to this Detailed Assessment Report

Site ID	**Site Name**	**Site Type**	**X OS Grid Reference**	**Y OS Grid Reference**	**Site Height (m)**	**Pollutants Monitored**	**In AQMA?**	**Is Monitoring Co-located with a Continuous Analyser (Y/N)**	**Relevant Exposure?** (Y/N with distance (m) from monitoring site to relevant exposure)	**Distance to Kerb of Nearest Road (m)** (N/A if not applicable)	**Does this Location Represent Worst-Case Exposure?**
WC	Watts Crescent (R)	R	556314	178765	2	NO_2	12	N	N	2	N
GDSO	Gatehope Drive (UB)	UB	557595	181060	1.25	NO_2	15	N	Y (23m)	105	Y
KCNO	Kemps Cottage (UB)	UB	558148	183532	2	NO_2	16	N	Y (10m)	57	Y
PBP	Purfleet By-pass (R)	R	556257	178438	1.5	NO_2	No	N	Y (5.5m)	9.5	Y
AVSL	Aveley Ship Lane (R)	R	556713	180167	2	NO_2	No	N	Y (1m)	2	Y
AVHS	Aveley High Street (R)	R	556661	180180	2	NO_2	No	N	N	0.75	N

None of these locations are near to the Purfleet By-pass or Aveley High Street/ Ship Lane. However the data from Thurrock 1 Grays AURN monitoring station has been used in this report for the purpose of using as local background concentrations for the air quality modelling conducted within this report.

Table 5 Annual mean NO_2 concentrations in Thurrock (2006 – 2013 inclusive)(µg m^{-3})

LAQN site	Type	2007	2008	2009	2010	2011	2012	2013
Thurrock 1	U	*33.83*	31.78	30.98	*29.2*	*28.17*	28.72	27.46

(Note - italics indicates < 90% data capture; bold indicates > annual mean objective)

Table 6 NO_2 data capture for year (%)

LAQN Site	Type	2007	2008	2009	2010	2011	2012	2013
Thurrock 1	UB	87.30%	96.79%	97.48%	84.43%	89.69%	98.29%	97.03%

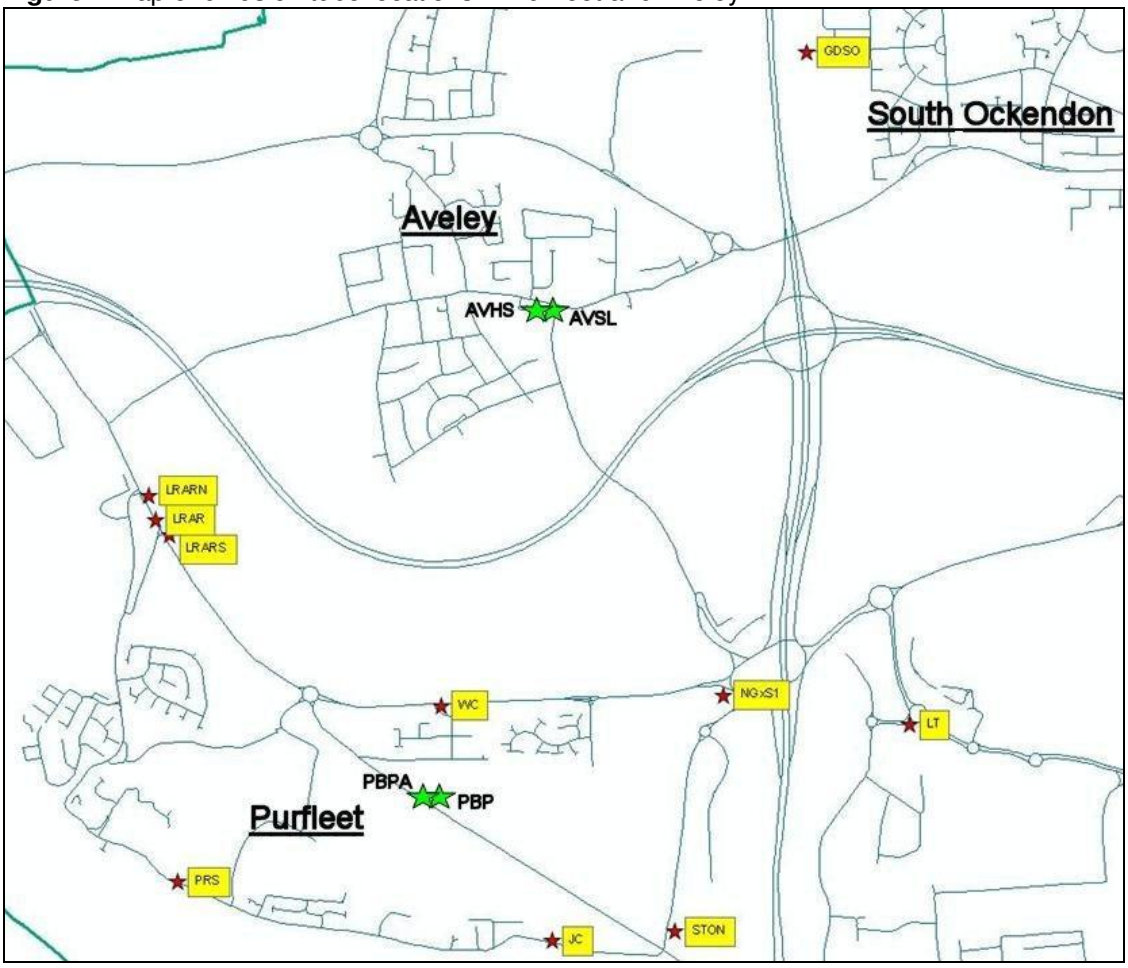
2.3.2 Diffusion Tube Monitoring

Thurrock Council currently operates 48 diffusion tube monitoring locations around the borough. There are currently two sites along the Purfleet By-pass (PBP & PBPA) and another diffusion tube location nearby to the north at Watts Crescent (WC). Aveley has two diffusion tube locations, one is located along the Aveley High Street (AVHS) and the other is located at the roundabout junction on Ship Lane that intersects with Aveley High Street (AVSL).

The Purfleet By-pass site (PBP) was setup in 2011, as there were concerns that a recently built residential development at Watts Wood Estate along the Purfleet By-pass could be above the annual mean air quality objective for NO_2, due to the high proportion of Heavy Goods Vehicles (HGV's) which traverse this road. Monitoring data from this site confirmed that the air quality objective was being breached during 2011, 2012 and 2013. The Council has also recently setup a new site (PBPA) which is located on the north-western side of the Watts Wood Estate, however there has not been enough data gathered thus far to make this site usable in this report.

The Aveley High Street (AVHS) and Aveley Ship Lane (AVSL) sites were setup in 2012 to assess whether there was an issue with nitrogen dioxide. Both Aveley High Street and Ship Lane are busy roads, which are quite narrow with a number of residential and commercial properties immediately adjacent to these two roads. There were concerns that the annual mean air quality objective for NO_2 might well be breached at along this road, hence the Council decided to start monitoring at this locations in 2012. The monitoring data for 2012 and 2013 confirms that the air quality objective is being breached at these two locations.

Figure 2 Map of diffusion tube locations in Purfleet and Aveley



*Green Stars indicates diffusion tube locations which are relevant to this report
*Red Stars indicates other diffusion tube sites

Figure 3 Detailed Map of Aveley with diffusion tube locations

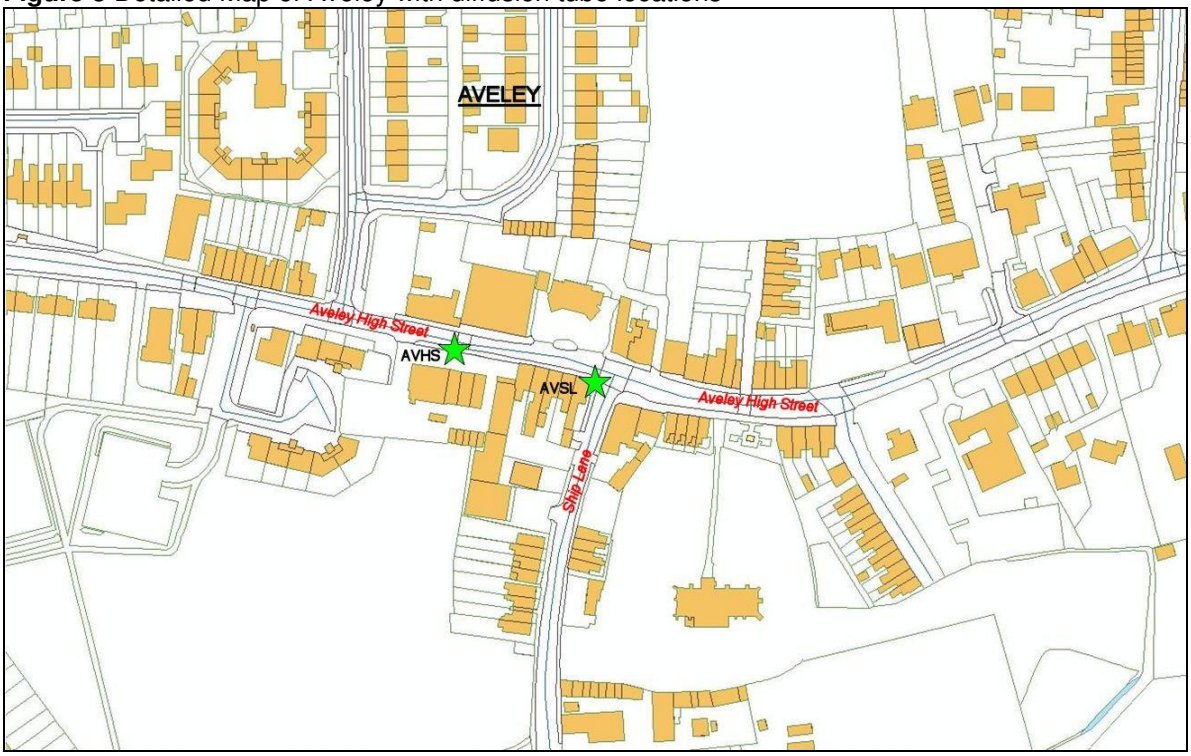


Figure 4 Detailed Map of Purfleet with diffusion tube locations

Co-location studies to determine suitable local bias factors were undertaken at the Council's automatic sites. One tube was co-located at the Thurrock 1 background site and three tubes were co-located at the Thurrock 3 roadside site, and two tubes were co-located with Thurrock 4 roadside site, and 1 tube co-located with Thurrock 8 roadside site. The local bias factors were derived from these (see table 7).

The Council have been advised by Defra that they would prefer Thurrock to use the national bias adjustment factors, as the Council was using four separate bias adjustment factors in previous reports, it was thought that this may unfairly bias the results from individual diffusion tube sites.

Table 7 National Bias adjustment factors for Gradko diffusion tubes (2006 – 2013)

Analysis Method	Year	National Bias Adjustment Factor
50% TEA/Water	2006	0.96
50% TEA/Water	2007	0.93
50% TEA/Water	2008	1.05
20% TEA/Water	2009	0.9
20% TEA/Water	2010	0.92
20% TEA/Water	2011	0.9
20% TEA/Water	2012	0.96
20% TEA/Water	2013	0.95

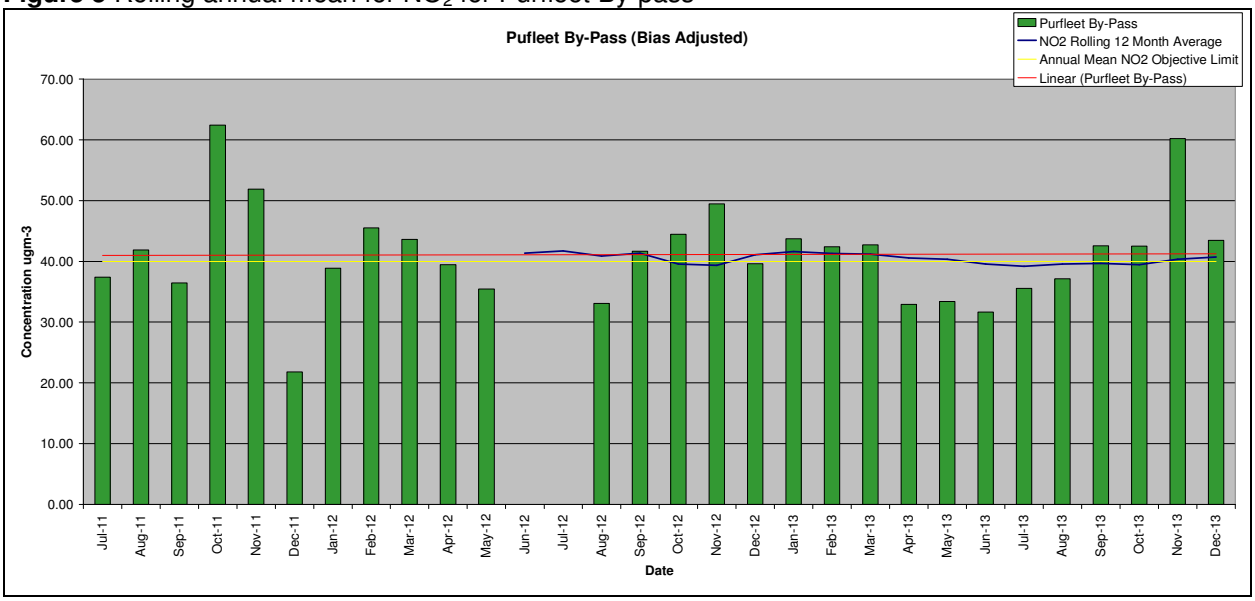
Table 8 Bias adjusted NO_2 Diffusion Tube results for years (2006 – 2013)

Site	2006	2007	2008	2009	2010	2011	2012	2013
Gatehope Drive (UB)	36.21	35.72	41.31	32.07	31.21	29.47	30.28	28.46
Kemps Cottages (UB)	36.91	37.85	40.7	34.65	33.2	32.63	34.22	35.21
Watts Crescent (R)	**44.65**	**48.45**	**51.58**	39.88	**40.89**	38.7	**40.54**	**43.43**
Purfleet By-pass (R)						**41.96**	**41.11**	**40.69**
Aveley Ship Lane (R)							**46.99**	**41.39**
Aveley High Street (R)							38.96	39.41

(Bold indicates was above the objective limit for NO_2)
(Purple indicates less than 9 months data capture)

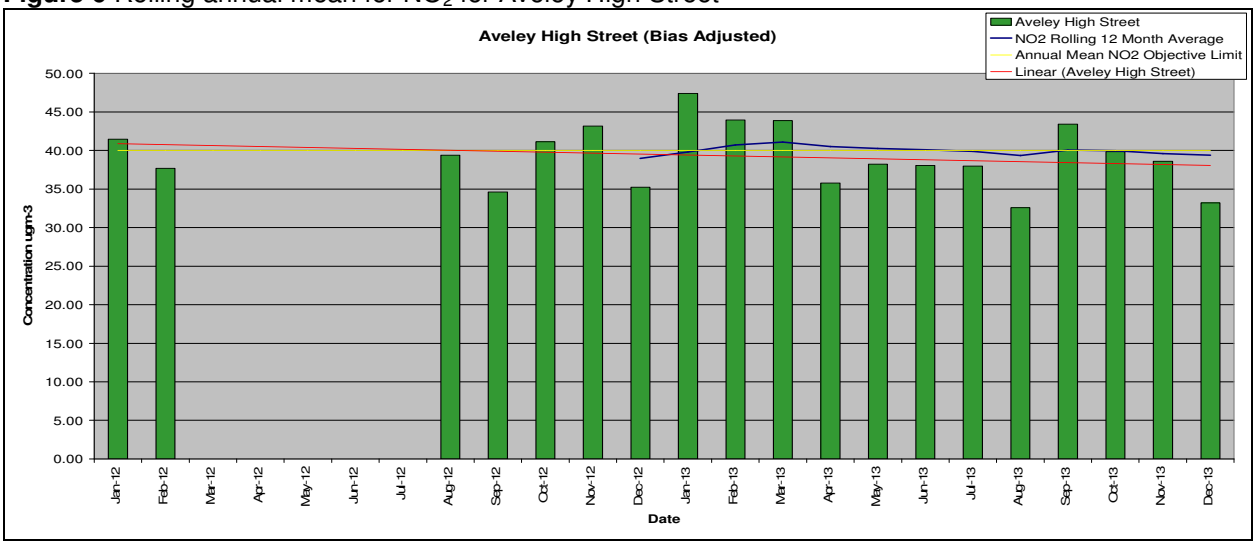
Table 8 shows that the annual mean is clearly being breached along the Purfleet-Bypass (PBP) for 2011-2013, although for 2011 the data capture is below the threshold required. For the two Aveley sites the annual mean objective was breached in 2012, although for the Aveley High Street site (AVHS) the data capture was limited as a number of tubes went missing and thus the data capture level was below the requirement threshold. However in 2013 both sites were below the annual mean objective level. It must be noted that 2013 has had lower concentrations of NO_2 than in previous years at most of Thurrock's diffusion tube sites.

Figure 5 Rolling annual mean for NO_2 for Purfleet By-pass



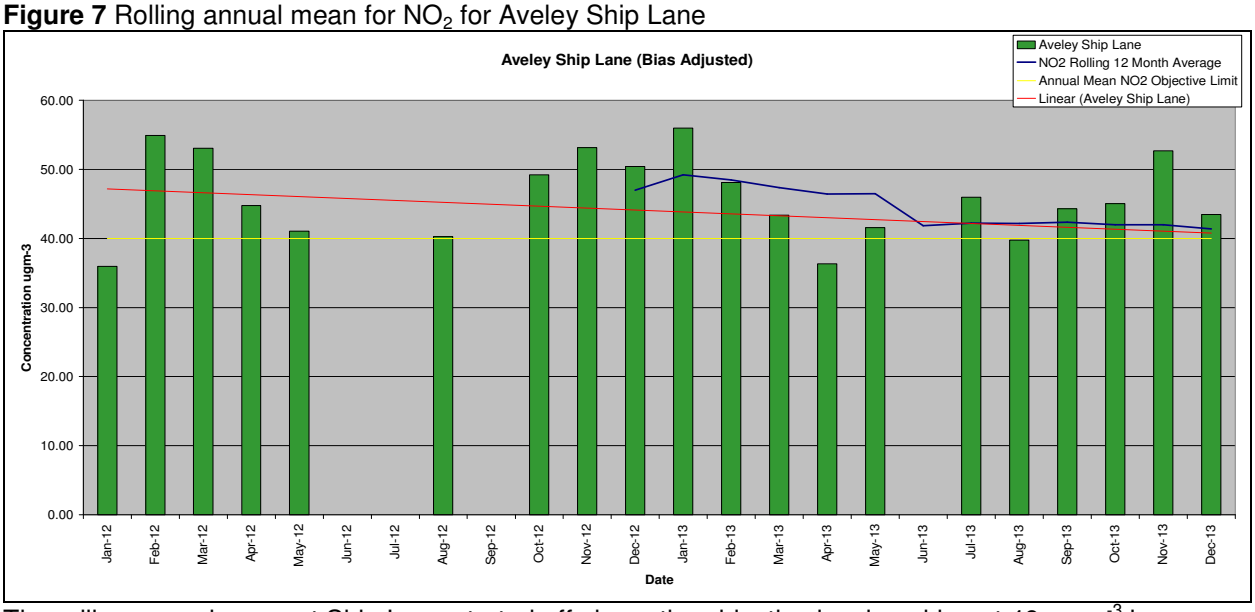
The rolling annual mean has been hovering around and above the annual mean objective at Purfleet By-pass, there has been little change in the rolling annual mean since the site started operating in 2011.

Figure 6 Rolling annual mean for NO_2 for Aveley High Street



The rolling annual mean at Aveley High Street has been lingering around the annual mean objective of 40µg m^{-3}. There has been little change in concentrations since the site started operation in 2012.

Figure 7 Rolling annual mean for NO_2 for Aveley Ship Lane



The rolling annual mean at Ship Lane started off above the objective level peaking at 49 µg m^{-3} in January 2013, but has shown a slight decrease in concentrations since, however it was still above the annual mean objective at the end of 2013.

3 Air Quality Modelling for NO_2

3.1 Outline of the Air Quality Model

In order to assess the full extent of exceedence of the annual mean objective for NO_2, so that an AQMA can be declared on a scientific basis rather than just an arbitrary declaration, then detailed modelling has been used. The Model used is the Advanced Dispersion Model for Roads (ADMS-Roads), version 3.2.4 developed by Cambridge Environmental Research Consultants (CERC). This version has incorporated into it the latest Defra emission factor toolkit (v6.0.1).

ADMS-Roads is a complex model with many variables to consider, it is deemed suitable for the purposes of Detailed Assessment according to TG(09) Defra Guidance. The model has been run numerous times for both Aveley & Purfleet. The model has then been verified against the diffusion tube monitoring sites to ensure that the results are as precise as possible, in order to get a snap shot of conditions.

3.2 Outline of the Model variables used

Detailed modelling has been conducted along the main roads in Purfleet. The roads modelled are:-

- **Purfleet By-pass**
- **A1306 Arterial Road Purfleet**

Detailed modelling has been conducted along the main roads in Aveley. The roads modelled are:-

- **Aveley High Street**
- **Ship Lane**

3.2.1 Road Traffic Data

Traffic data for these roads has been limited, and some assumptions have had to be made due to the lack of traffic data available. There are traffic counts for all the roads, however some of the data is crude with either no vehicle classification or average speed data. So some assumptions have been made relating to the average speed data for some of these roads.

3.3 Aveley Model Inputs

Road traffic data was available for Aveley High Street for 2010, the data was obtained from the Council, the data included traffic counts only, with no vehicle classification. The traffic along this road has been observed and is made up predominantly of Passenger Cars or Light Duty Vehicles (LDV's), there are occasionally Heavy Duty Vehicles (HDV's) on this road (i.e. buses and freight traffic). For the purposes of the model, an assumption of 10% of the total traffic for this road has been classified as HDV road traffic. Also for Aveley High Street (Stifford Road) which is on the far eastside of Aveley there was more up to date traffic data available for 2011, this data was added into the model with the same assumptions for HDV's as the Aveley High Street. Classifying into these two categories is considered acceptable in accordance with the TG(09) Defra Guidance for the purpose of modelling for Detailed Assessments.

Road traffic data was available for Ship Lane for 2010, it would have been desirable to have more up to date information for this road, but due to budget restraints it was not possible to acquire more recent road traffic data. The data was obtained by the Council, the data included only road traffic counts. Like the Aveley High Street the traffic makeup is predominantly consists of Passenger Cars. For the purposes of the model, an assumption of 10% of the total traffic for this road has been classified as HDV road traffic.

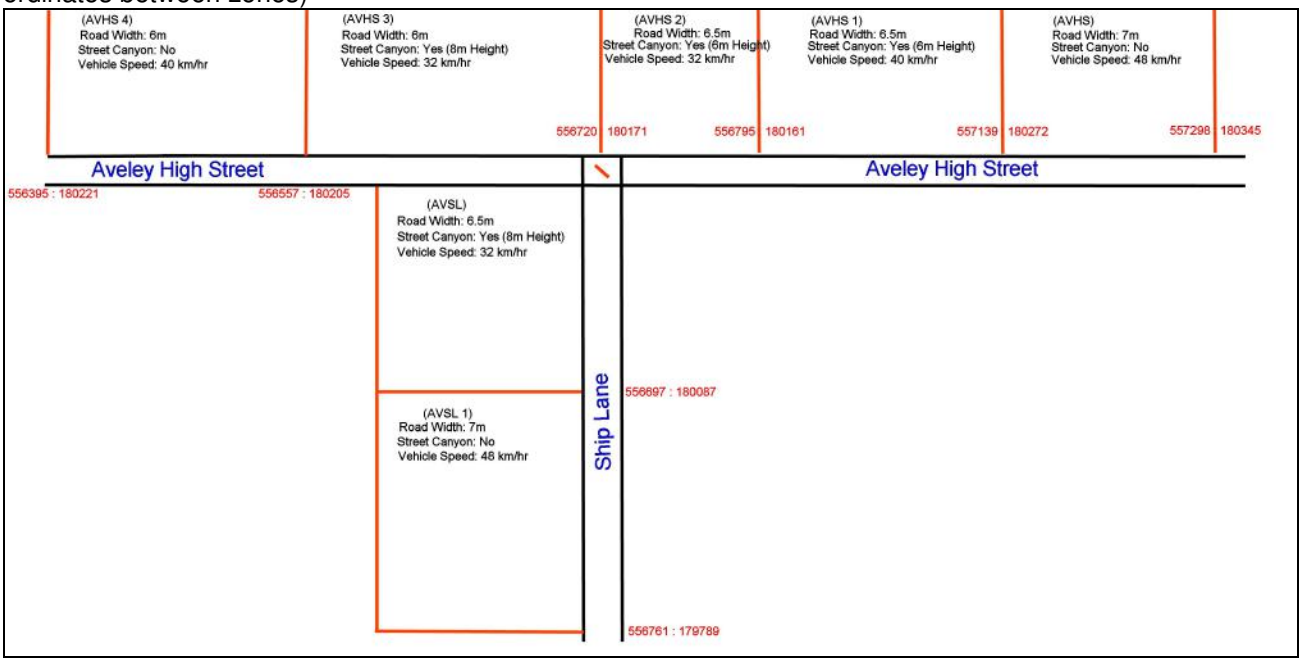
Vehicle speeds do vary across the both roads, with traffic slowing significantly at the mini roundabout junction with Aveley High Street and Ship Lane. Table 9 below lists the model parameters for both roads.

Both Roads have been split into sections in the model as these sections vary significantly in their characteristics. Aveley High Street has been split into 5 zones and Ship Lane has been split into 2 zones. Figure 8 below shows the various parameters for each zone.

Table 9 Aveley Road Traffic Data and NO_x Emission Factors used in the Model

Road	Vehicle Class	Average Speed (km/hr)	Vehicles (per hr)	Vehicles (per day)	NOx Emission Factors (g/km)
Aveley High Street (Stifford Road) (AVHS)	LDVs (i.e. Passenger Cars, Light Goods)	48	297	7128	0.367
	HDVs (i.e. Art, Rigid Lorries & Buses)	48	33	792	4.038
Aveley High Street (AVHS 1)	LDVs (i.e. Passenger Cars, Light Goods)	40	298	7158	0.399
	HDVs (i.e. Art, Rigid Lorries & Buses)	40	33	795	4.659
Aveley High Street (AVHS 2)	LDVs (i.e. Passenger Cars, Light Goods)	32	298	7158	0.442
	HDVs (i.e. Art, Rigid Lorries & Buses)	32	33	795	5.576
Aveley High Street (AVHS 3)	LDVs (i.e. Passenger Cars, Light Goods)	32	341	8185	0.442
	HDVs (i.e. Art, Rigid Lorries & Buses)	32	38	910	5.576
Aveley High Street (AVHS 4)	LDVs (i.e. Passenger Cars, Light Goods)	40	341	8185	0.399
	HDVs (i.e. Art, Rigid Lorries & Buses)	40	38	910	4.659
Ship Lane (AVSL)	LDVs (i.e. Passenger Cars, Light Goods)	32	339	8149	0.442
	HDVs (i.e. Art, Rigid Lorries & Buses)	32	38	905	5.576
Ship Lane (AVSL 1)	LDVs (i.e. Passenger Cars, Light Goods)	48	339	8149	0.367
	HDVs (i.e. Art, Rigid Lorries & Buses)	48	38	905	4.038

Figure 8 Schematic of the Roads modelled in Aveley with their model parameters (includes X,Y co-ordinates between zones)



(Table 10) below shows the NO_x emission rates which were input into the model, emission rates are automatically calculated within the model itself based on the parameters input in (Table 9) above, and for which year the emission factors are based which in this case they were based on the year 2013.

Table 10 Road NO_x Emissions Rates for the Modelled Roads for Aveley

Road	NOx Emission Rate (g/km/s)
Aveley High Street (AVHS)	0.0673189
Aveley High Street (AVHS 1)	0.0757093
Aveley High Street (AVHS 2)	0.0876996
Aveley High Street (AVHS 3)	0.1007230
Aveley High Street (AVHS 4)	0.0869422
Ship Lane (AVSL)	0.1004780
Ship Lane (AVSL 1)	0.0772126

Time varying emission factors were also input into the model, these factors were based on road traffic counts from Aveley High Street as seen in Table 11.

Table 11 Time Varying Emission Factors applied into the Model For Aveley

Local Time (hrs)	Weekdays	Saturdays	Sundays
1	0.11	0.29	0.36
2	0.04	0.18	0.18
3	0.04	0.11	0.15
4	0.03	0.05	0.11
5	0.06	0.09	0.1
6	0.29	0.17	0.12
7	0.58	0.28	0.17
8	0.85	0.46	0.31
9	1.26	0.97	0.49
10	1.32	1.42	1.19
11	1.34	1.9	2.04
12	1.3	1.73	2.12
13	1.36	2.02	2.32

14	1.27	1.85	2.3
15	1.6	1.77	2.09
16	1.86	1.71	1.91
17	1.96	1.78	1.87
18	2.13	1.84	1.75
19	1.87	1.56	1.22
20	1.66	1.34	1.08
21	1.15	0.9	0.86
22	0.8	0.73	0.61
23	0.63	0.47	0.42
24	0.48	0.4	0.22

The diffusion tube sites at AVSL and AVHS were also plotted in the model run. The results from the model run outputs were then used in the verification process, to see whether any adjustment in the model results was needed.

3.4 Purfleet Model Inputs

Data was available for the A1306 Arterial Road Purfleet, road traffic data collected by the Department for Transport (DfT) was used for 2011. The data was of high quality showing many vehicle classes, however for the purposes of the Model these have been categorised into two vehicle classes only HDV's and LDV's, as shown in Table 12.

Traffic data for the Purfleet By-pass was available from Council obtained road data which was also of high quality with many vehicle classifications. The data was obtained in January 2013. The data like the A1306 Arterial Road Purfleet was split into two vehicle classifications HDV's & LDV's, as shown in Table 12.

Table 12 Purfleet Road Traffic Data and NO_x Emission Factors used in the Model

Road	Vehicle Class	Average Speed (km/hr)	Vehicles (per hr)	Vehicles (per day)	NOx Emission Factors (g/km)
A1306, Arterial Road Purfleet (A1306)	LDVs (i.e. Passenger Cars, Light Goods)	64	379	9213	0.338
	HDVs (i.e. Art, Rigid Lorries & Buses)	60	59	1368	3.440
A1306, Arterial Road Purfleet (A1306 a)	LDVs (i.e. Passenger Cars, Light Goods)	64	379	9213	0.338
	HDVs (i.e. Art, Rigid Lorries & Buses)	60	59	1368	3.440
A1306, Arterial Road Purfleet (A1306 b)	LDVs (i.e. Passenger Cars, Light Goods)	64	379	9213	0.338
	HDVs (i.e. Art, Rigid Lorries & Buses)	60	59	1368	3.440
Purfleet By-pass (PBP)	LDVs (i.e. Passenger Cars, Light Goods)	60	270	6480	0.341
	HDVs (i.e. Art, Rigid Lorries & Buses)	60	113	2712	3.440
Purfleet By-pass (PBP 1)	LDVs (i.e. Passenger Cars, Light Goods)	60	270	6480	0.341
	HDVs (i.e. Art, Rigid Lorries & Buses)	60	113	2712	3.440
Purfleet By-pass (PBP 2)	LDVs (i.e. Passenger Cars, Light Goods)	60	270	6480	0.341
	HDVs (i.e. Art, Rigid Lorries & Buses)	60	113	2712	3.440
Purfleet By-pass (PBP 3)	LDVs (i.e. Passenger Cars, Light Goods)	60	270	6480	0.341
	HDVs (i.e. Art, Rigid Lorries & Buses)	60	113	2712	3.440

(Table 13) below shows the NO_x emission rates which were input into the model, emission rates are automatically calculated within the model itself based on the parameters input in (Table 12) above, and for which year the emission factors are based which in this case they were based on the year 2013.

Table 13 Road NO_x Emissions Rates on Modelled Roads for Purfleet

Road	NOx Emission Rate (g/km/s)
A1306, Arterial Road Purfleet (A1306)	0.0894428
A1306, Arterial Road Purfleet (A1306a)	0.0894428
A1306, Arterial Road Purfleet (A1306b)	0.0894428
Purfleet By-pass (PBP)	0.133554
Purfleet By-pass (PBP 1)	0.133554
Purfleet By-pass (PBP 2)	0.133554
Purfleet By-pass (PBP 3)	0.133554

Time varying emission factors were also input into the model, these factors were based on road traffic counts from Purfleet By-pass as seen in Table 14. Unfortunately a full traffic count was not available for Sunday so these factors have been based on Saturdays instead, which is more representative than using the weekday factor.

Table 14 Time Varying Emission Factors applied into AQ Model for Purfleet

Local Time (hrs)	Weekdays	Saturdays	Sundays
1	0.18	0.34	0.34
2	0.25	0.29	0.29
3	0.3	0.17	0.17
4	0.38	0.44	0.44
5	0.93	0.58	0.58
6	1.35	0.96	0.96
7	1.53	0.73	0.73
8	1.64	0.92	0.92
9	1.46	1.13	1.13
10	1.56	1.52	1.52
11	1.43	1.69	1.69
12	1.55	2.09	2.09
13	1.63	2.14	2.14
14	1.55	1.91	1.91
15	1.33	1.79	1.79
16	1.52	1.39	1.39
17	1.53	1.19	1.19
18	1.01	1.1	1.1
19	0.81	0.87	0.87
20	0.48	0.69	0.69
21	0.5	0.72	0.72
22	0.48	0.46	0.46
23	0.34	0.4	0.4
24	0.27	0.47	0.47

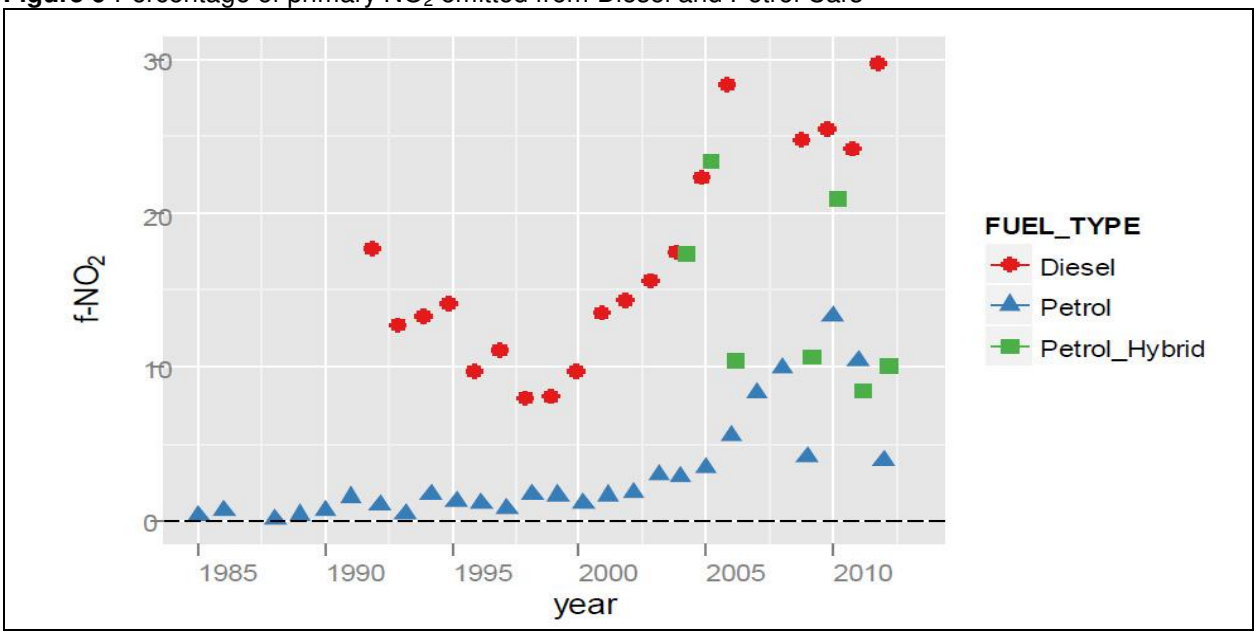
The diffusion tube sites at PBP and WC were also plotted in the model run. The results from the model run outputs were then used in the verification process, to see whether any adjustment in the model results was needed.

3.5 Primary NO_2

The model gives the option of inputting the proportion of primary NO_2 which is directly emitted from motor vehicles. However finding what % to use can be problematic, as one type of motor vehicle can vary widely from another, in either fuel type, vehicle class, and engine type to name a few as seen in Figures 9 & 9.

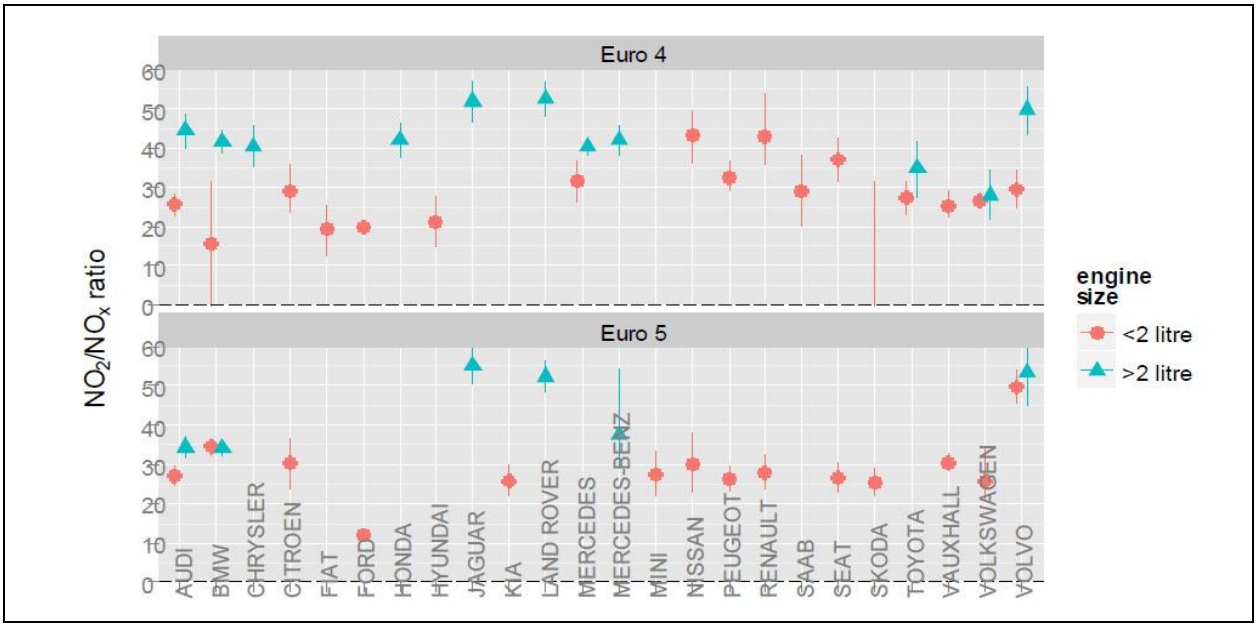
The (Figures 9,10 & 11) shown below are from a study of remote sensing of motor vehicle exhaust emissions by (Carslaw et al 2013)

Figure 9 Percentage of primary NO_2 emitted from Diesel and Petrol Cars



Diesel Cars are now much more common on the roads, and they emit far more primary % NO_2 (direct NO_2 from the exhaust) than Petrol Cars (Figure 9). Newer diesel Cars also emit more % primary NO_2 than older ones this pattern is also seen in Petrol Cars albeit to a lesser extent. The amount of primary NO_2 emitted from vehicles in the same Euro Classification standard also varies dramatically from different vehicle manufacturers (Figure 10)

Figure 10 Percentage of primary NO_2 emitted from different Euro Class Vehicles and Vehicle Manufacturers



Heavy Goods Vehicles (HGV's) also have considerable variation in primary NO_2 (Figure 11), older Euro Classes particularly Euro II & Euro III have a much higher percentage of primary NO_2 than the newer Euro IV & V vehicles.

Figure 11 Percentage of primary NO_2 emitted from different Euro Class HGV's

HGVs

Table NO_x/CO_2 and f-NO_2 for HGVs.

Euro Class	n	variable	mean	ymin	ymax
II	67	Q_NO_x	0.014	0.013	0.016
III	326	Q_NO_x	0.012	0.011	0.012
IV	530	Q_NO_x	0.012	0.012	0.013
V	421	Q_NO_x	0.012	0.011	0.012
II	67	fNO_2	18.5	13.7	23.5
III	326	fNO_2	18.6	12.2	23.1
IV	530	fNO_2	6.6	1.4	9.6
V	421	fNO_2	9.4	7.9	11.2

The model is limited to just one overall factor, the National Atmospheric Emissions Inventory (NAEI) has recently produced some emission factors for primary NO_2 (Figure 12). A factor of **0.231** or **23.1%** has been chosen for 2013. This is much more realistic than using the model default value which much lower at only 10%.

Also from seeing the analysis of the remote sensing of NO_2 from vehicle exhausts study by (Carslaw et al 2013) it is clear that the proportion of primary NO_2 has shown an increase in recent years, due to increasing diesel car usage in the UK and also with newer fleets being introduced onto the roads which have a higher proportion of primary NO_2 emissions than older vehicles.

Figure 12 NAEI primary NO_2 emission factors as a fleet average

Fraction of NOx Emitted by Vehicles as NO2 (by volume) Fleet-Averaged Values - all traffic
Base 2013

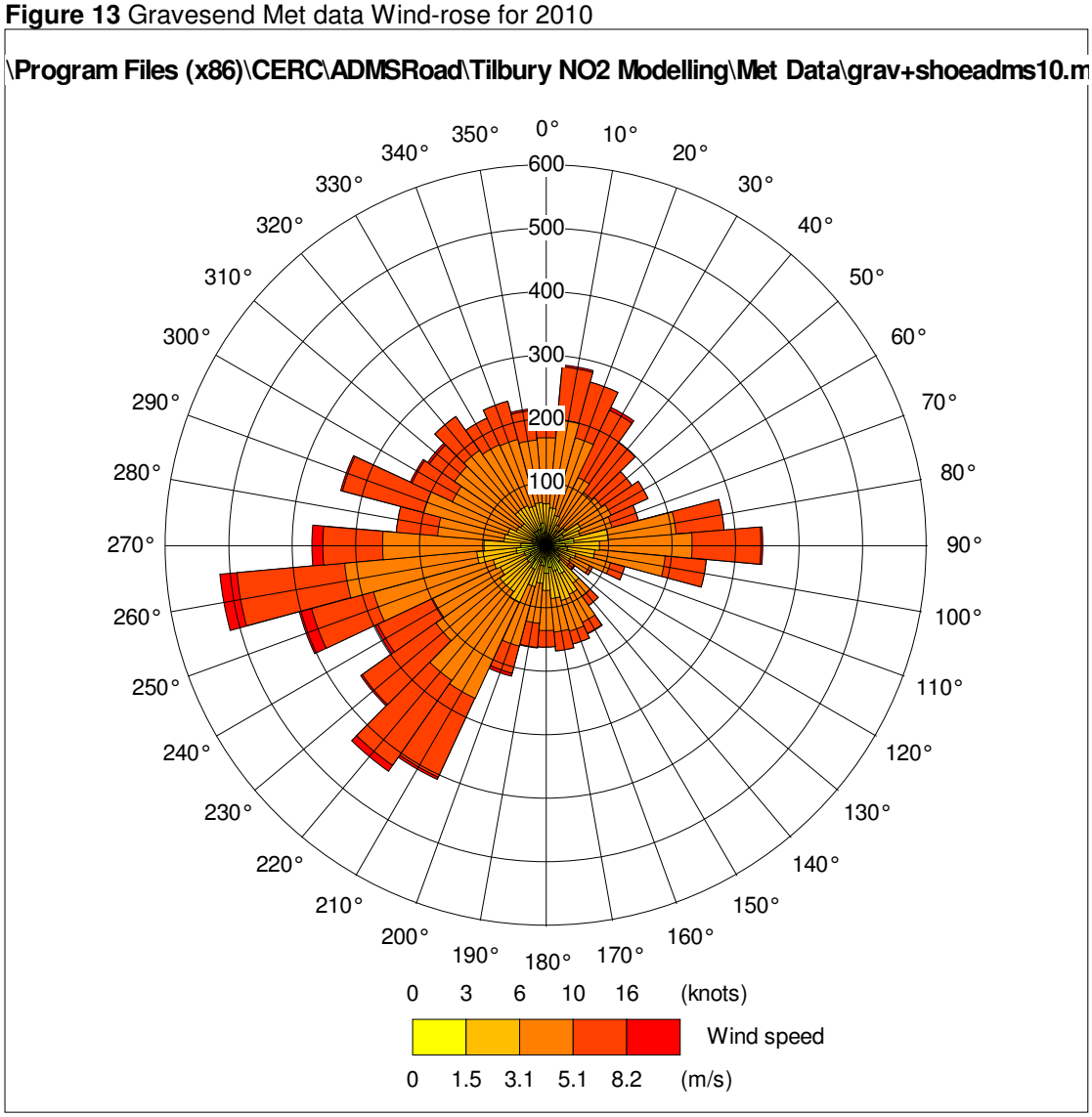
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
All UK traffic	0.101	0.128	0.153	0.179	0.191	0.205	0.215	0.223	0.231	0.238	0.240	0.237	0.233	0.228	0.223	0.217	0.211	0.206	0.201	0.196	0.192	0.189	0.186	0.183	0.181	0.179
All London traffic	0.098	0.123	0.147	0.170	0.182	0.194	0.202	0.211	0.218	0.225	0.227	0.225	0.221	0.217	0.212	0.207	0.201	0.196	0.191	0.186	0.181	0.177	0.174	0.171	0.168	0.166
All other urban UK traffic	0.096	0.122	0.146	0.169	0.182	0.198	0.207	0.214	0.222	0.228	0.230	0.227	0.223	0.219	0.213	0.208	0.202	0.197	0.192	0.188	0.184	0.180	0.177	0.175	0.172	0.171
All non-urban UK traffic	0.104	0.132	0.158	0.184	0.197	0.210	0.221	0.229	0.237	0.245	0.247	0.244	0.240	0.235	0.229	0.223	0.217	0.212	0.207	0.202	0.198	0.194	0.190	0.187	0.185	0.183

Fleet-average values of f-NO2 based on Base 2013 NAEI fleet projections

3.6 Meteorological Data

The model used meteorological data obtained from the UK Met Office, from the closest most representative site. Gravesend was chosen, it is less than 20 miles away from both Purfleet and Aveley, this site is representative of these two sites. The data used was hourly sequential data and was for the year 2010. (Wind-rose seen below in Figure 13). The data is of high quality with a high level of data capture at 99%.

Figure 13 Gravesend Met data Wind-rose for 2010



The model was also run with 2007 met data from Gravesend to see if there was any substantial variation in the modelled results, and to validate the use of this met data. The change in results however was minimal and within 0.5 µg m^{-3} at all modelled receptors, so it was deemed as an insignificant change.
As we are only looking at the long-term objective and not a short-term objective for NO_2 in this study, the met data variation year on year becomes less of a consideration.

3.7 Background Pollutant Data

Both of the modelled areas of this report i.e. Purfleet and Aveley are relatively close to one another and hence the background characteristics are very similar.

3.7.1 Aveley Background Pollutant Data

The background data used in the model was from various sites for different pollutants (Table 15). For NO_2, data was used from the Kemps Cottage (KCNO) diffusion tube monitoring site. This site is not the nearest background location, but is likely the most representative. As the nearest site at Gatehope Drive (GDSO) for some unknown reason had much lower background concentrations in 2013 compared to previous years, using this site would have led to an underestimation in the modelled results. For Kemps Cottage site the background concentrations have remained steady and are considered representative of the local area.

For background oxides of nitrogen (NO_x), the automatic urban background site at Thurrock 1 was used.

The Defra background maps modelled on a 1km / 1km grid were considered to be unrepresentative of the background levels around this area. If used they would not give a good modelled representation of the area, and would under-predict massively the concentrations at the modelled receptor locations.

Table 15 ADMS Urban Background Measurements used in the Aveley Model Run for the year 2013

Pollutant	Concentration	Units	Site used
NOx	47	ug/m^{-3}	TK1 (2013)
NO2	35.21	ug/m^{-3}	KCNO (2013)

3.7.2 Purfleet Background Pollutant Data

The background data used in the model was from various sites for different pollutants (Table 16), as Thurrock Council has a lack of good representative background data for Purfleet. For NO_2, data was used from the Kemps Cottage (KCNO) background diffusion tube monitoring site, rather than from Gatehope Drive (GDSO) background monitoring site, which tends to be lower than KCNO. This site is more representative for the Purfleet area, as Purfleet would be expected to have a higher background level than the rest of Thurrock as it is nearer to industrial sources near to the River Thames and also is surrounded by major and busy roads which have a higher proportion of HGV's in general than the roads in the East of the borough which would have an urban background level more typical to the rest of Thurrock, which are observed at Thurrock 1 Grays AURN site.

For background oxides of nitrogen (NO_x), the automatic urban background site at Thurrock 1 was used, as this has a high level of data capture and is the only background site within Thurrock to directly monitor NO_x.

The Defra background maps modelled on a 1km / 1km grid were considered to be unrepresentative of the background levels around this area. If used they would not give a good modelled representation of the area, and would under-predict massively the concentrations at the modelled receptor locations, which would then lead to correction factors in the model results.

For the initial model runs for Purfleet and Aveley, background data from GDSO was used, however this led to a massive under-prediction in the results and would have required the use of a large an adjustment factor. It was important in this case to get the modelled vs monitored results to read as close as possible, so that we would have confidence that the modelled exceedence line would be as representative as possible, in order to determine the spatial extent of the exceedence. For this purpose we chose a different background site at Kemps Cottage (KCNO) which had a higher background concentration than the GDSO site for 2013.

It is important therefore to get the modelled results of NO_2 to read as closely as possible to the monitored concentrations so that an exceedence line can be produced from the model output which is realistic and

as scientifically representative as possible in order to tell where any likely exceedence of the annual mean objective is occurring.

Table 16 ADMS Urban Background Measurements used in the Purfleet Model Run for the year 2013

Pollutant	Concentration	Units	Site used
NOx	47	ug/m^{-3}	TK1 (2013)
NO2	35.21	ug/m^{-3}	KCNO (2013)

3.8 Point Sources

There are not considered to be any point sources nearby to either of the Aveley or Purfleet sites that would contribute significantly to the modelled annual mean for NO_2. So no point sources have been input into the model runs.

4 Results of Air Quality Modelling For NO_2

4.1 Aveley Model Results

Table 17 Aveley Model Run vs Monitored results

Model Run Year & Monitored	**2013**
Monitored vs Modelled site	**Final Model Results (run 15)**
AVSL Modelled	41.87
AVSL Monitored	45.15
Difference Monitored / Modelled	3.28
% difference Monitored / Modelled	7.83%
Factor	1.08
AVHS Modelled	41.24
AVHS Monitored	39.41
Difference Monitored / Modelled	-1.83
% difference Monitored / Modelled	-4.44%
Factor	0.96
Emission Factors used in Model Run	EFT 6.0.1
BACKGROUND SITE	KCNO
Primary NO2 % used in Model Run	23.10%
traffic data used	2010/11
BIAS FACTOR Applied to diffusion tube results	2013 NATIONAL BIAS (0.95)
Overall Average % Difference all sites	**1.70%**
Overall Average Factor All Sites	**1.02**

Table 17 shows the results of the model run when compared to the monitoring data, both sites AVSL and AVHS were modelled to within 10% of the monitoring data, with the AVHS modelled site being only 1.83 ug/m^{-3} over reading the monitoring data, this shows a good level of agreement. As the model results are within 25% of the monitored results then no adjustment to the model results is necessary. The model was run many times using very different inputs before the final model run (Model Run 15) which showed very good agreement and was deemed acceptable for the purpose of designating the plotted exceedence line for NO2. All the model inputs described in section 3.3 of this report pertain to the final model run (Model Run 15).

4.1.1 Aveley Model Plots

The contour plots are based on a height of 1.3 m above the ground, which is a typical height for most individuals to breathe and intake air.

Figure 14 Aveley Model output contour plot for annual mean NO_2

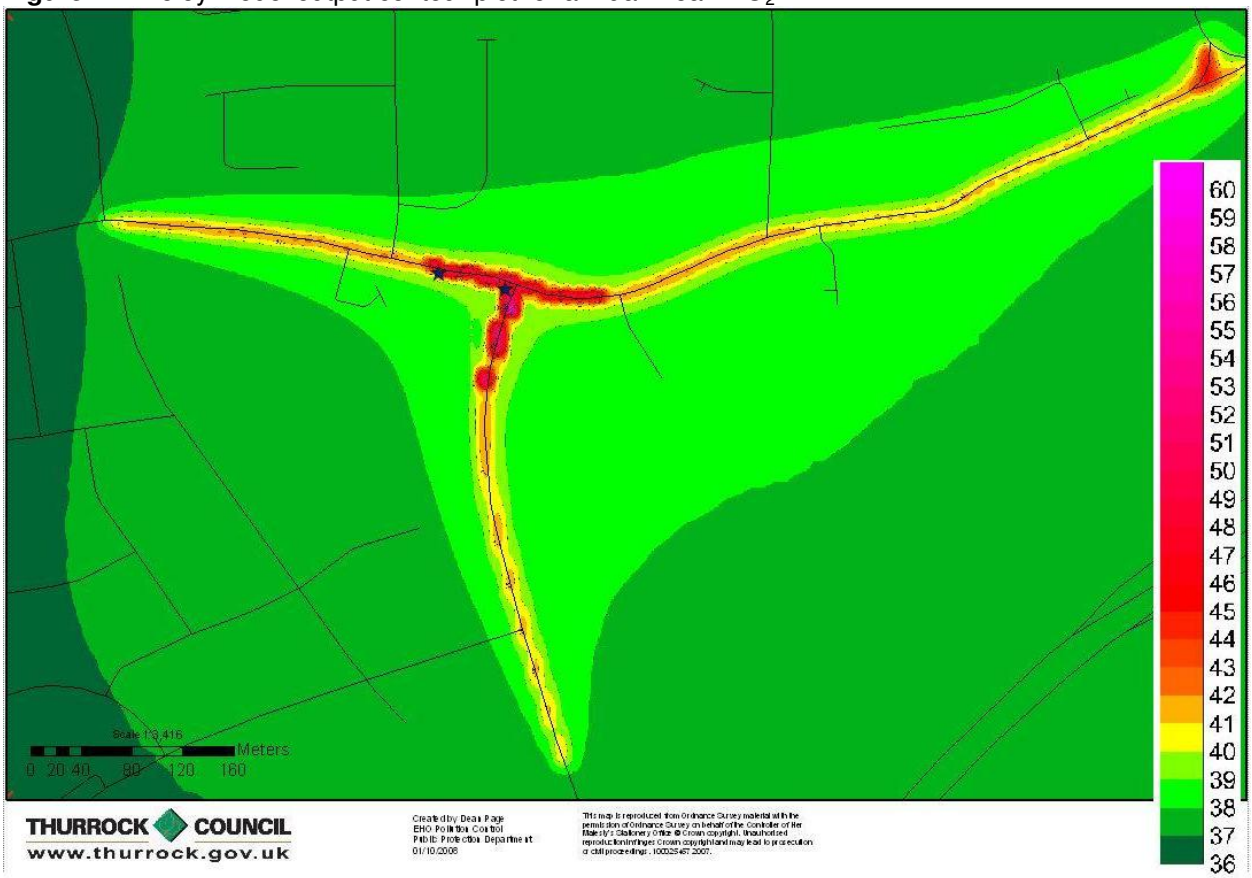


Figure 15 Aveley High Street (Westside) Model output contour plot for annual mean NO_2

Figure 16 Aveley High Street / Ship Lane intersection Model output contour plot for annual mean NO_2

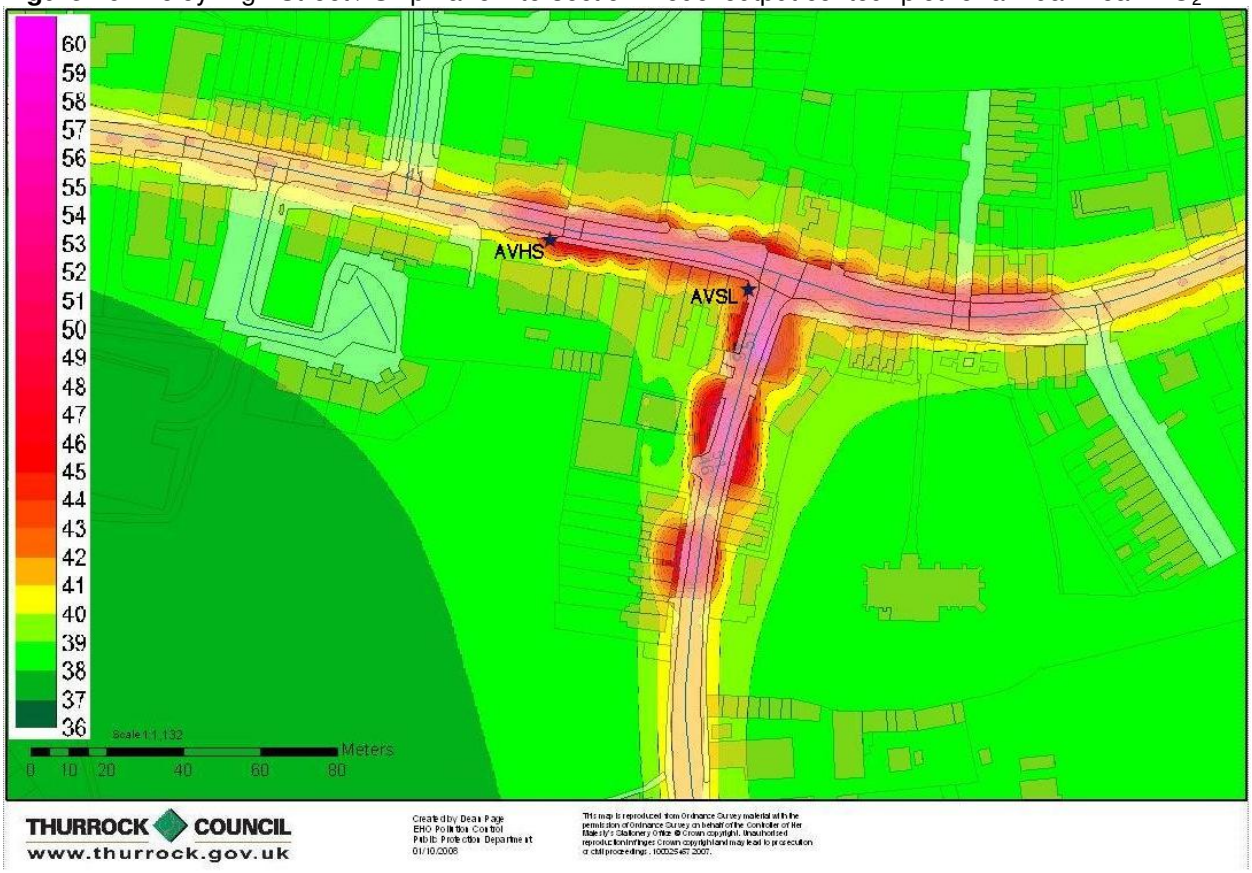


Figure 17 Aveley High Street (East) Model output contour plot for annual mean NO_2

Figure 18 Aveley Ship Lane Model output contour plot for annual mean NO_2

Figure 19 Aveley High Street (West) Modelled 40 ug/m^{-3} annual mean NO_2 exceedence line

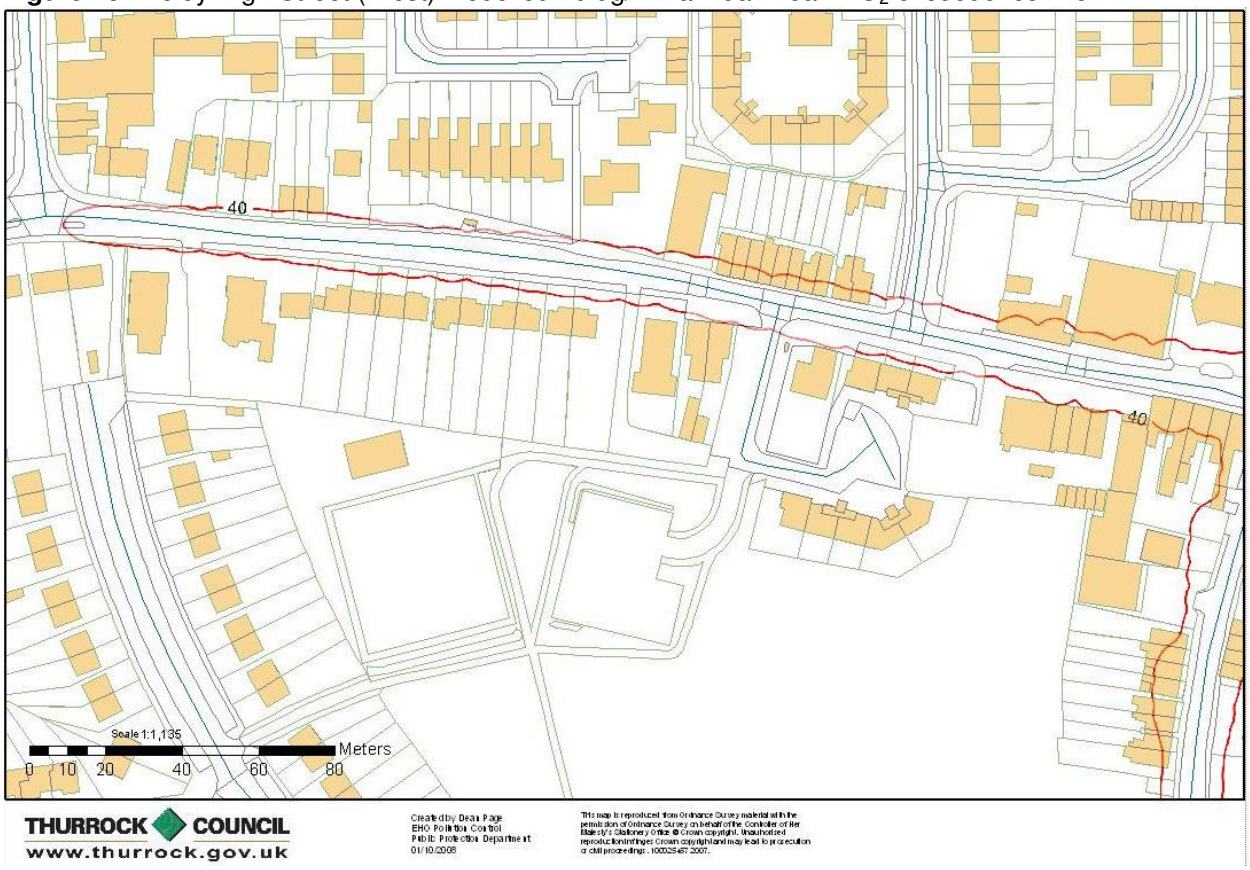


Figure 20 Aveley High Street (East) Modelled 40 ug/m^{-3} annual mean NO_2 exceedence line

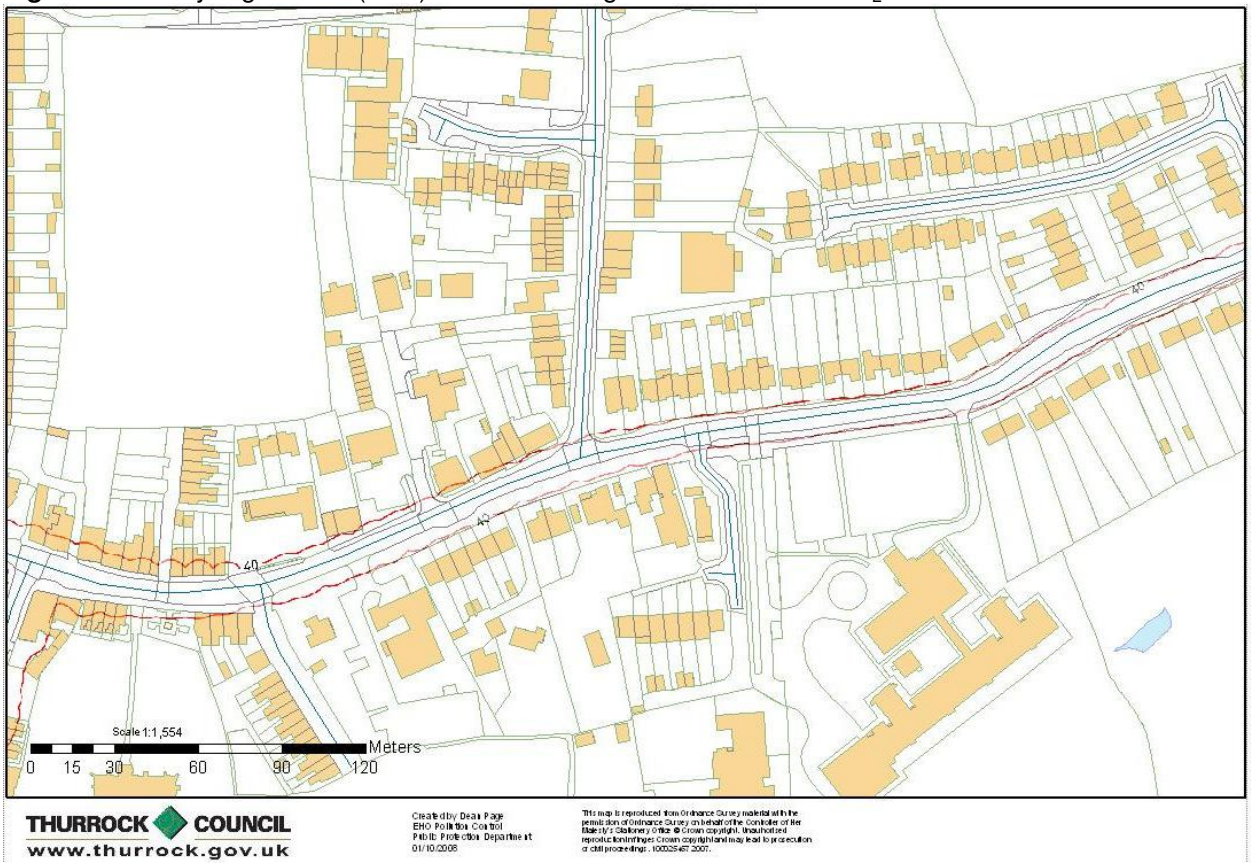
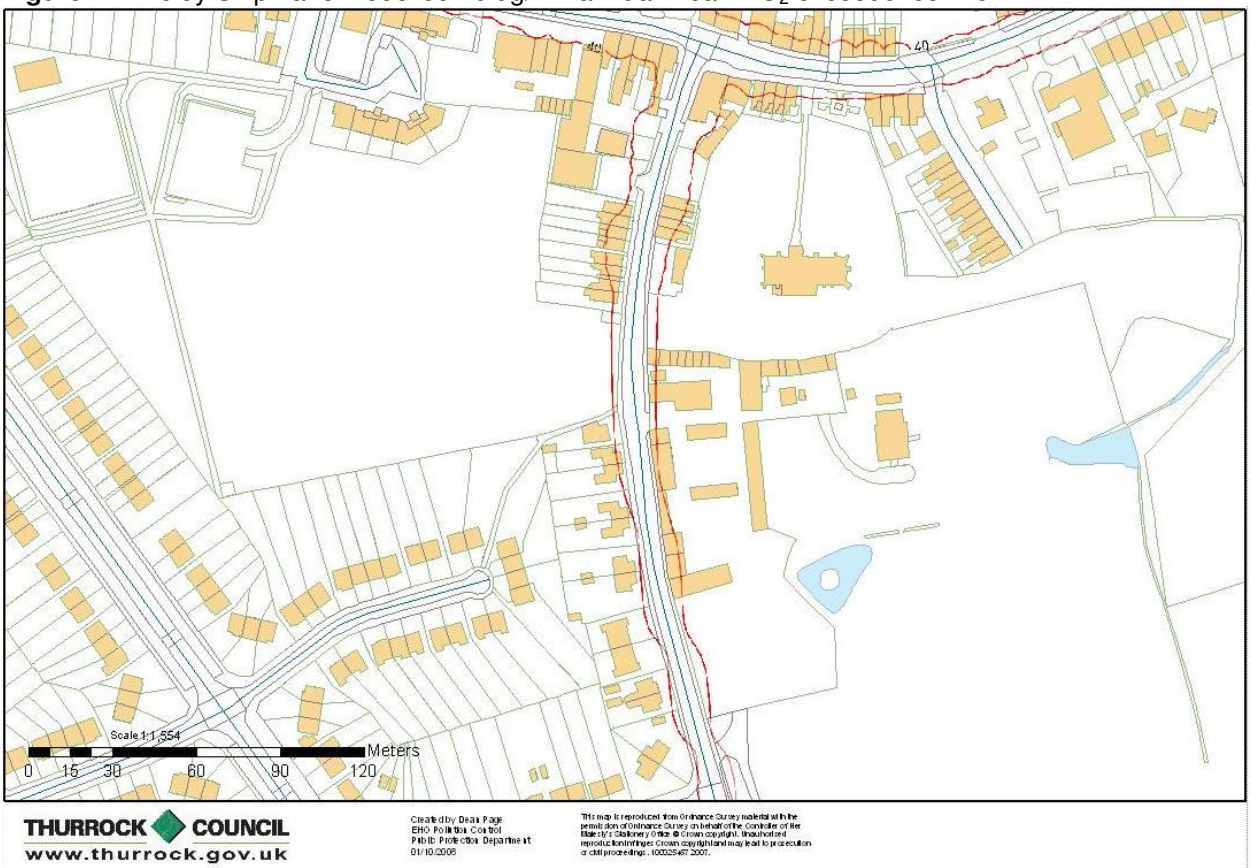


Figure 21 Aveley Ship Lane Modelled 40 ug/m^{-3} annual mean NO_2 exceedence line



The exceedence line clearly runs through a number of properties most of which are residential. A large number of properties along Aveley High Street fall within the exceedence line, in addition to this all the properties lining the north part of Ship Lane also fall within the exceedence line. Based on this a new Air Quality Management Area will be required, which covers both most Aveley High Street and part of Ship Lane. The Boundary of the AQMA will be based on any façade which is inside this line and all of that property will be included within the AQMA not just the part which is inside the boundary.

4.2 Purfleet By-pass Model Results

The model run was verified against two diffusion tube monitoring locations at PBP (Purfleet By-pass) site and WC (Watts Crescent) site. The table below shows the agreement of both modelled and monitored results.

Table 18 Purfleet By-pass Model Run vs Monitored results

Model Run Year & Monitored	**2013**
Monitored vs Modelled site	**Final Model Results (run 12)**
PBP Modelled	41.05
PBP Monitored	40.69
Difference Monitored / Modelled	-0.36
% difference Monitored / Modelled	-0.88%
Factor	0.99
WC Modelled	41.29
WC Monitored	43.43
Difference Monitored / Modelled	2.14
% difference Monitored / Modelled	5.18%
Factor	1.05
Emission Factors used in Model Run	EFT 6.0.1
BACKGROUND SITE	KCNO
Primary NO2 % used in Model Run	0.231
traffic data used	2010/11
BIAS FACTOR Applied to diffusion tube results	2013 NATIONAL BIAS (0.95)
Overall Average % Difference all sites	**2.15%**
Overall Average Factor All Sites	**1.02**

The final model results showed very good agreement against the monitored sites, with the model results for the PBP site only 0.36 µg m^{-3} above the monitored. Although for the WC site the model did underestimate slightly by 2.14 µg m^{-3} However this site is not as important as the area which is primary concern is along the Purfleet By-pass road itself and the residential buildings which are close to this section of road. The WC site is along a completely different road which has little or no impact on those receptors along the Purfleet By-pass, it was included in the model run as it aided the validation of the model run. The model results still show good agreement with the monitored concentrations for this site, under-predicting by only 5%. The PBP site is only 0.88% different, so on this basis the modelled output is as accurate as it can be when looking at where the modelled exceedence line is in reality to how it is at the present time for this location.

As the model results are within 25% of the monitored results then no adjustment to the model results is necessary. The model was run many times using very different inputs before the final model run (Model Run 12) showed very good agreement and was deemed acceptable for the purpose of designating the plotted exceedence line for NO2. All the model inputs described in section 3.4 of this report pertain to the final model run (Model Run 12).

4.2.1 Purfleet By-pass Model Plots

The contour plots are based on a height of 1.3 m above the ground, which is a typical height for most individuals to breathe and intake air.

Figure 22 Purfleet By-pass Model output contour plot for annual mean NO_2

Figure 23 Purfleet By-pass / Watts Wood Estate Model output contour plot for annual mean NO_2

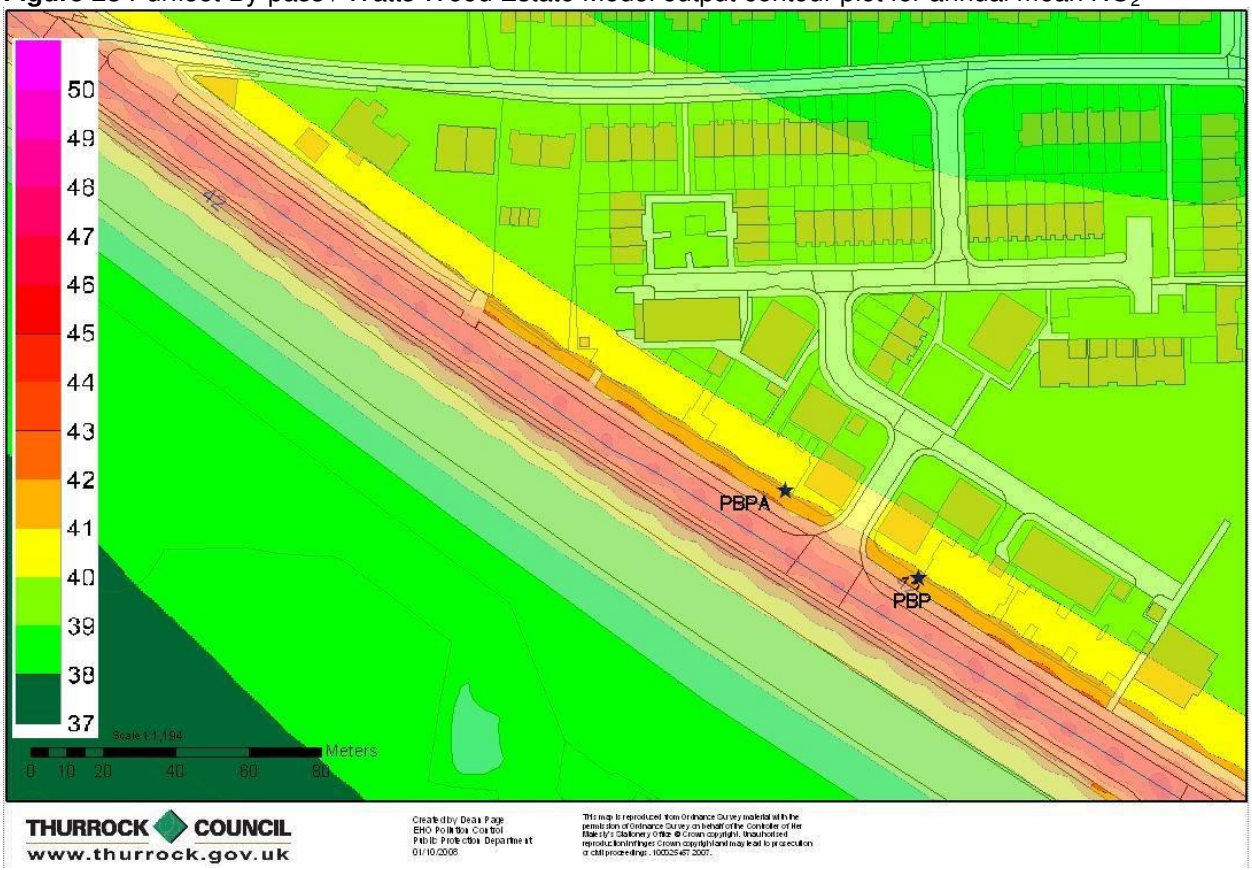
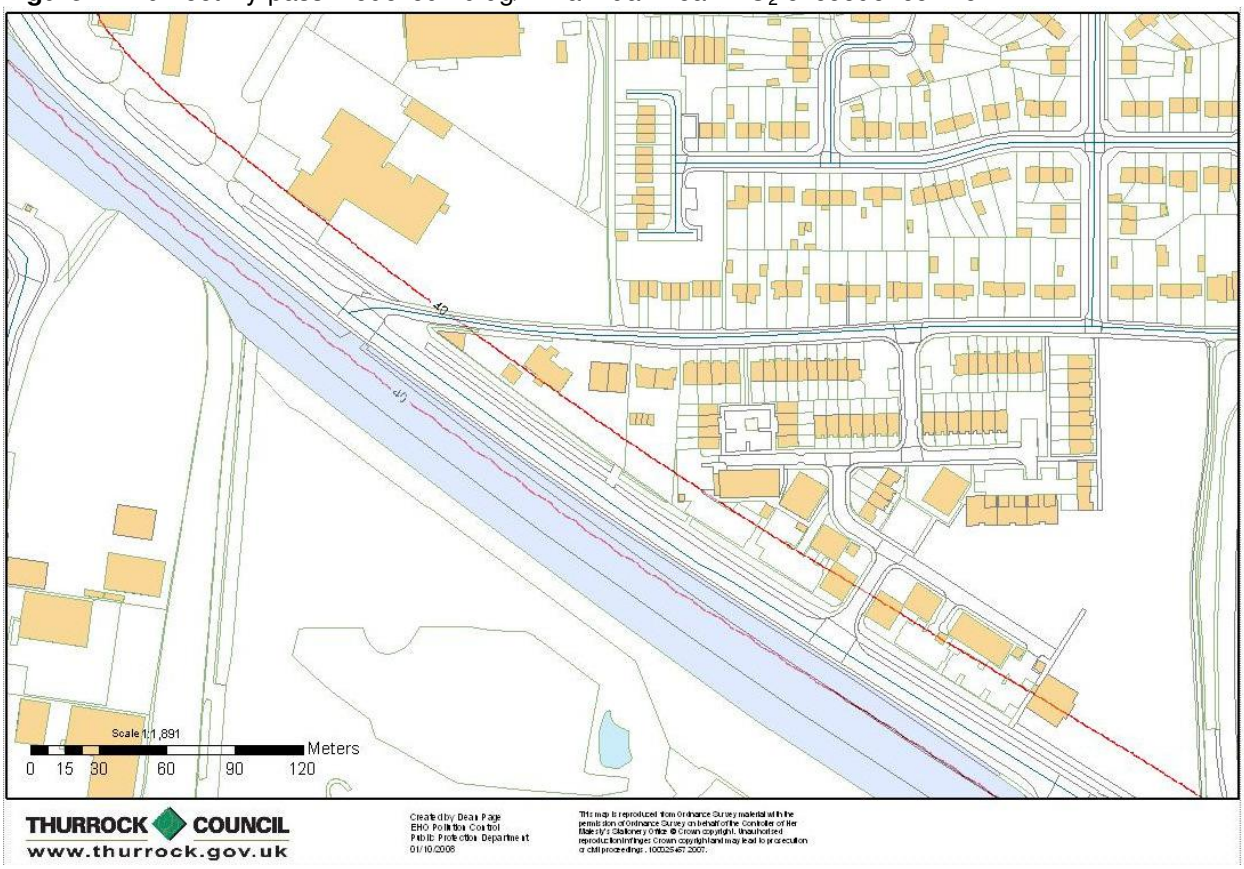


Figure 24 Purfleet By-pass Modelled 40 ug/m^{-3} annual mean NO_2 exceedence line



The exceedence line clearly runs through a number of properties most of which are residential. The main site at watts wood has a number of flats that fall inside this line. Based on this a new Air Quality Management Area will be required. The Boundary of the AQMA will be based on any façade which is inside this line and all of that property will be included within the AQMA not just the part which is inside the boundary.

4.3 Proposed AQMA's based on the Model Results

Based on the model results and constructed annual mean exceedence line for NO_2 the details for the proposed AQMA's in Aveley and along the Purfleet By-pass are shown below.

4.3.1 Proposed Boundary of the AQMA in Aveley

Figure 25 Proposed boundary of the new AQMA within Aveley

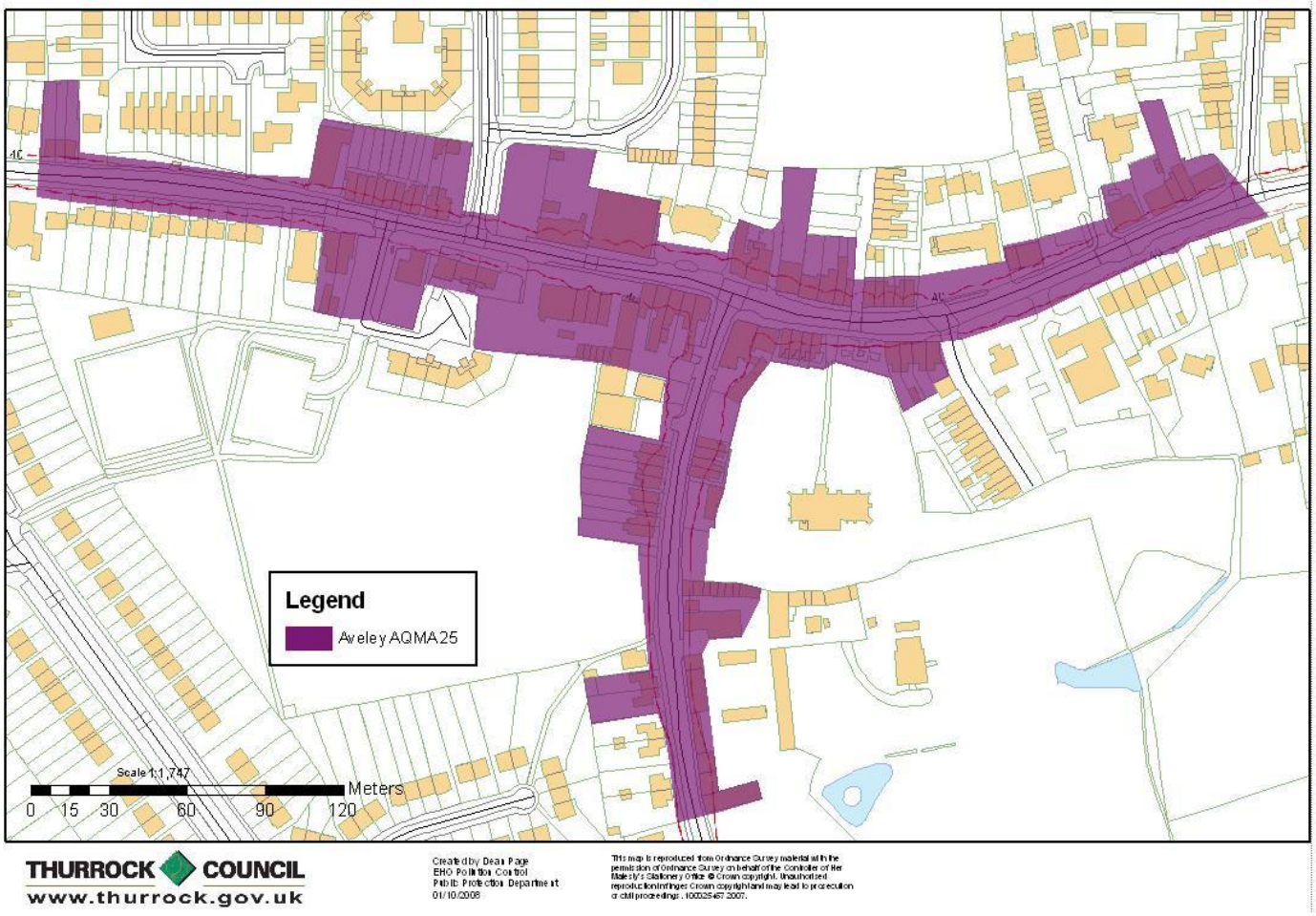


Figure 25 shows that there are a large number of residential or mixed-use residential / commercial properties which fall within the annual mean exceedence line for NO_2. All properties which fall inside this line have their property boundaries incorporated with the AQMA, and any properties adjoining them are included even if they fall just outside the exceedence line to keep the structure of the AQMA contiguous.

The total number off properties included within the AQMA totals 76 properties, off these approximately 61 of these are residential houses, the remaining 15 properties are mixed commercial residential. Of these properties only 66 of them fall inside the modelled exceedence line. However the 10 properties which are not within the exceedence line do sit very close to it, in most case they are within 1-2 metres outside it.

4.3.2 Proposed Boundary of the AQMA along the Purfleet By-pass

Figure 26 Proposed boundary of the new AQMA along the Purfleet By-pass

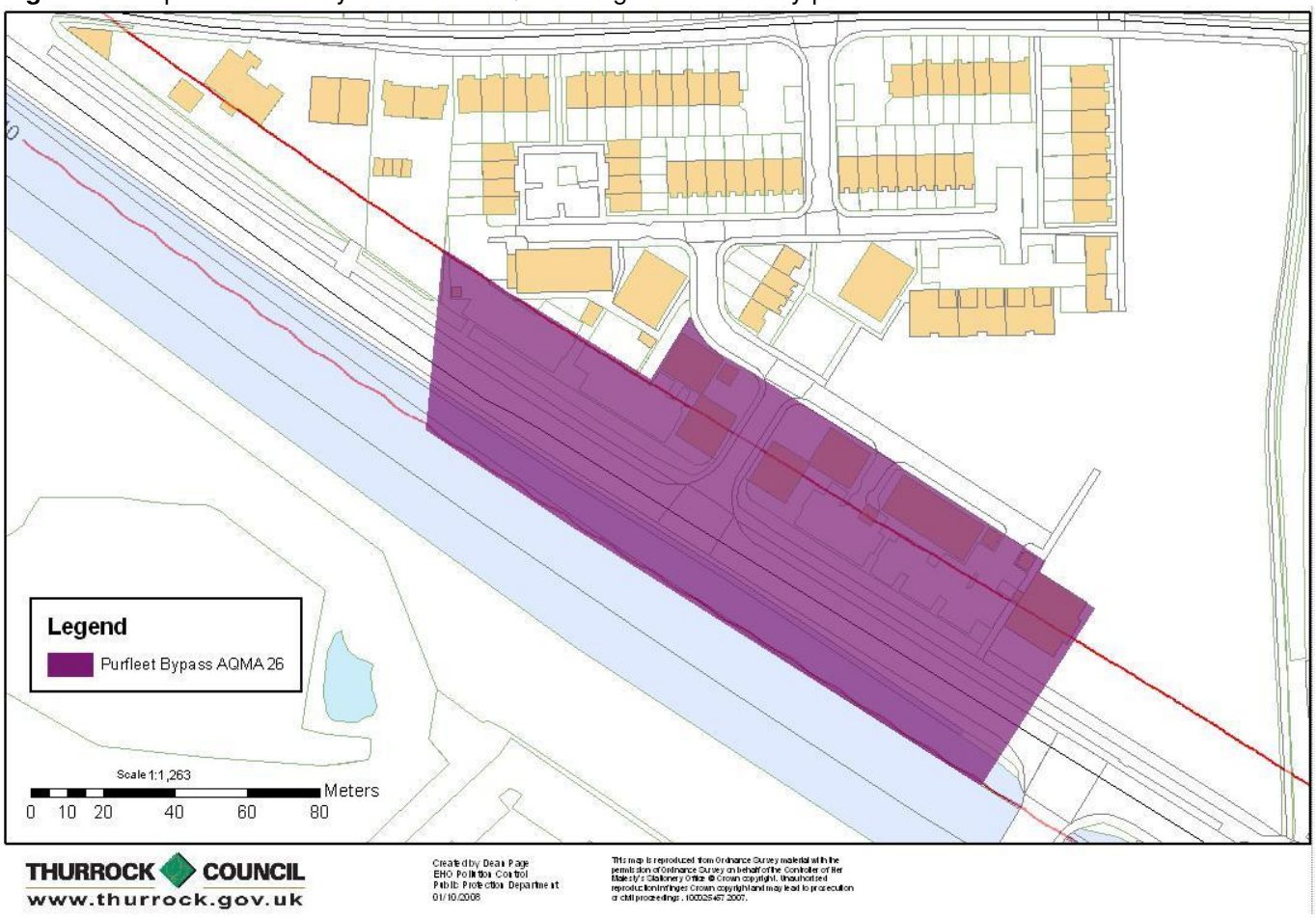


Figure 26 shows that there are three flats at watts wood that fall inside the annual mean exceedence line for NO_2, however some of these flats are adjoined to other flats which fall just outside the exceedence line. So it has been decided that these should be included within the new AQMA in order to have a more stream lined contiguous block for the AQMA. All the other buildings near to the Purfleet By-pass that fall inside the line are classified as non-residential and hence do not need to be included within an AQMA.

A total of 6 residential flats will be incorporated within the AQMA, these flats comprise of 2-3 stories high, so there are likely to be considerably more receptors than a standard residential house.

5 Conclusion

The diffusion tube monitoring results in Aveley and along the Purfleet By-pass still confirm that there is an exceedence of the annual mean air quality objective of 40 µg m^{-3} during 2013, however this alone was not proof that the objective was being breached at relevant receptors.

The air quality modelling results which have been verified against the monitoring data for 2013 confirm that there are areas along Aveley High Street / Aveley Ship Lane, Aveley which are above the annual mean air quality objective for NO_2. Also a small area along the Purfleet By-pass, Purfleet has been found to be above the annual mean air quality objective for NO_2.

Based on the model results the Council should declare an AQMA around the boundaries of any property which represents relevant public exposure which come into contact with the de-marketed exceedence line of 40 µg m^{-3} from the modelling results. Approximately 76 property boundaries will be incorporated into the new AQMA within Aveley. Of these only 66 properties fall inside the exceedence line, however the 10 other properties are very close to it within 1-2 metres for most of them.

Based on the model results the Council should declare an AQMA along the Purfleet By-pass, Purfleet. A total 6 properties and boundaries will be incorporated into new AQMA along the Purfleet By-pass, Purfleet, although only 3 of them fall within the exceedence line, the other 3 properties fall just outside the line but are adjoined to the properties which do fall inside the exceedence line.

6 Recommendations

- Undertake consultation on the findings arising from this report with statutory and other consultees as required

- Designate a new Air Quality Management Area (AQMA) along Aveley High Street / Aveley Ship Lane, Aveley, and designate a second AQMA along the Purfleet By-pass, Purfleet. *These are based on the modelled results from this report on the annual mean air quality objective of 40 µg m^{-3} for NO_2*

- Continue to monitor at all locations within Aveley and Purfleet.

- Produce an Air Quality Action Plan (AQAP) for NO_2 along Aveley High Street / Aveley Ship Lane, Aveley, and along the Purfleet By-pass, Purfleet.

- Possibly there may or may be a requirement to produce a Further Assessment for NO_2 for Aveley High Street / Aveley Ship Lane, Aveley, and along the Purfleet By-pass, Purfleet. *will confirm with Defra if this is required as a change in Local Air Quality Management (LAQM) regime is being proposed following a consultation exercise carried out by Defra in early 2014, with plans to remove the need to carry out a Further Assessment from Local Authorities. Any source apportionment work which would be carried out in a Further Assessment can be integrated into the new AQAP's if this is the case.*

7 References

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