Executive Summary

The 'Hereford City Air Quality Management Area' was declared along the A49 corridor in November 2001 because the pollutant nitrogen dioxide had been predicted by the Council to exceed the government's objective at about 115 roadside houses. Sampling in 2005 confirmed this to be the case and the target continues to be breached.

A 'Stage 4' report, completed by the Council in 2002, then undertook further modelling of nitrogen dioxide concentrations for 2005 within this designated Air Quality Management Area. A source apportionment exercise undertaken in this Stage 4 report concluded that HGVs on roads in Hereford were contributing disproportionately to nitrogen dioxide.

In accordance with statutory guidance and in an effort to improve the level of pollution, Herefordshire Council has therefore scoped 15 air quality actions in conjunction with the 'Herefordshire Air Quality Steering Group', which comprises relevant stakeholders.

This report is entitled 'The Hereford City Air Quality Action Plan'. It assesses these 15 actions and then models and evaluates their impact via a 'Further Assessment' exercise undertaken by consultants and included as an appendix to this report.

This report models the proposed actions and provided the actions are met on time shows that:

1. By 2010, the proposed actions should lead to a very significant decline in nitrogen dioxide concentrations when compared with 2005. This equates to a reduction in the number of houses at risk from elevated pollution from 115 to just 25. This is due to the reduction in both traffic flows and the percentage of HGVs.

2. By 2015, the number of houses at risk from elevated pollution should fall again, from 25 to only 6.

3. By 2025, the remaining 6 houses remaining at risk should fall further, to only one.

Defra (the government) appraised the draft of this report in 2007 and has accepted both its methodology and the science behind the modelling. Herefordshire Council therefore recommends that these 15 actions are implemented / continue to be implemented.

In addition, Herefordshire Council will:

- Maintain an Air Quality Management Area in Hereford until no houses are at risk from air pollution, reviewing the boundary regularly.

- Consider removing Holmer Road and Newtown Road from this Air Quality Management Area, due to a recent trend revealing that the air pollution here is reducing.

- Continue to monitor along the Whitecross Road corridor to determine how far the Air Quality Management Area should be extended along this corridor, following the increased pollution here.

The Council will regularly review and report back to the public, its members and Defra on the air quality impact of these 15 action plans via the Council's annual air quality reports.

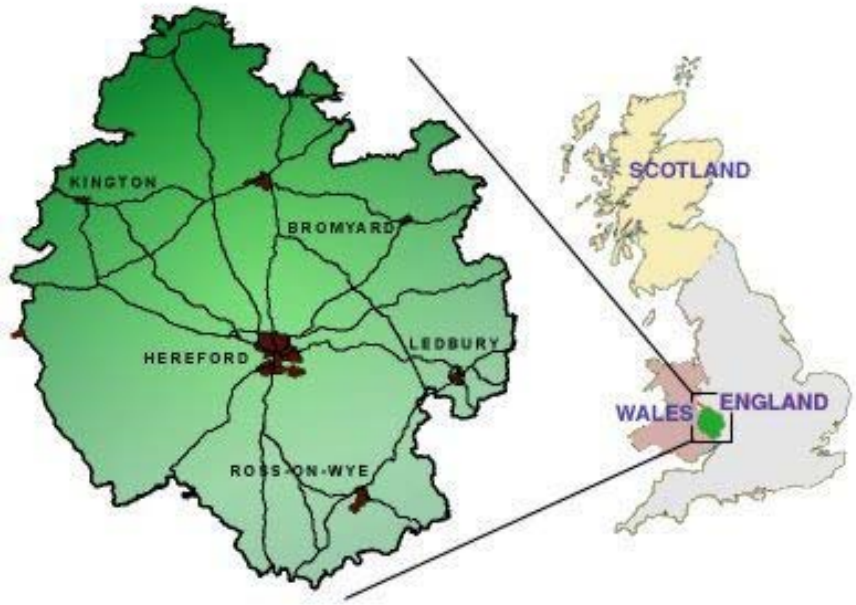
Contents Page

1. Introduction

The County of Herefordshire lies on the Welsh borders, being neighboured by the counties of Gloucestershire, Worcestershire, Shropshire, Powys and Gwent.

Like many principal county settlements in the UK, many of Herefordshire's main arterial roads lead into the centre of the City. However, unlike nearly all the UK's comparable cities, Hereford effectively only has one river crossing for this traffic and this has unfortunately led to elevated levels of traffic pollution in the city centre's A49 corridor and its feeder roads.

Hereford City lies approximately within the centre of the County, having a population of about 56,000 although this is increasing[9]. In addition to Hereford's own population, there are a number of large communities based in and around the villages surrounding Hereford that may commute in and out of the city on a daily basis for their employment, education and business needs. Latest 2004 estimates for these 'satellite' wards, project their population as an additional 30,000[9].



Map showing the central location of Hereford within the County and its location in the UK

The 2004 prediction therefore puts a population of about 86,000 living in or potentially commuting to Hereford, potentially on a daily basis. Of this figure, approximately one third live south of the river Wye[9] and this is significant because Hereford's central business district and main retail centres lie to the north of the river. As the City only has one effective bridge to carry traffic in from the south, it can be presumed that a significant proportion of the traffic will use the A49 to cross the Wye, which is the corridor designated as an air quality management area.

This is demonstrated by the high daily traffic flows along the populated area of Victoria Street (A49 north of the bridge), which have risen from 37,900 in 1999[4] to 44,822 in 2006[7] as reported in the successive air quality reports released since 1999 by Herefordshire Council.

2. The Air Quality Management Process

Herefordshire Council is required by the government to regularly review and assess the air quality across the entire county every three years, as part of the UK's 'National Air Quality Strategy' and its associated guidance[7].

Herefordshire has therefore been monitoring pollution for many years. This has comprised of nitrogen dioxide (NO_2) diffusion tube monitoring since 1993, the installation of a nitrogen dioxide continuous analyser in 1995 and the installation of a particulate (PM10) continuous analyser in 1997. During the first round of review and assessment, Herefordshire Council improved the standard of this monitoring by implementing various recommendations made by the Government (Defra) to ensure the accuracy and credibility of the data captured[7]. The nitrogen dioxide analyser was later upgraded in April 2007.

Since March 2000, approximately 50 nitrogen dioxide diffusion tubes have been placed around the county at various locations, 25 of these being in Hereford itself. The data from these tubes is adjusted for bias using a 'correction factor' calculated via triplicate tubes co-located beside the Hereford chemiluminescent analyser's inlet port. Herefordshire Council has tended to use these locally determined correction factors rather than the UWE's national factors and this has been historically accepted by Defra as being more locally accurate. Many of the diffusion tubes have now been relocated to more meaningful locations (house facades), which correspond to public exposure[7].

The 'Stage 2 Air Quality Assessment' for Herefordshire released in 2000 identified areas that required further assessment for nitrogen dioxide in Hereford. Defra agreed with this recommendation[4].

A 'Stage 3 Review and Assessment' was therefore completed in 2001, which involved detailed dispersion modelling around the selected Hereford hot spots to predict the areas of exceedance of the NO_2 objective. This report was used in conjunction with public consultation to delineate the areas most affected by the pollution. Defra agreed with the methodology and findings of this report[5].

The 'Hereford City Air Quality Management Area' (AQMA) was therefore declared in 2001. This area encompassed the housing adjacent to the A49 corridor, as measurement and modelling projected public exposure levels of pollution above the government's objective. This area contains about 160 or so houses, many of which are older Victorian housing stock and do not have front gardens. In 2005, 115 of these were still breaching the government's nitrogen dioxide annual mean objective. The facades of many of these houses are therefore within just a few metres of the kerb of the busy A49 Trunk Road. Herefordshire Council believe that there may therefore be about 500 people or so who live within Hereford's Air Quality Management Area and whose health may be affected by the elevated levels of pollution caused by traffic[6].

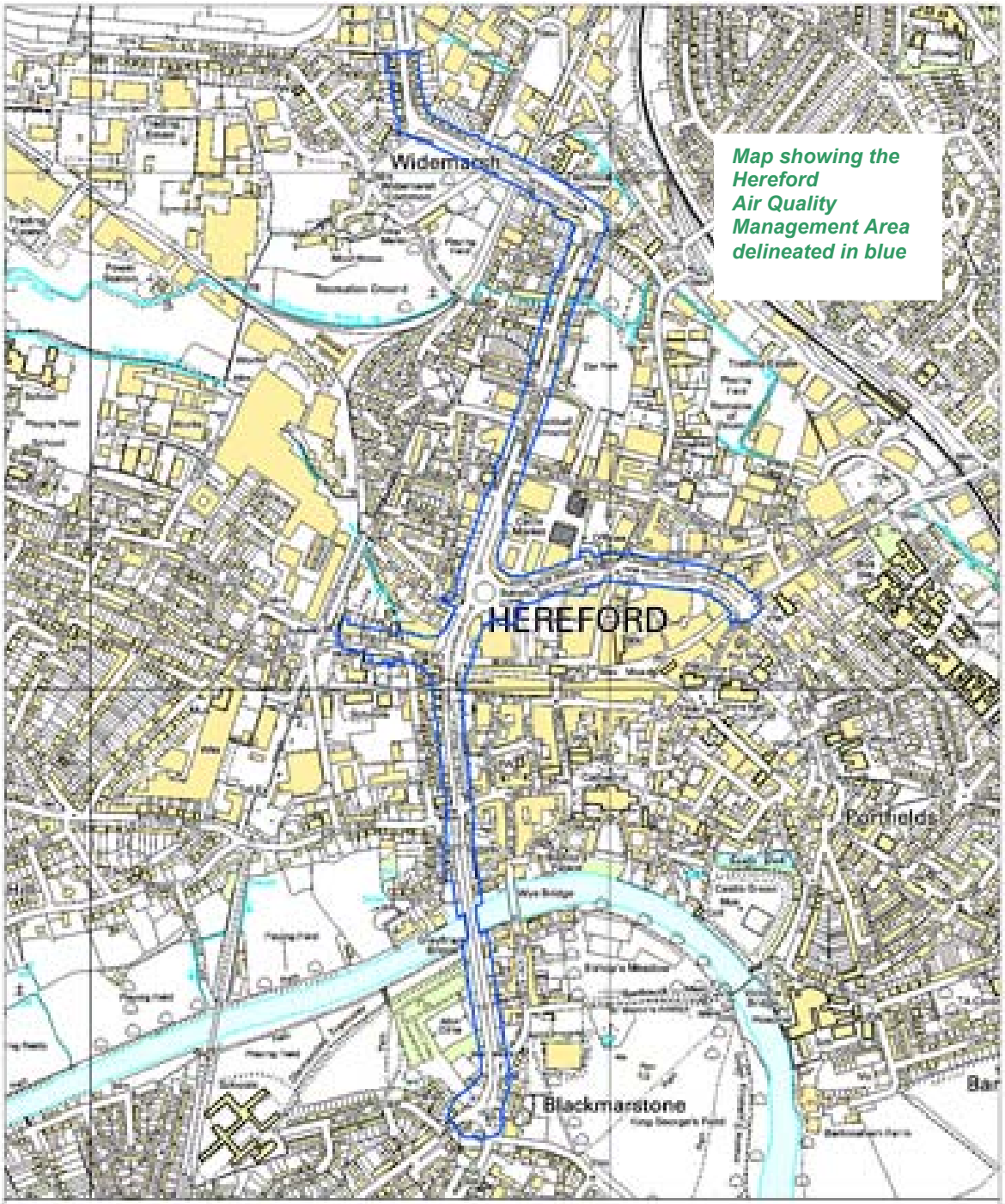
A Stage 4 report, completed in 2002, undertook further modelling of nitrogen dioxide (NO_2) concentrations within the designated AQMA for 2005. A brief source apportionment exercise within the report concluded that the HGVs on roads in central Hereford were contributing disproportionally to the concentrations of NO_2 – HGVs only accounting for less than 10% of the AADT, although they actually accounted for approximately 50% of the emissions. No changes to the AQMA were therefore recommended as a result of the Stage

4, as the area likely to be exceeding the annual average NO_2 objective was contained within the current AQMA. Defra accepted this report[6].

Since the release of this Stage 4 report, Herefordshire Council has been scoping the 'Hereford City Air Quality Action Plan' with the Herefordshire Air Quality Steering Group, which comprises relevant stakeholders.

During this period, the Council has also recommended various transport improvement proposals for the City via its Local Transport Plan for 2006/7 – 2010/11 (LTP2) [8]. This, combined with the outcome of the planning hearings relating to the Unitary Development Plan (UDP), has allowed Environmental Health & Trading Standards to scope various action planning proposals in a more meaningful and realistic way.

A recent study undertaken by a student assigned to the Council could not determine a direct correlation between poor health and the residents living within the A49 corridor / Hereford City Air Quality Management Area[13]. However, a variety of reasons may have contributed to this, such as the younger, healthier and more transient population residing in many of the houses along the A49, a number of these properties being rented out or owned by first time buyers.



Map showing the Hereford Air Quality Management Area delineated in blue

3. Why do we need an Action Plan and what must it achieve?

Herefordshire Council is required by section 84(1) of the Environment Act 1995 and its statutory guidance to formulate an 'Air Quality Action Plan' to aim to reduce the air pollution within the designated Hereford AQMA and to agree a timescale for this[1].

From 2002 onwards, the Council therefore considered as many as 42 potential improvements that would help reduce pollution and used these to screen and/or combine these actions down a much more manageable number. The majority of the reduction in the number of actions was achieved by merging various proposals under umbrella actions. In liaison with a number or stakeholders via the 'Herefordshire Air Quality Steering Group', the Council has therefore proposed 15 air quality actions.

The objective of this report is to propose these 15 actions and then appraise their impact on air quality in the City in a 'stand-alone' document designed to compliment the Local Transport Plan (LTP2) and the Unitary Development Plan (UDP).

In accordance with the technical guidance note LAQM PG(03), the best practice / requirements for this action planning report is explained in Table 1 below[1]:

Table 1: Action Planning Requirements from Statutory Guidance

Statutory Requirement	How this has been or will be achieved
Quantification of the source contributions to the predicted exceedances of the NO2 objective so that the action plans are effectively targeted.	This is undertaken in Netcen's 'Further Assessment' report, included as the appendix to the Action Plan.
Evidence that all available options have been considered on the grounds of cost effectiveness and feasibility.	The Herefordshire Air Quality Steering Group has scoped the 15 proposals offered in this report from 42 originally screened during the period 2002–05. The action plan takes into account the LTP2 and UDP recommendations and also takes account of the redevelopment of the Edgar Street Grid area.
How the Council will use its powers and also work in conjunction with other organisations in pursuit of the NO2 objective.	Many of the actions are the responsibility of the Council and are included in its LTP2. The Highways Agency also has joint responsibility for some actions and the Council is liaising with this organisation to ensure that this commitment is also met.
Clear timescales in which the Council and other organisations propose to implement the measures within its plan.	Timescales and responsibilities are included in the 15 action plan tables in Chapter 8 of this report.
Quantification of the expected impacts of the proposed measures and if possible an indication as to whether these measures will be sufficient to meet the NO2 objective.	This is undertaken in Netcen's 'Further Assessment' report, included as the appendix to the Action Plan.
How the Council intends to monitor and evaluate the effectiveness of the plan.	The action planning proposals and their impact will be evaluated by the continuing monitoring programme already in place and will be reported on via the Council's annual air quality progress reports.

The ‘Further Assessment’ which forms part of this report and which is mentioned in Table 1 above is required by statutory guidance to confirm the boundaries of identified areas of exceedance using the latest and most detailed input information available. It also provides source apportionment information to identify primary emission sources contributing to exceedances so that action planning measures can be targeted as well as test out the likely impact of potential action planning scenarios[1].

In order to undertake this ‘Further Assessment’ exercise, TPI Consultants were firstly appointed to project the future traffic flows and characteristics arising from these proposed air quality actions for the years 2010, 2015 and 2025, which were considered key to both the ‘National Air Quality Strategy’ and the Council’s Local Transport Plan (LTP2). The data derived from TPI’s model is given in Chapter 11 of this document.

Netcen Consultants were then appointed by Herefordshire Council to analyse this data and project the future air quality in Hereford arising from these proposed traffic predictions for the years 2010, 2015 and 2025. The methodology and data derived from Netcen’s model is given in the appendix of this document.

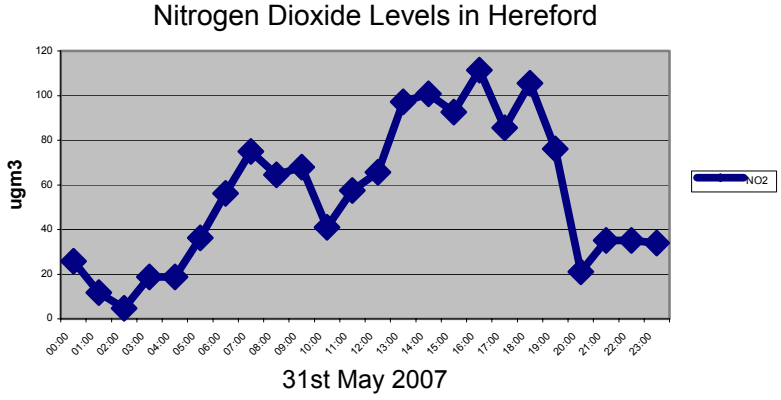
4. Where does the pollution come from?

4.1 The data from Herefordshire Council's monitoring station at the Edgar Street Roundabout clearly shows a direct link between traffic levels and pollution. From our research and data, it is clear that Herefordshire's air quality problem sites are predominantly related to traffic emissions[7].

Photograph showing the green enclosure on the Edgar Street Roundabout where pollution levels are continuously monitored

4.2 For example, pollution levels at the Edgar Street roadside enclosure can be seen to increase during rush-hour periods, school pick-up times, Christmas shopping weekends and during city centre road works, when congestion is worse. This correlation has been demonstrated during all stages of the review and assessment work undertaken by the Council and the reports published since 1999.

Graph showing the typical daily relationship between traffic levels and nitrogen dioxide at the Edgar Street Roundabout



4.3 Because Herefordshire Council recognises that the NO_2 pollution along the A49 corridor is linked to traffic, the action plan focuses only on traffic related issues and does not, for example, include those areas of pollution control work traditionally associated with environmental health departments and/or the work of the Environment Agency. Therefore, although the following list of environmental actions are ongoing and were originally included in the initial 42 actions considered, they have not been included in the final air quality plan.

- ‘Local Air Pollution Control’ and ‘Integrated Pollution Prevention and Control’ of industry by Herefordshire Council – The Council’s 2006 ‘Updating and Screening Assessment’ report[7] has found that the regulation of Part B and A2 industrial processes within the city is not significant in terms of the apportionment of nitrogen dioxide in the A49 corridor where the air quality management area has been declared.

- Integrated Pollution Prevention and Control (IPPC) by the Environment Agency – The Council’s 2006 ‘Updating and Screening Assessment’ report[7] has also found that the regulation of Hereford’s four Part A1 industrial processes within the city is not significant in terms of the nitrogen dioxide apportionment in the A49 corridor. These processes are Sun Valley Foods Ltd, Scottish Courage Ltd (Bulmers), Dalkia Utilities Ltd (Heat & Steam generation for Sun Valley and Bulmers) and Special metals Wiggins Ltd.

- Industrial Smoke Control via the Council’s enforcement of the Clean Air Act 1993 - The Council’s 2006 report[7] has also found that the regulation of dark smoke from industrial chimneys in Hereford is not significant in terms of the nitrogen dioxide apportionment in the A49 corridor.

- Domestic Smoke Control via the Council’s enforcement of the Clean Air Act 1993 - The Council’s 2006 report[7] does not find the absence of smoke control areas in Hereford relevant for the NO_2 objective along the A49 corridor.

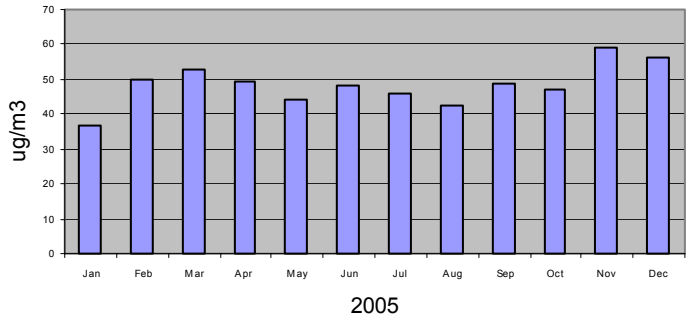
- Statutory nuisance via the Council’s enforcement of part III of the Environmental Protection Act 1990 – This is essentially a reactive power to be invoked in the case of smoke, dust, fume and smell nuisance complaints. The Council does not consider these to be relevant for the purposes of the action plan.

5. How much do pollution levels have to be reduced by?

5.1 The purpose of an air quality action plan is to help bring down air pollution in hot spot areas.

5.2 It is not just the occasional 'high pollution' day that can damage health, as it is thought that long term exposure to lower levels of pollution can also be harmful to health. This is relevant to Hereford as it is the annual 40ug/m^3 average NO_2 target that is being exceeded here, rather than the hourly 200ug/m^3 'acute' NO_2 target[7].

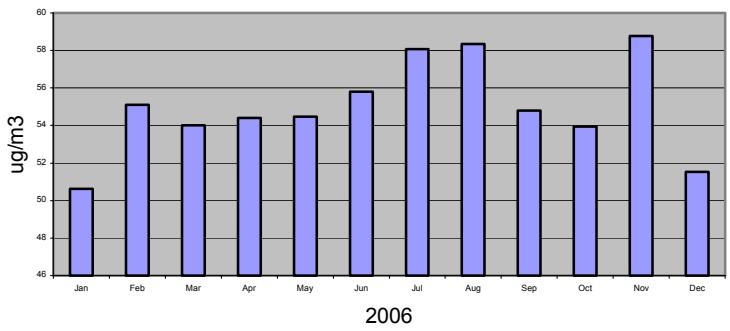
5.3 According to the 2005 set of data, we estimated that levels of NO_2 in Hereford's air quality management area would have to be reduced by about 15% (7 ugm^3) if the government target of 40 ugm^3 is to be achieved at the majority of houses closest to the A49 along Victoria Street[7].



Nitrogen Dioxide Pollution Levels at Edgar Street Roundabout in 2005

5.4 The 2006 Victoria Street data implies that this has worsened so that a significant 27% reduction (i.e. a drop of 15 ugm^3) would now be needed. However, it is believed that 2006's increase is likely to have been influenced by major road works on the A49's 'Asda roundabout' during the monitoring period, which would have almost certainly skewed the data. Other data, including 2007, implies that the reductions needed remain similar to that proposed in 2005, i.e. a reduction of between 3 and 7 ugm^3.

Nitrogen Dioxide Pollution Levels at Edgar Street Roundabout in 2006



5.5 As mentioned above in the previous chapters, this report therefore assesses the impact of the various 15 action plan measures on air quality to determine their effectiveness in meeting the necessary pollution reductions to meet the 40 ugm^3 target for annual nitrogen dioxide levels for roadside housing in Hereford.

6. What's being done already?

6.1 A number of policies are already in place which arguably should have some improvement on air quality in Hereford City.

6.2 National policies that might reduce NO_2 in Hereford include vehicle and fuel taxation, which attempt to reduce the emissions by reducing the rate of traffic growth. The government also provide grants through the 'Powershift' and the 'Cleanup' programme to fit pollution filters to buses and lorries or to promote less polluting vehicle technology, including LPG. These policies will hopefully bring some benefits, although much greater improvements could be achieved if stronger national policies were introduced to encourage smaller more fuel-efficient cars and to clean up the older car fleets[1].

6.3 There is a current trend for many diesel fleets to convert over to a blend of diesel and bio-fuel. A Hereford based company called Longma Fuels in Rotherwas currently meets this local demand and a number of council and other vehicles are being converted over to this fuel, as and when their warranties allow this. Such a move has obvious benefits in reducing their carbon footprint, although, from the point of view of nitrogen dioxide reduction, the implications of this are still largely unresearched. For the purposes of this report and the Netcen Further Assessment, the bio-fuel blend is presumed to generate similar levels of NOx pollution.

6.4 Local measures already in place are listed in the table under the next section. These include:

- Roman Road widening
- Parking Strategy
- Promotion of cycle routes
- City Centre pedestrianisation
- Behavioural change programmes
- Network management duty for the A49
- Vehicle emission testing
- Information and awareness raising

Vehicle emission testing in Hereford has found that vehicles are becoming more and more compliant as new vehicles tend to replace the older ones

6.4 The Herefordshire Air Quality Steering Group was set up in 1998 and comprises representatives from:

- Environmental Health & Trading Standards, Herefordshire Council
- Transportation, Herefordshire Council
- Forward Planning, Planning Services, Herefordshire Council
- Development Control, Planning Services, Herefordshire Council
- Environmental Sustainability Unit, Herefordshire Council
- Economic Development, Herefordshire Council
- Herefordshire Primary Care Trust
- Highway Agency
- Environment Agency

It meets to discuss the current levels and trends associated with pollution within Herefordshire and to agree action planning work.

This existence of the Herefordshire Air Quality Steering Group is considered to be 'best practice' by the technical guidance note LAQM $PG(03)_1$.

6.5 In addition to the Herefordshire Air Quality Steering Group, Herefordshire Council meets with the Highways Agency at 3 monthly intervals to discuss various matters relating to the county's trunk roads. Air quality has now been placed as a standing item on the agendas and therefore gives a regular opportunity to liaise on air quality matters relating to Hereford's A49 trunk road in the AQMA.

6.6 The Herefordshire & Worcestershire Pollution Group is a forum whereby Herefordshire Council can liaise with the Worcestershire councils. Through this initiative, a joint 'Air Quality Strategy for Herefordshire & Worcestershire' is currently being drawn up which will consolidate the various policies and data. The strategy is anticipated to be published in 2008.

7. Hereford City's Air Quality Action Plan Measures

7.1 The Council has scoped 15 proposed air quality actions from an original 42, in liaison with the multi discipline 'Herefordshire Air Quality Steering Group'. These 15 actions are listed below:

Table 2: Actions and their Target Dates

Number	Action	Target Date
1	Edgar Street Grid Redevelopment	2010, 2015 & 2025 in phases
2	Roman Road – Improvement of Road	2005 Signage in 2008
3	Rotherwas Access Road (1st Link) – New road connecting Rotherwas Industrial Estate with the A49 at Grafton	Summer 2008
4	New Outer Distributor Road (2nd Link) - New road connecting Grafton and the A465, although dates depending on LDF progress	Currently 2012 - 15
5	New Outer Distributor Road (3rd Link) - New road connecting the 1st and 2nd link roads with the city north of the river Wye, although dates depending on LDF progress	Scope route by 2010 and currently construct by 2011 - 16
6	'Hereford Intelligent Transport System' in Hereford	2010
7	Alteration of traffic management at the Belmont Roundabout	Nov 2006 & flows being reviewed
8	"North & South" Park and Ride Scheme in Hereford	North: 2009 - 10 South: 2011 onwards
9	Parking Strategy in Hereford to reduce commuter parking	2005 onwards
10	Improve and increase number of cycle routes and facilities in Hereford	2005 onwards
11	City Centre Pedestrian Enhancement in Hereford	In place
12	Behavioural Change Programme	2005 onwards
13	Designation of a Traffic Manager for Network Management Duties along the A49 in Hereford	In place
14	Continue to implement Vehicle Emission Testing in Hereford	In place
15	Information and awareness raising	2007/8

8. Assessment of Options

8.1 In accordance with the NSCA's guidance note entitled "Air Quality: Planning for Action"[2], the 15 actions listed in table 2 in the preceding section are expanded upon in tables 3 to 17 overleaf.

8.2 These tables individually assess each proposed measure against the various screening and scoping factors suggested in the guidance note, together with their impact on Herefordshire Council's 'Corporate Plan' and Herefordshire Partnership's 'Herefordshire Plan'.

8.3 The table also defines the responsibility for each action and the timeframe for its implementation. Where appropriate, the tables also indicate which of the three agreed dates (i.e. 2010, 2015 or 2025) that Netcen were to model the impact of the action plan to.

8.4 Where at all possible the cost of the action is given. Where this is not feasible, its cost is categorised as "low", "medium" or "high", which assisted the scoping exercise.

Table 3:

Action Number: 1	**Edgar Street Grid Redevelopment** (Modelled to 2010, 2015 & 2025 in phases)
Action	• Relocate Hereford's livestock market (and therefore its traffic) to an out of town location near Stretton Sugwas and replace with a 'retail quarter' development yet to be determined. • Downgrade inner ring road (New Market St & Blue School St). • Construct new A49/Commercial Road link road, linking Station Approach with Edgar St to compensate for the downgrading of part of the existing inner relief road. • Redevelop / reopen Hereford's canal basin • After the first development phase of the retail quarter and the link road, to potentially develop a 'grid' of mixed civic, commercial and housing land uses within the city centre 43 hectare 'Edgar Street Grid' area. It is proposed that this might include up to 1000 new homes, 26000m^3 of new office space, 9000m^3 of new retail/leisure space, 6000m^3 of new mixed use development, 4000 permanent new jobs • Possible relocation of buses from the city centre Tesco bus station • Enhanced network for pedestrians and cyclists
Responsibility	Herefordshire Council has considered several sites and has now agreed to relocate the existing cattle market to a location near to Wyevale Garden Centre near Stretton Sugwas, off the improved Roman Road. Herefordshire Council and Advantage West Midlands have formed a joint venture company called 'Edgar Street Grid Herefordshire Ltd' to oversee the development and the implementation of the Grid.
Other Environmental Effects	• Livestock market relocation will reduce traffic in city centre on market days, but may displace traffic. • Downgrading of the Newmarket and Blueschool Streets (part of the existing inner relief road) will displace traffic further out of the city centre via a new road linking Commercial Road with Edgar Street. • Redevelopment of retail/commercial/residential land uses will have to consider traffic generation and air quality issues. • Facades of any new residential development adjacent to the A49 should be scoped to be outside of the AQMA's boundary.
Council's Corporate Plan 2007 - 2010	• Should secure the essential infrastructure for a successful economy • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision • Cleaner, greener communities
Cost to Implement	Unknown – likely to be mostly developer funded as a result of brownfield site redevelopment and land acquisition
Time Needed to Implement	Relocation of market needs to be implemented first. This is a '20 year vision'. Probable 2009 for the market relocation and then subsequent 2010 – 2025 redevelopment of Edgar Street Grid. Retail Quarter likely to be constructed first, possibly in period 2010 - 2013.
Possible Public Perceptions	If new development is publicly favoured and the new livestock market site has the support of the local and agricultural community, perception should be good. Development should therefore embrace traffic congestion issues, poor strategic infrastructure, the lack of high quality leisure facilities and

	should aim to strengthen city centre retail. Effective public and stakeholder consultation , particularly for displaced businesses to be encouraged.
Practicality and Applicability	Parts of Hereford fall in 'Advantage West Midland's rural Regeneration Zone' and within the West Midlands Objective 2 area. Much of the land already owned by the Council, making redevelopment probable.
Action to Reduce Negative Perceptions	Needs to be politically acceptable and favoured and needs to compliment the UDP. Environmental mitigation / sustainability will need to be presented as a major part of the scheme. Consult public, businesses and other stakeholders at every stage.
Is it Included in the LTP?	Mentioned in the LTP and fully integrated into the UDP
Impact modelled?	Yes – AADTs, HGV% and speeds have been predicted for the new and existing roads after development. The approximate route of a new link road was also used in the model. Data for modelling was available via traffic models commissioned by Herefordshire Council, called the "Vissim Model" and the "Saturn Model". Traffic and air quality have therefore been modelled and predicted for the key years of 2010, 2015 & 2025 in Netcen's 'Further Assessment' which forms part of this action plan report.
Evaluation of Action?	Yes, via various city centre diffusion tubes and via future traffic flow (AADT) trends. New monitoring sites established in ESG area to benchmark future impact.

Table 4:

Action Number: 2	**Roman Road – Improvement of Road** (In place by 2005)
Action	• Improvement of existing A4103 road west of Hereford between Three Elms and Stretton Sugwas. Widening of road to two lanes with roundabout access at west end to link to A438 'Brecon Road'. • To include a cycle lane for entire length • To improve the current signage associated with the A4103 Roman Road to allow the route to be fully utilised for through traffic.
Responsibility	Herefordshire Council was granted Planning consent in 2003. Project managed and funded by the Highways and Transportation Service of Herefordshire Council.
Other Environmental Effects	• Required significant land-take either side of widened road. • Potential loss of wildlife habitat and disruption of archaeological roman road site. • May increase CO2 and other emissions in immediate vicinity. • Increase in noise levels, especially to a few adjacent properties. • Light intrusion if illuminated. • Anticipate this widening scheme will upgrade the road to a level that it may encourage re-routing of east-west through-traffic and thus avoid the city centre and AQMA.
Council's Corporate Plan 2007 - 2010	• Should secure the essential infrastructure for a successful economy • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision • Fewer accidents • Reduce health inequalities and promote healthy life styles
Cost to Implement	High
Time Needed to Implement	Road improvements completed summer 2005. Signposting of route in 2008.
Possible Public Perceptions	Positive perception regarding economic development and employment. Some negative perceptions from communities on proposed route and from environmental NGOs.
Practicality and Applicability	Road already granted planning consent and completed. Road junctions at either end still need signposting for it to be used as a northern east-west bypass.
Action to Reduce Negative Perceptions	Improvement of local economy. Improve cycling along existing route. Road was constructed having regard to full environmental mitigations approved in the application.
Is it Included in the LTP?	Yes – included in last LTP Annual Report
Impact to be modelled?	No – already in place. Impact being reviewed by nearby diffusion tube results.
Evaluation of Action?	Yes, via 2 diffusion tubes (by Roman Road and Three Elms and via future traffic flow (AADT) trends

Table 5:

Action Number 3	**New Rotherwas Access Road** (1st Link of an 'Outer Distributor Road')
Action	New Rotherwas Access Road, connecting A49 Ross Road at Grafton, to Rotherwas Industrial Estate. This will take HGVs and some other traffic off the traffic lights on the A49 Ross Road and the B4339 Holme Lacy Road. This road should form the first link of an outer distributor road (see actions 4 and 5 below).
Responsibility	This road scheme was granted planning consent in 2003. The Highways and Transportation Service of the Council led the funding efforts for this.
Other Environmental Effects	• May require significant land-take and loss of visual amenity. • Potential loss of wildlife habitat. • May increase CO2 and other emissions. • May increase noise levels, especially to a few remote rural properties. • Light intrusion if illuminated. • Anticipate reduction in NO2 at Holme Lacy Road and Ross Road junction, which is currently at full capacity.
Council's Corporate Plan 2007 - 2010	• Should secure the essential infrastructure for a successful economy • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• More and better paid employment • Reduced traffic congestion through better integrated transport provision • Fewer accidents – reducing traffic on busy Holme Lacy Road
Cost to Implement	High – about £12.6m, £9.5m of this being funded by Advantage West Midlands
Time Needed to Implement	Planning consent already granted and the route CPO'd. Construction commenced in spring 2007 with planned completion set for summer 2008.
Possible Public Perceptions	• Local economy to industrial estate will improve. • Does not encourage modal shift to public transport, but it will help travel plans and traffic calming/cycle routes into Rotherwas along the Holme Lacy Road. • Positive perception regards economic development and employment. • Some negative perceptions from communities on proposed route and from environmental NGOs. • This road will counter the concerns of the Highway Agency in relation to the Ross Road/Holme lacy Road junction being at capacity and should therefore address their objections to increased industrial development of the estate. • The Rotherwas Access Road will provide an alternative route avoiding the low railway bridge, which should also encourage economic growth of the estate.

Practicality and Applicability	Planning consent already granted in 2003. Compulsory purchasing (CPOs) completed in 2004. Under construction at time of updating this report.
Action to Reduce Negative Perceptions	• Road will be constructed having regard to the full environmental mitigations approved in the application and its EIA. • Improvement of local economy and bettering of the environment of the existing access along Holme Lacy Road which is heavily populated. • Improve cycling along existing route and may encourage city wide modal shift.
Is it Included in the LTP?	Yes
Impact to be modelled?	Yes - it might encourage limited modal shift from cars, as cycling should become more attractive along the Holme Lacy Road once the HGV % of this road reduces. Traffic and air quality have therefore been modelled and predicted for the key year of 2010 in Netcen's 'Further Assessment' which forms part of this action plan report.
Evaluation of Action?	Yes, via diffusion tube at Holme Lacy/A49 junction and comparison with background NO2 determined in 2001-2003 study and via future traffic flow (AADT) trends

Table 6:

Action Number 4:	**New Outer Distributor Road – 2nd Link** (2nd link of an 'Outer Distributor Road')
Action	Construction of the 2nd link of a new 'outer distributor road' around Hereford. Unknown route, but presumed to link the proposed Rotherwas Access Road (Air Quality Action No. 3) at the A49 Grafton end with the A465 Abergavenny Road. Route to be located away from housing and therefore not imposing new air quality issues on existing housing.
Responsibility	Highways and Transportation Service of Herefordshire Council
Other Environmental Effects	• Would require significant land-take and could lead to loss of visual amenity. • Potential loss of wildlife habitat. • Could increase CO2 and other emissions. • Could increase noise levels, especially to a few remote rural properties. • Potential light intrusion if illuminated. • Anticipate reduction in NO2 in southern part Hereford city and the AQMA in vicinity of ASDA.
Council's Corporate Plan 2007 - 2010	• Should secure the essential infrastructure for a successful economy • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• More and better paid employment • Reduced traffic congestion through better integrated transport provision
Cost to Implement	High. No current funding secured.
Time Needed to Implement	Presuming that funding can be secured, completion targeted at 2012 - 2015.
Possible Public Perceptions	• Positive perception regarding economic development and employment as it links the A465 traffic from the west and from Belmont with the Rotherwas Industrial Estate, bypassing the City. • Should significantly improve air quality by reducing pressure on the southern end of the AQMA, as traffic on the Belmont (Asda) roundabout should reduce. • Negative perceptions from communities on proposed route and from environmental NGOs.
Practicality and Applicability	A planning application would have to be made following consultation on the exact route. LTP2 shows approx route.
Action to Reduce Negative Perceptions	• Road would have to be constructed having regard to full environmental mitigations to be proposed in a planning application and its EIA. • Improvement of local economy and bettering of the environment of the existing A465 city centre corridor which is heavily populated. • Good landscaping required. • Improve cycling along proposed route.
Is it in LTP?	Yes
Impact to be modelled?	Yes – revised AADTs and HGV% were used for the AQMA corridor. Unknown exact route, so modelled to presume any new road is remote to housing. Traffic and air quality have therefore been modelled and predicted for the key year of 2015 in Netcen's 'Further Assessment' which forms part of this action plan report.
Evaluation of Action?	Yes, via diffusion tubes and via future traffic flow (AADT) trends

Table 7:

Action Number 5:	**New Outer Distributor Road – 3rd Link** (3rd link of an 'Outer Distributor Road')
Action	Completion of the 3rd link of a new 'outer distributor road' around Hereford. Unknown route, but proposed to link the new Rotherwas Access Road (Air Quality Action No. 3) and the new 2nd Link of the outer distributor road (Action 4) to the road infrastructure north of the City. Route not determined and could cross the Wye either east or west of the city. The road would be located away from housing and therefore would not impose new air quality issues on existing housing.
Responsibility	Highways and Transportation Service of Herefordshire Council
Other Environmental Effects	• Requires significant land-take and could lead to loss of visual amenity. • Potential loss of wildlife habitat. • Could increase CO2 and other emissions. • Could increase noise levels, especially to a few remote rural properties. • Potential light intrusion if illuminated. • Anticipate significant improvement of air quality in Hereford city centre and its AQMA.
Council's Corporate Plan	• Should secure the essential infrastructure for a successful economy • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• More and better paid employment • Reduced traffic congestion through better integrated transport provision
Cost	High. No current funding secured.
Time Needed to Implement	During the LTP2 period of 2006–11 it is proposed that a detailed assessment is undertaken in order to secure planning approval and identify sources of funding. Currently anticipate scoping route by 2010 and constructing road by 2011-2016. An investigation of the route options will be required to inform the LDF core strategy, which is due in Nov 2009.
Possible Public Perceptions	• Positive perception regarding economic development and employment as would link the north and south of the city via a new river crossing and for the first time it would also enable the bypassing of the city centre by through-traffic and by traffic seeking an orbital route. • Should improve air quality by reducing pressure on the entire AQMA, although it will also generate (and may increase) traffic elsewhere. • Negative perceptions from communities on proposed route and from environmental NGOs.
Practicality and Applicability	A planning application would have to be made following a detailed assessment during the LTP2 period of the various routes.
Action to Reduce Negative Perceptions	• Consultation with the public and stakeholders over preferred route. • Road would have to be constructed having regard to full environmental mitigations to be proposed in any planning application and its EIA. • Improvement of local economy and bettering of the environment of the existing city centre AQMA corridor which is heavily populated. • Good landscaping required. • Improve cycling along proposed route.
Is it Included in the LTP?	Yes – LTP2 proposes that a detailed assessment should be undertaken in order to secure planning approval and identify sources of funding.
Impact to be modelled?	Yes – revised AADTs and HGV% were used for the AQMA corridor. Unknown exact route, so model presumed any new road is remote to housing. Traffic and air quality have therefore been modelled and predicted for the key year of 2025 in Netcen's 'Further Assessment'.
Evaluation?	Yes, via diffusion tubes and via future traffic flow (AADT) trends

Table 8:

Action Number 6:	**Install and implement a new 'Hereford Intelligent Transport System' (HITS) on the A49 route and its feeder roads in Hereford**
Action	Development of the 'Hereford Intelligent Transport System' (HITS) to increase effective capacity of the road network, improve public transport and proactively manage demand and control of traffic. To be achieved by: • Urban traffic control – traffic lights to consider flows and prioritise accordingly • Bus priority – traffic signals to give priority to public transport and therefore speed up journey times • Traffic and traveller information – real time signage to prevent congestion and gridlocking • Car park guidance – real time signage to pin point available parking spaces in city
Responsibility	Partnership working of the Highway Agency (for A49's 5 junctions) and the Highways and Transportation Service of Herefordshire Council (for the remaining 8 feeder road junctions).
Environmental Effects	Reduce pollution, congestion and hopefully noise by altering AADT flows and by smoothing out start/accelerate/decelerate driving. HITS can ultimately also be used to restrict traffic entering the City at times of congestion, thus reducing impact of high pollution episodes.
Corporate Plan	Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision • Fewer accidents
Cost to Implement	Medium (less than £5million). Scoot system upgraded for less than £100,000 in 2005.
Time Needed to Implement	Scoot system already upgraded since 2005. Funding for the 'HITS' will be bid for in the LTP2 period and will hopefully be in place by 2010.
Possible Public Perceptions	Improved road safety and smoothing of traffic flows.
Practicality and Applicability	Applicable on the A49 AQMA corridor in Hereford where congestion during peak times is the norm and traffic gridlocks when route blocked due to lack of alternative routes. Highway Agency and major bus operators need to work in partnership. Must take into account the Edgar Street Grid implications (Air Quality Action No.1)
Action to Reduce Negative Perceptions	Other than probable Council funded expenditure on a Highway Agency road, no negative perceptions are anticipated. Need to emphasise non air quality benefits, e.g. lower congestion, improved safety and quality of life for residents.
Is it in LTP?	Yes
Impact to be modelled?	Yes – revised speeds were needed for the AQMA area. Possible modal shift to buses were also modelled by revised AADT if buses become more popular as a result. In absence of specific projected data, the LTP percentage reductions were used, i.e.: • 10 – 40% reduction in traffic delays • 30 % reduction in time taken to find parking spaces • 20-30% reduction in delays to public transport Traffic and air quality have therefore been modelled and predicted for the key year of 2010 in Netcen's 'Further Assessment' which forms part of this report. Once all Air Quality Actions have been instigated, if necessary HITS can then be adjusted / remodelled to reduce the pollution plot so that no houses will be projected to fall within the 40$\mu g/m^3$ nitrogen dioxide contour.
Evaluation of Action?	Yes, via city centre diffusion tubes and the Edgar Street Monitoring Station.

Table 9:

Action Number 7:	**Alteration of traffic management at the Belmont ('Asda') Roundabout**
Action	• Alteration of traffic management at the Belmont Roundabout by the new Asda Superstore, to include traffic signals and alterations to the roundabout size/markings etc. • Inclusion of these roundabout signals within the HITS mentioned above under Air Quality Action No. 6.
Responsibility	Highway Agency
Other Environmental Effects	Congestion during construction phase. Braking and acceleration noise may increase by roundabout.
Council's Corporate Plan 2007 - 2010	Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision • Fewer accidents
Cost to Implement	Medium – Private investment from ASDA as implemented via a planning agreement for the development of the adjacent ASDA superstore.
Time Needed to Implement	Implemented. This coincided with the ASDA superstore construction. Works started in Oct 2005 and were completed by November 2006.
Possible Public Perceptions	Traffic congestion because of lengthy road works encouraged major criticisms. May reduce congestion and traffic pollution if traffic moves more fluently, but this may be countered by increased AADT resulting from Asda superstore opening. Welcomed by many residents along Ross Road, but possibly less by those along Belmont Road who previously benefited from a better priority of the present roundabout.
Practicality and Applicability	Part of a wider integrated transport policy. Planning approval given and now project completed. Impact still being reviewed.
Action to Reduce Negative Perceptions	Emphasise overall improvement in emissions as traffic smoothed out.
Is it Included in LTP?	No.
Impact to be modelled?	Yes – queuing times and speed now different at this roundabout. Revised Highway Agency data was modelled. Traffic and air quality have therefore been modelled and predicted for the key year of 2010 in Netcen's 'Further Assessment' which forms part of this action plan report.
Evaluation of Action?	Yes, via 2 diffusion tubes at Belmont Roundabout.

Table 10:

Action Number 8:	**Implement a "North & South" Park and Ride Scheme for Hereford**
Action	Currently implemented at two sites for Saturdays at Christmas since December 2001. Owen Williams's consultants have undertaken a feasibility study for Park and Ride permanent schemes for Hereford, HC now has permission to proceed to Planning Permission and Detailed Design stage for the North Site, with the intention of completion within LTP2. The south site is also scheduled for development and completion within LTP2.
Responsibility	Highways and Transportation Service of Herefordshire Council.
Other Environmental Effects	Will reduce car travel into city centre if priced correctly and advertised well. Should lead to reduced congestion, lower emissions / noise and improve road safety.
Council's Corporate Plan 2007 - 2010	• Should help protect the environment • Should secure the essential infrastructure for a successful economy • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision • Cleaner, greener communities • Fewer accidents • Reduce health inequalities and promote healthy life styles
Cost to Implement	£1million guide price for each of the sites.
Time Needed to Implement	Christmas Park and Ride already implemented. Provision of North site is scheduled for delivery between 2009 and 2010, and the South site to follow after this – aim for 2011 onwards.
Possible Public Perceptions	The public expect such a service if congestion is bad. They also expect to pay for the service, but less than car parking in town and they expect the service to be as efficient as travelling by car all the way into Hereford City Centre. Seen as a good idea for *'everyone else*' and allowing more road capacity for them driving into town. May promote Hereford as a shopping centre. Will assist non motorists such as low income groups, young persons and the elderly if they can get to pick up point. Also for cyclists. Should benefit city centre retail.
Practicality and Applicability	Practical and applicable for Hereford only, from at least two points north and south of river. Needs to be integrated to other actions / improvements such as reduced parking in the City Centre and bus priority measures, pedestrianisation and the Edgar Street Grid.
Action to Reduce Negative Perceptions	Emphasise and publicise park & ride schemes. Reasonable fare, clean, frequent and reliable service needed.
Is it Included in LTP?	Yes.
Impact to be modelled?	Yes – before and after AADTs along A49 corridor / AQMA were modelled, based on forecast of turnover and spaces likely to be filled on buses. Traffic and air quality have therefore been modelled and predicted in Netcen's 'Further Assessment' for the key years of 2010 for the north site and 2015 for the south site.
Evaluation of Action?	Yes, via city centre diffusion tubes and via future traffic flows and HGV % (AADT) trends

Table 11:

Action Number 9:	**Continue to Implement the Parking Strategy in Hereford to reduce commuter parking**
Action	• Zonal charging system to deter long stay parking in the central area. • Commitment to consider on-street charges to help fund park and ride (Air Quality Action No. 8). • Reduced parking for new development in the City Centre, imposed through planning consents as directed by PPGs 3, 6 and 13. • New business and commuter pass initiative for Council employees.
Responsibility	Herefordshire Council - Highways and Transportation Service and Planning Services
Other Environmental Effects	May encourage modal shift to public transport, if public transport action is integrated and linked. Reduced emissions and noise.
Council's Corporate Plan 2007 - 2010	• Should help protect the environment • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision • Cleaner, greener communities • Fewer accidents • Reduce health inequalities and promote healthy life styles
Cost to Implement	Low
Time Needed to Implement	Commenced in 2001 and continuing. Planning conditions reinforcing this for new city centre developments.
Possible Public Perceptions	Negative as reduction in long stay spaces and increased enforcement by attendants. More taxes. Unfair for employees without parking spaces. Perceived penalising of car users and unfair benefit to private car park owners and bus operators. Need to ensure disability drivers are not adversely affected.
Practicality and Applicability	Applicable in city centre only.
Action to Reduce Negative Perceptions	Need to emphasise environmental and congestion gains and offer a good public transport alternative. The business and commuter pass initiative for Council employees was implemented in May 2007.
Is it Included it LTP?	Yes. Also in UDP.
Impact to be modelled?	Yes – before and after AADTs based on predicted modal shift from cars to buses, walking or cycling. Traffic and air quality have therefore been modelled and predicted in Netcen's 'Further Assessment' for the key years of 2010, 2015 and 2025 which forms part of this action plan report.
Evaluation of Action?	Yes, via city centre diffusion tubes and via future traffic flows (AADT)

Table 12:

Action Number 10:	**Improve and increase number of cycle routes and facilities in Hereford**
Action	Improve and increase the number of cycle routes in Hereford, to encourage motorists to transfer to cycling as their commuter/shopper/leisure trip travel mode. Herefordshire Council aim to deliver at least one new cycling scheme and one new cycle parking facility per year.
Responsibility	Highways and Transportation Service of Herefordshire Council.
Other Environmental Effects	Improves overall city environment through reduced noise, emissions and congestion. Improved visual amenity.
Council's Corporate Plan 2007 - 2010	• Should help protect the environment • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision • Cleaner, greener communities • Fewer accidents • Reduce health inequalities and promote healthy life styles
Cost to Implement	Medium
Time Needed to Implement	Already being implemented. Since 2004 there has been a 19% increase in cycling, which is encouraging.
Possible Public Perceptions	Encourages improved health and fitness. More social interaction, more socially inclusive. Reduced cost for cycle commuters. Facilities for cyclists needed. Council spending too much tax payers money on non-effective measures. Too expensive for limited return. Negative perception on personal safety, cyclists on their pavements and cyclists jumping red lights. Reduced congestion.
Practicality and Applicability	It is always practicable but limited by cost and perceived negative perception for motorists' road space. 8.9% of the population of Hereford City currently cycle to work.
Action to Reduce Negative Perceptions	Disseminate information relating to successful schemes. Highlight funding sources, secure partnership funding where applicable. Marketing campaign.
Is it Included it LTP?	Yes.
Impact to be modelled?	Yes – a before and after AADT was determined for the AQMA / A49 due to modal shift. Traffic and air quality have therefore been modelled and predicted in Netcen's 'Further Assessment' for the key years of 2010, 2015 and 2025 which forms part of this action plan report.
Evaluation of Action?	Yes, via city centre diffusion tubes and via future traffic flows (AADT)

Table 13:

Action Number 11:	**City Centre Pedestrian Enhancement**
Action	• Experimental 10.30 am – 4.30 pm pedestrianisation of Widemarsh Street and High Street in the city centre shopping area during 2nd half of 2005, followed up with permanent pedestrianisation. • Additional pedestrian improvements to be incorporated in High Town, including refurbishment / paving of Widemarsh Street south of ring road, to dissuade usage as rat run.
Responsibility	Highways and Transportation Service of Herefordshire Council.
Other Environmental Effects	This prevents the city centre shopping streets being used as an alternative 'rat-run' route across the River Wye 24 hours/day. Improves overall city shopping environment through reduced noise emissions and congestion. Improved visual amenity. Improved road safety for shopping pedestrians. Possible negative effect on AQMA if displaced traffic causes increased congestion of A49 corridor.
Council's Corporate Plan 2007 - 2010	• Should help protect the environment • Should secure the essential infrastructure for a successful economy
Community Strategy for Herefordshire	• Cleaner, greener communities • Fewer accidents • Reduce health inequalities and promote healthy life styles
Cost to Implement	Medium.
Time Needed to Implement	Trial was in place in 2005/6 and finalised in 2006/7. Now permanent.
Possible Public Perceptions	• Some traders and tourist companies resisted on access grounds. • May cause congestion elsewhere. • Encourages pleasant shopping centre and promotes economic development. • Facilities for cyclists still needed.
Practicality and Applicability	Following the public consultation exercise, a compromise was met whereby the route is open to traffic during peak commuter hours.
Action to Reduce Negative Perceptions	Consultation exercise was undertaken and helped acceptance.
Is it Included it LTP?	Yes.
Impact to be modelled?	Yes – A revised AADT was determined for the A49, based on a possible increase in cars along the A49. NO2 diffusion tube data before and after was also available. Traffic and air quality have therefore been modelled and predicted in Netcen's 'Further Assessment' for the key year of 2010 which forms part of this action plan report.
Evaluation of Action?	Yes, via city centre diffusion tubes at the Widemarsh St, Broad St and Edgar St sites. Also future trends in traffic flows (AADT),

Table 14:

Action Number: 12	**Behavioural Change Programme**
Action	• Further promote 'school travel plans' in Hereford to reduce solo passenger school car journeys and implement the 'Safer Routes to Schools' project. • Implementation of the 'Rotherwas Travel Plan', for the Rotherwas Industrial Estate. This initiative seeks to promote modal shift and reduce single occupancy commuting. • Initiate a Herefordshire Council 'Travel Plan' to encourage Council workers to commute to work by cycling, walking, public transport and car sharing. Also to encourage car pooling, bike pooling, and encourage council employee car parking restrictions. Encouraging flexible ways of working. • Encourage Hereford Businesses to adopt 'Travel Plans', through planning consents, campaigns and personal contact. • Encouraging greater car sharing through the development and promotion of 'Twoshare', Herefordshire's dedicated car sharing scheme. Car drivers are encouraged to share lifts by enrolling onto a countywide database of participating members. Currently in 2008 it is being promoted to over 200 businesses.
Responsibility	Highways and Transportation Service of Herefordshire Council.
Other Environmental Effects	• Reduces peak hour congestion. • Reduces traffic on roads. • Reduces parking and congestion pressures • Improves wider environment by reduced noise levels and visual quality. • Improves pedestrian and cycling infrastructure. • Improved town environment • Long term protection of built environment. • Socially inclusive
Council's Corporate Plan 2007 - 2010	• Should help protect the environment • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision • Cleaner, greener communities • Fewer accidents • Reduce health inequalities and promote healthy life styles
Cost to Implement	Low to medium
Time Needed to Implement	Short to medium: 2010 for all: *Rotherwas Travel Plan* Already started. Travel plan will hopefully increase in take up. 2010.

	Council Travel Plan Already being implemented. Take up hopefully to increase following continued promotion and relocation of majority of staff to one central office, location and date not yet known. Business and commuter pass initiative for Council employees implemented in May 2007 and there has been a 23% decrease in business miles claimed compared to the 2003 baseline. There has also been a 29% increase in cycling, with a 253% increase in council employee cycle miles too. The Council now has a pool fleet of 23 bikes to aid this. *School Travel plans* Objective already in place and Council's School Travel Advisor is already working with schools to adopt travel plans. Over the last four years 80% of Herefordshire Schools have written travel plans, and the Council is well on track to achieve the national target of 100% of schools to have travel plans by 2010 early in Herefordshire. *Other Travel Plans* Already started. Travel plans for other Hereford businesses will hopefully increase in take up. In 2007, 35 businesses had travel plans, with 40 signatories, covering over 50% of Rotherwas Industrial Estate. 26.7% of employees in Hereford are covered by a travel plan. *Herefordshire Two-Share Initiative* Being implemented and campaign continuing. Hopefully take-up increasing. Future survey anticipated to determine successful take up of those registered on scheme, but since 2004 there has been a 4% increase in car sharing for council employees.
Possible Public Perceptions	• Encourages healthier and fitter adults and children. • May not be flexible for work, college and school needs of family. • Personal and road safety concerns, particularly for schools. • Commuters feel they are doing something positive and saving money. • Possible resistance to change from staff who enjoy free parking. • May need to engender trust in list and users for Two-Share
Practicality and Applicability	• Applicable in cases where adults, students and children commute to work, college or school by car in Hereford. • Needs to be linked to other strategies such as cycling etc.
Action to Reduce Negative Perceptions	• Highlight positive health benefits through information campaign, • Overcome negative concerns of personal and road safety through training and through publicity campaigns. • Emphasise cheaper, healthier, safer travel and more choice. • Emphasise better home – life balance.
Is it in LTP?	Yes – behavioural change programme mentioned in LTP2
Impact to be modelled?	Yes – Revised cumulative AADTs resulting from modal shift and car sharing were determined for the A49 corridor and AQMA. Traffic and air quality have therefore been modelled and predicted in Netcen's 'Further Assessment' for the key years of 2010, 2015 and 2025, which forms part of this action plan report.
Evaluation of Action?	Yes, via city centre diffusion tubes and also via future trends in traffic flows (AADT)

Table 15:

Action Number 13:	**Designation of a Traffic Manager for Network Management Duties along the A49 in Hereford**
Action	The Council to designate an 'A49 Traffic Manager' to improve road working liaison and notification procedure between Highway Agency and Contractors on the A49 route, as imposed by the Traffic Management act 2004. Permits to undertake road-works to be considered, to ensure integrated approach and joined up planning.
Responsibility	Highway Agency & Herefordshire Council
Other Environmental Effects	Avoidance of peak time working for road works may reduce peak air pollution by smoothing out traffic flow and avoiding unnecessary congestion. Noise may increase as this might result in evening/night and Sunday working.
Council's Corporate Plan 2007 - 2010	• Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Reduced traffic congestion through better integrated transport provision
Cost to Implement	Low
Time Needed to Implement	In place already. A new Highway Network Manager has been designated to lead, reflecting the high importance the Council places on this role. Network Management Plan in progress for the entire county, including the A49. Three monthly liaison meetings held, with the AQMA on the agenda.
Possible Public Perceptions	Less congestion will improve local economy and reduce travel times. Likely to be well received (if publicised), although care needs to be taken in noise sensitive areas.
Practicality and Applicability	Practical on A49 route in Hereford where traffic tends to gridlock when even one lane is blocked.
Action to Reduce Negative Perceptions	Noise consultation required for evening/Sunday working. Need to publicise joined up approach.
Is it Included in the LTP?	Yes
Impact to be modelled?	Not yet – as the impact is not fully understood at present. This will be kept under review.
Evaluation of Action?	Yes, via city centre diffusion tubes along A49 corridor and complaints about the timing of road-works

Table 16:

Action Number 14:	**Vehicle Emission Testing in Hereford**
Action	Continue random vehicle emission testing in the Hereford AQMA, in conjunction with the Vehicle & Operators Services Agency (VOSA).
Responsibility	Herefordshire Council led by Environmental Health and Trading Standards. Liaison and joint working required with the VOSA.
Other Environmental Effects	• Reduces gross polluting vehicles. • Improves overall awareness of fuel efficiency and environmental impact of vehicles.
Council's Corporate Plan 2007 - 2010	• Should help protect the environment • Should help to improve transport and the safety of roads
Community Strategy for Herefordshire	• Cleaner, greener communities
Cost to Implement	Low, as VOSA provide equipment and staff and work jointly with Herefordshire Council who facilitate the events. The Council may have to subsidise calibration costs of analyser in future.
Time Needed to Implement	Already in place, although dependant on availability of VOSA to assist.
Possible Public Perceptions	Social exclusion implications as low income groups are more likely to be recipients of fixed penalty tickets. May affect a higher percentage of taxis and buses. Press release after every event. Motorists may not be aware of their vehicle emission problem. Motorists may feel that they are not in control of their vehicle emissions and cannot therefore be held accountable. Public are likely to support bus, taxi and HGV checks, but not private cars.
Practicality and Applicability	Practical only if sufficient enforcement provided with VOSA. Need not be too frequent (currently twice yearly) but best to publicise outcome via the media.
Action to Reduce Negative Perceptions	Ensure enforcement policy is fair and equitable (anti poverty and social inclusion aim of Council)
Is it Included in the LTP?	No
Impact to be modelled?	No – This is perceived to be more of a PR / public awareness initiative and as the result is not expected to significantly influence the AQMA pollution levels - it keeps air quality on the agenda and in the media.
Evaluation of Action?	Yes, through comparison of statistical information derived from the surveys. Necessity for emission testing will be kept under review, as recent tests tend to imply 100% compliance, due to newer vehicles.

Table 17:

Action Number 15:	**Information and Awareness Raising**
Action	• Improve the web site on air quality, • Mail shot, draft press releases and consult affected members of the public / stakeholders at relevant stages of the 'air quality management' process.
Responsibility	Herefordshire Council led by Environmental Health and Trading Standards. Liaison with Herefordshire PCT.
Other Environmental Effects	• Web site will raise environmental awareness in public • Release of information will hopefully help raise public awareness, particularly the fraction of the community who live in the AQMA or are prone to serious asthma and respiratory illness.
Council's Corporate Plan 2007 - 2010	• Should help protect the environment - by keeping public informed
Community Strategy for Herefordshire	• Cleaner, greener communities
Cost to Implement	Low
Time Needed to Implement	• Web site already updated and in place. • Consultations and press releases are ongoing
Possible Public Perceptions	Public likely to welcome information as being cost effective and informative. Asthma and 'Chronic Obstructive Pulmonary Disease' (COPD) sufferers particularly likely to benefit
Practicality and Applicability	Practical only if web site reviewed and kept up to date and equipment maintained. Success also dependant on joined up working / information sharing with the PCT.
Action to Reduce Negative Perceptions	Reassure public that cost is minimal compared to benefit.
Is it Included in the LTP?	No
Impact to be modelled?	No – This is purely for information and awareness raising purposes only.
Evaluation of Action?	Yes, via hits on the web site to be recorded, together with feedback from consultation and press releases.

9. Predicted Impact of Options

The following tables 16 to 19 analyse and interpret the pollution contour plots in Netcen's 'Further Assessment', which is attached as an appendix to this report. The tables therefore gauge the effect of the 15 actions over the key years by determining the number of houses touching or still remaining within the predicted 40 ugm^3 contour plot and therefore still affected by high pollution levels.

Table 16: Edgar Street / North Section of AQMA

	2005	2010	2015	2025
Figures in Further Assessment	Figure 4.3	Figure 4.7	Figure 4.11	Figure 4.15
Location	**Top of Edgar Street**	**Top of Edgar Street**	**Top of Edgar Street**	**Top of Edgar Street**
Comments		Significant improvement over 2005	Same as 2010	Zero achieved
Houses at risk of exceeding objective	31 on west of Edgar St 14 on east of Edgar St	1 on roundabout 0 on east of Edgar St	1 on roundabout 0 on east of Edgar St	None
Total houses exceeding	**45 houses**	**1 flat over public house**	**1 flat over public house**	**0**

Table 17: Middle Section of AQMA

	2005	2010	2015	2025
Fig in Further Assessment	Figure 4.4	Figure 4.8	Figure 4.12	Figure 4.16
Location	**Bottom of Edgar Street**	**Bottom of Edgar Street**	**Bottom of Edgar Street**	**Bottom of Edgar Street**
Comments		Significant improvement over 2005	Similar	Zero achieved
Houses at risk of exceeding objective	8 on west of Edgar St 0 houses on east of Edgar St, but most retail units within	0 on west of Edgar St 0 houses, but 8 retail units on east of Edgar St	0 on west of Edgar St 0 houses, but 5 retail units on east of Edgar St	0 on west of Edgar St 0 houses, but 2 retail units on east of Edgar St
Total houses exceeding	**8 houses**	**0 houses**	**0 houses**	**0 houses**
Location	**Eign Street**	**Eign Street**	**Eign Street**	**Eign Street**
Comments		Significant reduction from 2005	Slight further decrease	Zero achieved
Houses at risk of exceeding objective	11 on north side of Eign St 13 on south side of Eign St	0 on north side of Eign St 6 on south side of Eign St	0 on north side of Eign St 4 on south side of Eign St	0 on north side of Eign St 0 on south side of Eign St
Total houses exceeding	**24 flats**	**6 flats**	**4 flats**	**0 flats**
Location	**New Market St**	**New Market St**	**New Market St**	**New Market St**
Comments		Reduction from 2005 due to downgrading of route	Same improvement as for 2010 due to downgrading	Zero achieved
Houses at risk of exceeding objective	Only 1 exceedence at flat over pub	No exceedences	No exceedences	No exceedences
Total houses exceeding	**1 flat**	**0 flats**	**0 flats**	**0 flats**

Location	Top of Victoria St	Top of Victoria St	Top of Victoria St	Top of Victoria St
Comments		Significant reduction from 2005	Significant reduction from 2010	Zero achieved
Houses at risk of exceeding objective	28 on west side of road	14 on west side of road	0 on west side of road	0 on west side of road
Total houses exceeding	**28 houses**	**14 houses**	**0 houses**	**0 houses**

Table 18: Blue School Road & Newmarket Street / East Section of AQMA

	2005	2010	2015	2025
Figs in Further Assessment	**Figure 4.5**	**Figure 4.9**	**Figure 4.13**	**Figure 4.17**
Location	**Blueschool Rd**	**Blueschool Rd**	**Blueschool Rd**	**Blueschool Rd**
Comments	No exceedences	No exceedences	No exceedences	Zero achieved No exceedences
Total exceeding	**0 flats**	**0 flats**	**0 flats**	**0 flats**
Location	**Commercial St**	**Commercial St**	**Commercial St**	**Commercial St**
Comments		Significant reduction from 2005		Zero achieved
Houses at risk of exceeding objective	4 flats exceeding	No exceedences	No exceedences	No exceedences
Total exceeding	**4 flats**	**0 flats**	**0 flats**	**0 flats**

Table 19: Bottom area of AQMA

	2005	2010	2015	2025
Figures in Further Assessment	**Figure 4.6**	**Figure 4.10**	**Figure 4.14**	**Figure 4.18**
Location	**Bottom of Victoria St**	**Bottom of Victoria St**	**Bottom of Victoria St**	**Bottom of Victoria St**
Comments	1 exceedence on Wye Terrace	Reduction from 2005 No exceedences on Wye Terrace	No exceedences on Wye Terrace	Zero achieved No exceedences on Wye Terrace
Total exceeding	**1 house**	**0 house**	**0 houses**	**0 houses**

Location	Asda Roundabout	Asda Roundabout	Asda Roundabout	Asda Roundabout
Comments **Houses at risk of exceeding objective**	About 13 houses / flats exceeding	Significant reduction from 2005 4 houses / flats exceeding	Improvement over 2010 1 flat over public house exceeding	1 remains in 40 ugm3 contour plot projection 1 flat over public house exceeding
Total exceeding	**13 houses**	**4 houses**	**1 house**	**1 house**

The next chapter summarises the analyses of the impact of the 15 proposed action plans.

10. Conclusion

Since the declaration of an AQMA in Hereford in 2001, there have been exceedances along the A49 corridor for the government NO_2 objective. These continue into 2008.

Although no new exceedance areas outside the AQMA are expected by Netcen, further monitoring has continued by Herefordshire Council along Whitecross Road to keep this under review as recent trends imply that the objective may now be breached at certain places here.

Further monitoring has continued along the Holmer Road/Newtown Road section at the north end of the AQMA, as recent trends imply that the housing here no longer breaches the objective.

Between 2002 to 2005, Herefordshire Council scoped 42 actions down to 15 *'air quality actions*' and these make up the proposed air quality action plan.

All 15 actions are likely to have an impact on traffic pollution levels either directly or indirectly and have therefore been examined by the transport consultants TPI who have projected revised traffic flows for the years 2010, 2015 and 2025.

All 15 actions modelled by TPI have then been examined by the air quality consultants Netcen, who have projected pollution levels from this traffic data for the years 2010, 2015 and 2025.

From the 'source apportionment' exercise undertaken by Netcen, the model concludes that traffic accounts for at least half of all the predicted future local nitrogen dioxide concentrations and that HGVs account for at least half of this again.

Having regard to the tables in the previous chapter, modelling by Netcen of the nitrogen dioxide levels in Hereford after the implementation of the relevant actions in place by 2010 indicates that there is likely to be a significant decline in nitrogen dioxide when compared with 2005. The predictions find reducing exceedances of the 40$\mu g/m^3$ annual mean objective at Edgar Street, Victoria Street, Eign Street and at housing near to the 'Asda Roundabout'. Netcen's Further Assessment Report states that this is due to the reduction in both AADT flow and the percentage of HGVs locally predicted for Hereford. Table 20 below shows that the modelling predicts that the number of properties at risk from the 40$\mu g/m^3$ objective will reduce from about 115 to 25 from 2005 to 2010, due to the actions proposed. This is a very significant reduction.

By 2015, Table 20 below then shows that the modelling predicts that the number of properties at risk from the 40$\mu g/m^3$ objective will reduce by a further 19 houses from the 2010 level, to just 6, due to the actions proposed. This is again significant.

By 2025, Netcen's modelling shows that the only possible exceedance should be at a flat over a public house on the Asda roundabout. This is summarised in Table 20 overleaf.

Table 20: Total Number of Houses Exceeding the NO_2 Objective in the AQMA

	2005	2010	2015	2025
Total houses exceeding	**115**	**25**	**6**	**1**

In summary, Netcen conclude that the 15 actions proposed are predicted to have positive effects in reducing the extent of NO_2 exceedances in the AQMA.

Herefordshire Council therefore concurs with this by concluding that the 15 actions proposed will significantly help to reduce the number of houses in Hereford which are currently affected by pollution. This conclusion is reached, despite year on year annual increases in vehicle ownership and the inevitable increases in traffic movements up to 2025 that this will lead to.

The next chapter makes recommendations based on the above and also proposes that the actions are reviewed to ensure that these projections remain accurate, particularly in relation to the uncertainties incorporated in the Edgar Street Grid traffic proposals.

When significant areas of the AQMA are no longer relevant, then the boundary should be altered and ultimately undeclared.

11. Recommendations

Herefordshire Council recommends that the 15 actions put forward by this report are implemented and their performance regularly evaluated and reviewed via its annual air quality reports. In particular, the Council will regularly review the performance of the proposed 'Hereford Intelligent Transport System' - *HITS*, (Action 6) once implemented, so that the levels of congestion and therefore pollution are kept to a minimum. In doing so, it is anticipated that once installed, the HITS can be adjusted if necessary to reduce the pollution plot so that ultimately no houses will be projected to fall within the 40$\mu g/m^3$ nitrogen dioxide contour by 2025 when the 3rd Link Road and the Edgar Street Grid developments are completed.

Herefordshire Council will lobby central government to implement effective national policy measures to reduce vehicle emissions at source and therefore compliment the 15 actions to be instigated locally.

Following further monitoring, the Council will consider removing Holmer Road and Newtown Road from the air quality management area, due to a recent trend revealing that the air pollution levels here were originally over predicted. Consideration will therefore be given in the 2008 Annual Progress Report to amending the boundary of the AQMA if necessary.

The Council will also continue to monitor along Whitecross Road to determine whether the air quality management area should be further extended along this corridor. Consideration will therefore also be given in the 2007 and 2008 Annual Progress Reports to amending the boundary of the AQMA here too.

Herefordshire Council will maintain the air quality management area in Hereford until satisfied that no houses are at risk of exceeding the 40$\mu g/m^3$ nitrogen dioxide objective. In the interim, the boundary will be reviewed and if necessary formally amended to take into account changes in pollution levels.

12. Data from TPI Transport Planning Consultants

(for projections to years 2010, 2015 and 2025)

Location	2005 AADTs	% HDV	2010 AADTs	%HDV	2015 AADTs	%HDV	2025 AADTs	%HDV
A49 Holmer Rd (northbound)	6969	7	6578	7	6913	7	7144	5
A49 Holmer Rd (southbound)	7315	7	776	8	8002	7	7837	6
A49 Newtown Rd (northbound)	7876	6	8662	5	10224	5	10670	3
A49 Newtown Rd (southbound)	9675	5	12265	5	11550	4	12271	4
A49 Edgar Street (northbound)	11628	5	8701	5	13376	4	8283	3
A49 Edgar Street (southbound)	10390	8	11830	7	13024	6	13750	6
A49 Victoria St (northbound)	16841	7	10516	7	9647	7	9944	9
A49 Victoria St (southbound)	12815	9	16225	5	11803	6	11748	6
A438 Eign Street (eastbound)	7898	7	6149	4	8459	6	8310	4
A438 Eign Street (westbound)	7728	7	6286	7	3657	10	3586	15
Newmarket St / Blue School St (eastbound)	10582	5	7650	1	0	0	0	0
Newmarket St / Blue School St (westbound)	12364	4	12336	1	3514	2	3778	2
A49 Ross Rd (northbound)	10698	8	10455	7	12353	8	11676	13
A49 Ross Rd (southbound)	9323	9	6292	8	6105	8	6704	10
Grandstand Road (eastbound)	5968	4	6171	4	5923	4	6748	5
Grandstand Road (westbound)	4516	6	3630	6	5439	5	5351	4
A465 Belmont Rd (northbound)	9741	5	7062	3	6237	3	4229	4
A465 Belmont Rd (southbound)	9032	5	5252	3	4856	3	3773	3
Barton Rd (eastbound)	5687	3	6176	3	6495	3	6358	3
Barton Rd (westbound)	5957	4	4477	3	4174	3	3118	7
St Nicholas St (eastbound)	2685	4	5318	2	6352	2	6325	2
St Nicholas St (westbound)	3009	4	4482	2	4884	3	4823	3
St Martins St (northbound)	2866	0.4	2926	1	2887	2	2937	3
St Martins St (southbound)	2211	4	4372	2	4268	2	4158	2
Bath Street (eastbound)	4917	5	5307	2	2271	2	2282	2
Bath Street (westbound)	3218	2	9168	2	5978	2	6407	2
Commercial Rd (northbound)	6397	6	6710	1	5978	2	5252	2
Commercial Rd (southbound)	6584	6	6319	0	1974	2	2106	1
North part of Widemarsh St (northbound)	3977	1	940	0	4933	6	5192	3
North part of Widemarsh St (southbound)	0	0	4829	2	5500	2	4669	3
South part of Widemarsh St (northbound)	171	0	1276	1	0	0	0	0
South part of Widemarsh St (southbound)	0	0	4103	2	4554	2	4405	3
Whitecross Rd (eastbound)	8756	6	6193	2	9586	4	9509	3
Whitecross Rd (westbound)	7732	4	2343	1	2403	2	2057	1

13. How to contact us

We would welcome the opportunity to discuss this report with you or to discuss any other issues relating to the air quality of Herefordshire.

You can contact us as follows:

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or

Helpdesk	ethelpline@herefordshire.gov.uk	01432 261761

Or write to us at:

Environmental Health & Trading Standards,
Bath Street Offices,
Bath Street,
Hereford.
HR1 2ZF

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APPENDIX

FURTHER ASSESSMENT OF ACTIONS CONTAINED WITHIN THE HEREFORD CITY AIR QUALITY ACTION PLAN

A 'further assessment' report commissioned by Herefordshire Council in support of the actions proposed in the action plan

Air Quality Review and Assessment - Further

A Report produced for Herefordshire Council

netcen/ED49375001/Draft Issue 3
April 2007

Title	Air Quality Review and Assessment- Further
Customer	Herefordshire Council
Customer reference	
Confidentiality, copyright and reproduction	Copyright AEA Technology plc All rights reserved Enquiries about copyright and reproduction should be addressed to the Commercial Manager, AEA Technology plc
File reference	ED49375001
Report number	AEAT/ENV/R/2163/Draft Issue 3
Report status	Unrestricted

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Approved by	Beth Conlan		

Executive Summary

The UK Government published its strategic policy framework for air quality management in 1995 establishing national strategies and policies on air quality, which culminated in the Environment Act, 1995. The Air Quality Strategy provides a framework for air quality control through air quality management and air quality standards. These and other air quality standards[1] and their objectives[2] have been enacted through the Air Quality Regulations in 1997 and 2000 and the Air Quality (Amendment) Regulations 2002. The Environment Act 1995 requires Local Authorities to undertake an air quality review. In areas where the air quality objective is not anticipated to be met, Local Authorities are required to establish Air Quality Management Areas to improve air quality.

The intention is that local authorities should only undertake a level of assessment that is proportionate to the risk of air quality objectives being exceeded. The first step in the second round of review and assessment is an Updating and Screening Assessment (USA), which is to be undertaken by all authorities. Where the USA has identified a risk that an air quality objective will be exceeded, the authority is required to undertake a detailed assessment.

Following the outcome of their Stage 4 Review and Assessment of December 2002, Herefordshire Council have commissioned **netcen** to undertake a Further Assessment for nitrogen dioxide (NO_2) for the following thirteen streets in Hereford:

- Belmont Road
- Ross Road A49(T)
- Victoria Street A49(T)
- Eign Street A438
- New Market Street A438
- Widemarsh Street
- Blue School Street A438
- Commercial Road A465
- Bath Street A438
- Edgar Street A49(T)
- Newtown Road
- Grandstand Road
- Holmer Road A49(T)

The Stage 4 report, completed in 2002, estimated and modelled the NO_2 concentrations within the designated AQMA for 2005. The key findings of the source apportionment concluded that the HDVs on roads in central Hereford are contributing disproportionally to the concentrations of NOx – HDVs only accounting for less than 10% of the AADT but also accounting for approximately 50% of the NOx emissions.

The objective of this Further Assessment was to test out action planning scenarios and assess the likely impact they may have on pollutant concentrations in future years, and therefore their likely effectiveness.

The present report therefore constitutes a Further Assessment for Herefordshire Council. Only the impact of nitrogen dioxide emissions are considered in this report. This report investigates current and potential future nitrogen dioxide levels through an examination of the location and size of principal traffic emission sources, emissions modelling exercises and by reference to monitored air quality data.

[1] Refers to standards recommended by the Expert Panel on Air Quality Standards. Recommended standards are set purely with regard to scientific and medical evidence on the effects of the particular pollutants on health, at levels at which risks to public health, including vulnerable groups, are very small or regarded as negligible.
[2] Refers to objectives in the Strategy for each of the eight pollutants. The objectives provide policy targets by outlining what should be achieved in the light of the air quality standards and other relevant factors and are expressed as a given ambient concentration to be achieved within a given timescale.

Nitrogen Dioxide

It is recommended that Herefordshire Council maintain the current AQMA boundary.

- Exceedances are predicted at roadside locations along the following roads for the 2005 base case:
  - Edgar Street Roundabout
  - Edgar Street
  - Eign Street (as far as monitoring location site 57)
  - Newmarket Street
  - Victoria Street
  - Newtown Road
  - Blue School Street (west of the junction with Bath Street)
  - Belmont/Ross Roundabout

- Scenario testing has predicted that by 2010 the action plan measures proposed will reduce the margin of annual average exceedances at all locations and by 2015 and 2025 the size of this exceedance area and the margins of exceedance will be limited to relevant receptors at A49 junctions only. The current problems along Newmarket Street and Blue School Street are predicted to be resolved by 2015.
- Overall it is recommended that action planning measures along the A49 corridor focus strongly on reducing HDV flows and junction congestion in future years.

Maps reproduced within this document

Acronyms and definitions

AADT	annual average daily traffic flow
ADMS	an atmospheric dispersion model
AQDD	Common Position on Air Quality Daughter Directives
AQMA	Air Quality Management Area
AQS	Air Quality Strategy
AURN	Automatic Urban and Rural Network
CNS	central nervous system
d.f.	degrees of freedom
DEFRA	Department for the Environment, Food and Rural Affairs
DETR	Department of the Environment, Transport and the Regions
DMRB	Design Manual for Roads and Bridges
EA	Environment Agency
EPA	Environmental Protection Act
EPAQS	Expert Panel on Air Quality Standards
ERG	Environmental Research Group, Kings College, London
GIS	Geospatial Information System
HDV	Heavy Duty Vehicles
HFSC	Herefordshire Council
kerbside	0 to 5 m from the kerb
n	number of pairs of data
NAEI	National Atmospheric Emission Inventory
NAQS	National Air Quality Strategy (now called the Air Quality Strategy)
NETCEN	National Environmental Technology Centre
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
NPL	National Physical Laboratory
NRTF	National Road Traffic Forecast
ppb	parts per billion
r	the correlation coefficient
roadside	1 to 5 m from the kerb
SD	standard deviation
TEMPRO	A piece of software produced by the DfT used to forecast traffic flow increases
UWE	University of West of England

Contents

1 Introduction

1.1 PURPOSE OF THE STUDY

Following the outcome of their Stage 4 Review and Assessment of December 2002, Herefordshire Council have commissioned **netcen** to undertake a Further Assessment for nitrogen dioxide (NO_2) for the following thirteen streets in Hereford:

- Belmont Road
- Ross Road A49(T)
- Victoria Street A49(T)
- Eign Street A438
- New Market Street A438
- Widemarsh Street
- Blue School Street A438
- Commercial Road A465
- Bath Street A438
- Edgar Street A49(T)
- Newtown Road
- Grandstand Road
- Holmer Road A49(T)

The Stage 2 Air Quality Assessment for Herefordshire identified areas that required further assessment for nitrogen dioxide. A Stage 3 Review and Assessment was completed, which involved detailed dispersion modelling around the selected hot spots to predict the areas of exceedance of the NO_2 objectives (netcen 2001).

The report concluded that it was probable (i.e. with a probability between 50% and 80%) that exceedances of the annual mean objective for NO_2 in 2005 could occur at the following locations for houses close to:

- Newtown Road
- Edgar Street Island
- Eastern side of the A49(T) between Edgar Street Island and Belmont Road Island
- Belmont Road Island

It was possible (probability 20%-50%) that exceedances of the annual average objective would occur at the following locations:

- Edgar Street (50 to 62 Edgar Street)
- Edgar Street Island (52 Bewell Street)

At all locations the hourly objective was considered unlikely or very unlikely to be exceeded. Herefordshire Council declared the following area as an AQMA:

- A49 from Belmont Road Island, along Edgar Street and Newtown Road as far as Spring Gardens; and;
- A438 along Eign Street and Newmarket/Blue School Street.

The Stage 4 report, completed in 2002, undertook further modelling of the NO_2 concentrations within the designated AQMA for 2005. The source apportionment exercise concluded that the HDVs on roads in central Hereford were contributing disproportionally to the concentrations of NOx – HDVs only accounting for less than 10% of the AADT but also accounting for approximately 50% of the NOx emissions.

No changes to the AQMA were recommended as a result of the Stage 4, as the area likely to be exceeding the annual average NO_2 objective was contained within the current AQMA.

The Stage 4 estimated that the exceedances of the objective were considered probable (50%-80%) at the following monitoring locations:

- Victoria Street sites 8 and 9
- 7 Victoria House Façade site 10
- Edgar Street Traffic Island sites 12-14
- Cross Street House Façade site 53

And possible (20%-50%) at:

- Belmont Road/Ross Road site 16
- Holmer Road/Newtown Road site 20

The objective of this Further Assessment is to test out action planning scenarios and assess the likely impact they may have on pollutant concentrations, and therefore their likely effectiveness.

1.2 GENERAL APPROACH TAKEN

The approach taken in this study was to:

- Collect and interpret additional data to that already used in previous assessments, in order to support the Further Assessment, including more detailed traffic flow data around the areas outlined above;
- Utilise the monitoring data from the Council's monitoring campaign to assess the ambient concentrations resulting from road traffic emissions, and to validate the output of the modelling studies;
- Model the concentrations of NO_2 around the selected roads for the base case (2005) and for 2010, 2015 and 2025 taking into account 10 proposed action planning scenarios due to be implemented in a phased manner over the next 20 years, concentrating on the locations (receptors) where people might be exposed over the relevant averaging times of the air quality objectives;
- Present the concentrations as contour plots and assess the uncertainty in the predicted concentrations; and
- Undertake source apportionment work, where exceedances are predicted.

1.3 VERSION OF THE POLLUTANT SPECIFIC GUIDANCE USED IN THIS ASSESSMENT

This report has used the latest guidance in LAQM.TG(03), published in February 2003.

1.4 NUMBERING OF FIGURES AND TABLES

The numbering scheme is not sequential, and the figures and tables are numbered according to the chapter and section that they relate to.

1.5 UNITS OF CONCENTRATION

The units throughout this report are presented in $\mu g\ m^{-3}$ (which is consistent with the presentation of the new AQS objectives), unless otherwise noted.

1.6 STRUCTURE OF THE REPORT

This document is a Further Air Quality review for Herefordshire Council for nitrogen dioxide. This chapter, Chapter 1 has summarised the need for the work and the approach to completing the study.

Chapter 2 of the report describes developments in the UK's Air Quality Strategy (AQS). In addition, it discusses when implementation of an AQMA is required.

Chapter 3 contains details of the information used to conduct the Further Assessment for Herefordshire Council.

Chapter 4 introduces the latest standards and objectives for nitrogen dioxide and summarises the monitoring of NO_2 that has taken place in Hereford in the areas of concern. It also describes the results of the modelling assessment and discusses whether the nitrogen dioxide objectives will be exceeded in Hereford in 2010, 2015 and 2025. The results of the analysis are displayed in tabular form and as contour plots. It also presents the recommendations for NO_2 from the Hereford assessment.

Chapter 5 presents a summary of the conclusions of this study.

1.7 GIS DATA USED

Herefordshire Council provided the Ordnance Survey landline data for use in this project.

1.8 EXPLANATION OF THE MODELLING OUTPUT

The contour maps generated in the modelling for this report are an indication of the predicted pollutant concentrations around the area modelled. They are not lines of absolute values and should not be considered as such. Care should also be taken, in cases where contours join up as enclosed loops. This is common, for example along a section of road. The contours may appear to circle a section of the road, rather than extend all the way along it. This is due to the input area over which the model was run being only a section of the road in question. No assumptions of pollutant concentrations can be made on locations outside of the area being modelled.

2 The updated Air Quality Strategy

2.1 THE NEED FOR AN AIR QUALITY STRATEGY

The Government published its proposals for review of the National Air Quality Strategy in early 1999 (DETR, 1999). These proposals included revised objectives for many of the regulated pollutants. A key factor in the proposals to revise the objectives was the agreement in June 1998 at the European Union Environment Council of a Common Position on Air Quality Daughter Directives (AQDD).

Following consultation on the Review of the National Air Quality Strategy, the Government prepared the Air Quality Strategy for England, Scotland, Wales and Northern Ireland for consultation in August 1999. It was published in January 2000 (DETR, 2000).

The Environment Act (1995) provides the legal framework for requiring LA's to review air quality and for implementation of an AQMA. The main constituents of this Act are summarised in Table 2.1 below.

Table 2.1 Major elements of the Environment Act 1995

Part IV Air Quality	Commentary
Section 80	Obliges the Secretary of State (SoS) to publish a National Air Quality Strategy as soon as possible.
Section 81	Obliges the Environment Agency to take account of the strategy.
Section 82	Requires local authorities, any unitary or Borough, to review air quality and to assess whether the air quality standards and objectives are being achieved. Areas where standards fall short must be identified.
Section 83	Requires a local authority, for any area where air quality standards are not being met, to issue an order designating it an air quality management area (AQMA).
Section 84	Imposes duties on a local authority with respect to AQMAs. The local authority must carry out further assessments and draw up an action plan specifying the measures to be carried out and the timescale to bring air quality in the area back within limits.
Section 85	Gives reserve powers to cause assessments to be made in any area and to give instructions to a local authority to take specified actions. Authorities have a duty to comply with these instructions.
Section 86	Provides for the role of County Councils to make recommendations to a district on the carrying out of an air quality assessment and the preparation of an action plan.
Section 87	Provides the SoS with wide ranging powers to make regulations concerning air quality. These include standards and objectives, the conferring of powers and duties, the prohibition and restriction of certain activities or vehicles, the obtaining of information, the levying of fines and penalties, the hearing of appeals and other criteria. The regulations must be approved by affirmative resolution of both Houses of Parliament.
Section 88	Provides powers to make guidance which local authorities must have regard to.

2.2 OVERVIEW OF THE PRINCIPLES AND MAIN ELEMENTS OF THE NATIONAL AIR QUALITY STRATEGY

The main elements of the AQS can be summarised as follows:

- The use of a health effects based approach using national air quality standards and objectives.
- The use of policies by which the objectives can be achieved and which include the input of important factors such as industry, transportation bodies and local authorities.
- The predetermination of timescales with target dates of 2003, 2004, 2005, 2008 and 2010 for the achievement of objectives and a commitment to review the Strategy every three years.

It is intended that the AQS will provide a framework for the improvement of air quality that is both clear and workable. In order to achieve this, the Strategy is based on several principles which include:

- the provision of a statement of the Government's general aims regarding air quality;
- clear and measurable targets;
- a balance between local and national action and
- a transparent and flexible framework.

Co-operation and participation by different economic and governmental sectors is also encouraged within the context of existing and potential future international policy commitments.

2.2.1 National Air Quality Standards

At the centre of the AQS is the use of national air quality standards to enable air quality to be measured and assessed. These also provide the means by which objectives and timescales for the achievement of objectives can be set. Most of the proposed standards have been based on the available information concerning the health effects resulting from different ambient concentrations of selected pollutants and are the consensus view of medical experts on the Expert Panel on Air Quality Standards (EPAQS). These standards and associated specific objectives to be achieved between 2003 and 2010 are shown in Table 2.2. The table shows the standards in ppb and $\mu g\ m^{-3}$ with the number of exceedances that are permitted (where applicable) and the equivalent percentile.

Specific objectives relate either to achieving the full standard or, where use has been made of a short averaging period, objectives are sometimes expressed in terms of percentile compliance. The use of percentiles means that a limited number of exceedances of the air quality standard over a particular timescale, usually a year, are permitted. This is to account for unusual meteorological conditions or particular events such as November 5th. For example, if an objective is to be complied with at the 99.9th percentile, then 99.9% of measurements at each location must be at or below the level specified.

Table 2.2 Air Quality Objectives in the Air Quality Regulations (2000) and (Amendment) Regulations 2002 for the purpose of Local Air Quality Management.

Pollutant	Concentration limits		**Averaging period**	**Objective** [number of permitted exceedances a year and equivalent percentile]	
	($\mu g\ m^{-3}$)	(ppb)		(**$\mu g\ m^{-3}$**)	date for objective
Benzene	16.25	5	**running annual** mean	**16.25**	by 31.12.2003
	5	1.5	**Annual mean**	**5**	by 31.12.2010
1,3-butadiene	2.25	1	**running annual** mean	**2.25**	by 31.12.2003
CO	10,000	8,600	**running 8-hour** mean	**10,000**	by 31.12.2003
Pb	0.5	-	**annual** mean	**0.5**	by 31.12.2004
	0.25	-	**annual** mean	**0.25**	by 31.12.2008
NO_2 (see note)	200	105	**1 hour** mean	**200** [maximum of 18 exceedances a year or equivalent to the 99.8th percentile]	by 31.12.2005
	40	21	**annual** mean	**40**	by 31.12.2005
PM_{10} gravimetric (see note)	50	-	**24-hour** mean	**50** [maximum of 35 exceedances a year or ~ equivalent to the 90th percentile]	by 31.12.2004
	40	-	**annual** mean	**40**	by 31.12.2004
SO_2	266	100	**15 minute** mean	**266** [maximum of 35 exceedances a year or equivalent to the 99.9th percentile]	by 31.12.2005
	350	132	**1 hour** mean	**350** [maximum of 24 exceedances a year or equivalent to the 99.7th percentile]	by 31.12.2004
	125	47	**24 hour** mean	**125** [maximum of 3 exceedances a year or equivalent to the 99th percentile]	by 31.12.2004

Notes

1. Conversions of ppb and ppm to ($\mu g\ m^{-3}$) correct at 20°C and 1013 mb.
2. The objectives for nitrogen dioxide are provisional.

PM_{10} measured using the European gravimetric transfer standard or equivalent.

2.2.2 Relationship between the UK National Air Quality Standards and EU air quality Limit Values

As a member state of the EU, the UK must comply with EU Directives.

There are three EU ambient air quality directives that the UK has transposed in to UK law. These are:

- **96/62/EC** Council Directive of 27 September 1996 on ambient air quality assessment and management (the Ambient Air Framework Directive).
- **1999/30/EC** Council Directive of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide, oxides of nitrogen, particulate matter and lead in ambient air (the First Daughter Directive).
- **2000/69/EC** Directive of the European Parliament and the Council of 16 Nov 2000 relating to limit values for benzene and carbon monoxide in ambient air (the Second Daughter Directive).

The first and second daughter directives contain air quality Limit Values for the pollutants that are listed in the directives. The United Kingdom (i.e. Great Britain and Northern Ireland) must comply with these Limit Values. The UK air quality strategy should allow the UK to comply with the EU Air Quality Daughter Directives, but the UK air quality strategy also includes some stricter national objectives for some pollutants, for example, the 15-minute sulphur dioxide objective.

The Government is ultimately responsibility for achieving the EU limit values. However, it is important that Local Air Quality Management is used as a tool to ensure that the necessary action is taken at local level to work towards achieving the EU limit values by the dates specified in those EU Directives.

2.2.3 New particle objectives (not included in Regulations[3])

For particulates (as PM10) new objectives are proposed.

- For all parts of the UK, except London and Scotland, a 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 7 times a year and an annual mean of 20 $\mu g/m^3$, both to be achieved by the end of 2010;
- For London, a 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 10 times a year and an annual mean of 23 $\mu g/m^3$, both to be achieved by the end of 2010;
- For Scotland, a 24 hour mean of 50 $\mu g/m^3$ not to be exceeded more than 7 times a year and an annual mean of 18 $\mu g/m^3$, both to be achieved by the end of 2010.

2.2.4 Policies in place to allow the objectives for the pollutants in AQS to be achieved

The policy framework to allow these objectives to be achieved is one that that takes a local air quality management approach. This is superimposed upon existing national and international regulations in order to effectively tackle local air quality issues as well as issues relating to wider spatial scales. National and EC policies that already exist provide a good basis for progress towards the air quality objectives set for 2003 to 2008. For example, the Environmental Protection Act 1990 allows for the monitoring and control of emissions from industrial processes and various EC Directives have ensured that road transport emission and fuel standards are in place. These policies are being developed to include more stringent controls. Recent developments in the UK include the announcement by the Environment Agency in January 2000 on controls on emissions of SO_2 from coal and oil fired power stations. This system of controls means that by the end of 2005 coal and oil fired power stations will meet the air quality standards set out in the AQS.

Local air quality management provides a strategic role for local authorities in response to particular air quality problems experienced at a local level. This builds upon current air quality control responsibilities and places an emphasis on bringing together issues relating to transport, waste, energy and planning in an integrated way. This integrated approach involves a number of different aspects. It includes the development of an appropriate local framework that allows air quality issues

[3] The exception is the Scottish Executive which has incorporated the new PM10 objectives in their Regulations.

to be considered alongside other issues relating to polluting activity. It should also enable co-operation with and participation by the general public in addition to other transport, industrial and governmental authorities.

An important part of the Strategy is the requirement for local authorities to carry out air quality reviews and assessments of their area against which current and future compliance with air quality standards can be measured. Over the longer term, these will also enable the effects of policies to be studied and therefore help in the development of future policy. The Government has prepared guidance to help local authorities to use the most appropriate tools and methods for conducting a review and assessment of air quality in their District. This is part of a package of guidance being prepared to assist with the practicalities of implementing the AQS. Other guidance covers air quality and land use planning, air quality and traffic management and the development of local air quality action plans and strategies.

2.2.5 Timescales to achieve the objectives

In most local authorities in the UK, objectives will be met for most of the pollutants within the timescale of the objectives shown in Table 2.2. It is important to note that the objectives for NO_2 remain provisional. The Government has recognised the problems associated with achieving the standard for ozone and this will not therefore be a statutory requirement. Ozone is a secondary pollutant and transboundary in nature and it is recognised that local authorities themselves can exert little influence on concentrations when they are the result of regional primary emission patterns.

2.3 AIR QUALITY REVIEWS

A range of Technical Guidance has been issued to enable air quality to be monitored, modelled, reviewed and assessed in an appropriate and consistent fashion. This includes LAQM.TG(03), on 'Local Air Quality Management: Technical Guidance, February 2003. This review and assessment has considered the procedures set out in the guidance.

The primary objective of undertaking a review of air quality is to identify any areas that are unlikely to meet national air quality objectives and ensure that air quality is considered in local authority decision making processes. The complexity and detail required in a review depends on the risk of failing to achieve air quality objectives and it has been proposed in the second round that reviews should be carried out in two stages. Every authority is expected to undertake at least a first stage Updating and screening Assessment (USA) of air quality in their authority area. Where the USA has identified a risk that an air quality objective will be exceeded at a location with relevant public exposure, the authority will be required to undertake a Further assessment. The Stages are briefly described in the following table, Table 2.3.

Table 2.3: The phased approach to review and assessment.

Level of assessment	Objective	Approach
Updating and screening assessment (USA)	To identify those matters that have changed since the last review and assessment, which might lead to a risk of the air quality objective being exceeded.	Use a check list to identify significant changes that require further consideration. Where such changes are identified, apply simple screening tools to decide whether there is sufficient risk of an exceedance of an objective to justify a Further assessment
Detailed assessment	To provide an accurate assessment of the likelihood of an air quality objective being exceeded at locations with relevant exposure. This should be sufficiently Further to allow the designation or amendment or any necessary AQMAs.	Use quality-assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective.
Further assessment	Confirm boundaries of identified areas of exceedance using the latest and most detailed input information available. Provide source apportionment information to identify primary emissions sources contributing to exceedances so that action planning measures can be targeted. Test out the likely impact of potential action planning scenarios if possible.	Use quality-assured monitoring and validated modelling methods to determine current and future pollutant concentrations in areas where there is a significant risk of exceeding an air quality objective.

2.4 LOCATIONS THAT THE REVIEW AND ASSESSMENT MUST CONCENTRATE ON

For the purpose of review and assessment, the authority should focus their work on locations where members of the public are likely to be exposed over the averaging period of the objective. Table 2.4 summarises the locations where the objectives should and should not apply.

Table 2.4 Typical locations where the objectives should and should not apply (England only)

Averaging Period	Pollutants	Objectives *should* apply at …	Objectives should *not* generally apply at …
Annual mean	• 1,3 Butadiene • Benzene • Lead • Nitrogen dioxide • Particulate Matter (PM_{10})	• All background locations where members of the public might be regularly exposed.	• Building façades of offices or other places of work where members of the public do not have regular access.
		• Building façades of residential properties, schools, hospitals, libraries etc.	• 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
24 hour mean and 8-hour mean	• Carbon monoxide • Particulate Matter (PM_{10}) • Sulphur dioxide	• All locations where the annual mean objective would apply.	• Kerbside sites (as opposed to locations at the building façade), or any other location where public exposure is expected to be short term.
		• Gardens of residential properties.	

Table 2.4 (contd.) Typical locations where the objectives should and should not apply (England only)

Averaging Period	Pollutants	Objectives should apply at …	Objectives should generally not apply at …
1 hour mean	• Nitrogen dioxide • Sulphur dioxide	• All locations where the annual mean and 24 and 8-hour mean objectives apply.	• Kerbside sites where the public would not be expected to have regular access.
		• Kerbside sites (e.g. pavements of busy shopping streets).	
		• Those parts of car parks and railway stations etc. which are not fully enclosed.	
		• Any outdoor locations to which the public might reasonably expected to have access.	
15 minute mean	• Sulphur dioxide	• All locations where members of the public might reasonably be exposed for a period of 15 minutes or longer.	

It is unnecessary to consider exceedances of the objectives at any location where public exposure over the relevant averaging period would be unrealistic, and the locations should represent non-occupational exposure.

Key Points

- The Environment Act 1995 has required the development of a National Air Quality Strategy for the control of air quality.
- A central element in the Strategy is the use of air quality standards and associated objectives based on human health effects that have been included in the Air Quality Regulations.
- The Strategy uses a local air quality management approach in addition to existing national and international legislation. It promotes an integrated approach to air quality control by the various factors and agencies involved.
- Air quality objectives, with the exception of ozone, are to be achieved by specified dates up to the end of 2010.
- A number of air quality reviews are required in order to assess compliance with air quality objectives. The number of reviews necessary depends on the likelihood of achieving the objectives.

3 Information used to support this assessment

This Chapter summarises the information used to support this review and assessment.

3.1 MAPS

Herefordshire Council provided OS Landline data of the areas in the district, which needed to be modelled. This enabled accurate road widths and the distance of the housing to the kerb to be determined.

3.2 ROAD TRAFFIC DATA

3.2.1 Average flow, hourly fluctuations in flow, speed and fraction of HDVs.

Annual average daily traffic (AADT) flow data for 2005 and estimates for 2010, 2015 and 2025 were provided by Herefordshire Council and TPI for the roads of concern.

Data on the percentage of Heavy Duty Vehicles (HDVs), free-flowing traffic, on queuing and congestion and Bus Stops and Bus movements were also available. To determine the hourly fluctuations in traffic flow the (then) DETR's diurnal traffic variation default figures were used (DETR, 1999). Appendix 1 summarises the traffic flow data used.

3.3 METEOROLOGICAL DATA USED IN THE DISPERSION MODELLING

Hourly sequential meteorological data for the nearest suitable meteorological station with adequate data capture, Birmingham airport with cloud cover data from Coleshill, was obtained for 2003. The meteorological data provided information on wind speed and direction and the extent of cloud cover for each hour of 2003. Other sites closer to Hereford have failed to record adequate data capture levels in recent years.

3.4 AMBIENT MONITORING

Nitrogen dioxide concentrations are monitored:

- By continuous monitoring at a roadside site at Edgar Street Island, Hereford. Concentrations of NO_X and NO_2 are recorded by the continuous monitor (OS co-ordinates 350776 240224). No background automatic monitoring is currently undertaken in Hereford. The regional background NO_2 concentrations were taken from the nearest rural AURN site at Aston Hill (OS co-ordinates 329800 290100).

- By diffusion tubes. Herefordshire Council have also been undertaking a collocation study at the Edgar Street Island automatic monitoring station since January 2000. Diffusion tube results are also available for 21 other roadside locations within Hereford. The tubes are analysed by Gradko. The locations of the tubes and their average concentrations in 2004 and 2005 are given in Appendix 2.

3.5 COMPUTER MODELLING

The modelling programmes used in this assessment make a number of assumptions during the calculations. These include no consideration of terrain relief, or direct consideration of buildings over the surface being modelled. Modelling of pollutant concentrations on roads can sometimes provide misleading information on produced contour maps. For example, polygons and circles on certain areas of the contour maps, e.g. roundabouts or the centres of roads, can be generated. This is not a deficiency in the model – it is an artefact of the data. As such, these additional features should be ignored and the wider context and implications of the contour maps be considered.

4 Further Assessment for Nitrogen Dioxide

4.1 INTRODUCTION

Nitrogen oxides are formed during high temperature combustion processes from the oxidation of nitrogen in the air or fuel. The principal source of nitrogen oxides, nitric oxide (NO) and nitrogen dioxide (NO_2), collectively known as NO_x, is road traffic, which is responsible for approximately half the emissions in Europe. NO and NO_2 concentrations are therefore greatest in urban areas where traffic is heaviest. Other important sources are power stations, heating plant and industrial processes.

Nitrogen oxides are released into the atmosphere mainly in the form of NO, which is then readily oxidised to NO_2 by reaction with ozone. Elevated levels of NO_x occur in urban environments under stable meteorological conditions, when the air mass is unable to disperse.

Nitrogen dioxide has a variety of environmental and health impacts. It is a respiratory irritant, may exacerbate asthma and possibly increase susceptibility to infections. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone. In addition, nitrogen oxides have a lifetime of approximately 1-day with respect to conversion to nitric acid. This nitric acid is in turn removed from the atmosphere by direct deposition to the ground, or transfer to aqueous droplets (e.g. cloud or rainwater), thereby contributing to acid deposition.

4.2 LATEST STANDARDS AND OBJECTIVES FOR NITROGEN DIOXIDE

The National Air Quality Regulations (1997) set two provisional objectives to be achieved by 2005 for nitrogen dioxide:

- An annual average concentration of 40 $\mu g\ m^{-3}$ (21 ppb);
- A maximum hourly concentration of 286 $\mu g\ m^{-3}$ (150 ppb).

In June 1998, the Common Position on Air Quality Daughter Directives (AQDD) agreed at Environment Council included the following objectives to be achieved by 31 December 2005 for nitrogen dioxide:

- An annual average concentration of 40 $\mu g\ m^{-3}$ (21 ppb);
- 200 $\mu g\ m^{-3}$ (100 ppb) as an hourly average with a maximum of 18 exceedances in a year.

The National Air Quality Strategy was reviewed in 1999. The Government proposed that the annual objective of 40 $\mu g\ m^{-3}$ be retained as a provisional objective and that the original hourly average be replaced with the AQDD objective. The revised Air Quality Strategy for England, Scotland, Wales and Northern Ireland (DETR, 1999; 2000) included the proposed changes. Modelling studies suggest that in general achieving the annual mean of 40 $\mu g\ m^{-3}$ is more demanding than achieving the hourly objective. If the annual mean is achieved, the modelling suggests the hourly objectives will also be achieved.

4.3 THE NATIONAL PERSPECTIVE

The main source of NO_x in the United Kingdom is road transport, which, in 2003 accounted for approximately 40% of emissions. Power generation contributed approximately 29% and domestic

sources 5%. In urban areas, the proportion of local emissions due to road transport sources is larger (NAEI, 2005).

National measures are expected to produce reductions in NO_x emissions and achieve the objectives for NO_2 in many parts of the country. However, the results of the analysis set out in the National Air Quality Strategy suggest that for NO_2 a reduction in NO_x emissions over and above that achievable by national measures will be required to ensure that air quality objectives are achieved everywhere by the end of 2005. Local authorities with major roads, or highly congested roads, which have the potential to result in elevated levels of NO_2 in relevant locations, are expected to identify a need to progress to a Further Assessment for this pollutant.

4.4 SUMMARY OF PREVIOUS AIR QUALITY REVIEW AND ASSESSMENT REPORTS

A significant risk of exceedance of the UK objective for annual average NO_2 in 2005 at the following locations in Hereford was predicted in the Council's Stage 4 report of 2002. This study predicted that the exceedances of the objective were considered probable (50%-80%) at the following monitoring locations:

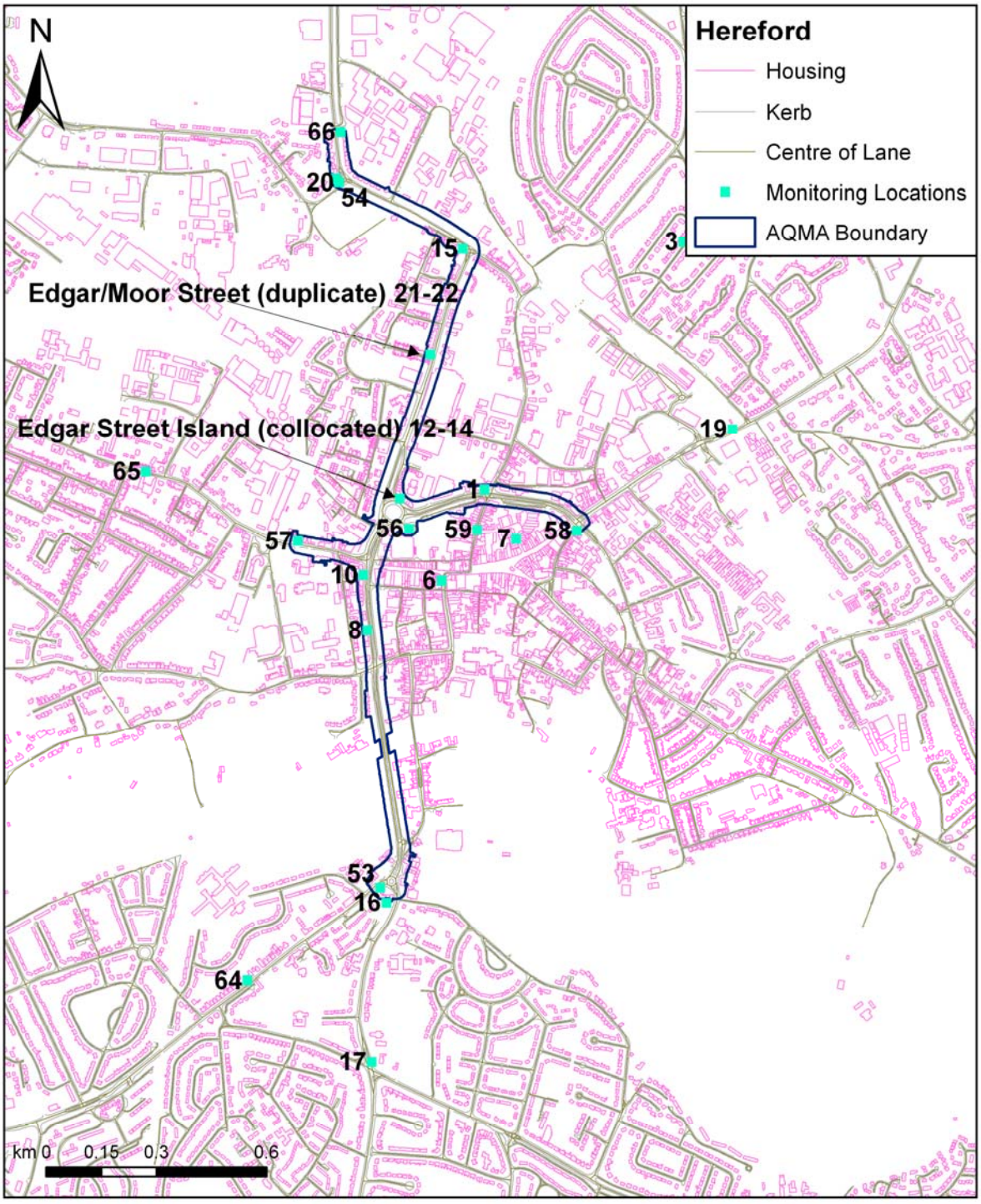
- Victoria Street sites 8 and 9
- 7 Victoria House Façade site 10
- Edgar Street Traffic Island sites 12-14
- Cross Street House Façade site 53

And possible (20%-50%) at:

- Belmont Road/Ross Road site 16
- Holmer Road/Newtown Road site 20

Figure 4.1 indicates the area subsequently declared as an air quality management area (AQMA) in Hereford City. It is this area which is the subject of this Further Assessment.

Figure 4.1 Monitoring locations and AQMA in Hereford



4.5 PROPOSED ACTION PLANNING MEASURES

The following action plans are proposed to be implemented in a phased manner, all of which have been taken into account within the traffic modelling and are planned over the next 20 years:

Action 1 Edgar Street Grid Redevelopment
Action 2 Roman Road – Improvement of Road
Action 3 New Rotherwas Access Road -1st link of Outer Distributor Road
Action 4 New Outer Distributor Road – 2nd link
Action 5 New Outer Distributor Road – 3rd link
Action 6 Install and Implement new Hereford ITS on A49 route in Hereford
Action 7 Alteration of traffic management at the Belmont Roundabout
Action 8 Implement North and South Park and Ride scheme for Hereford
Action 9 Continue to Implement the Parking Strategy in Hereford
Action 10 Improve and increase number of cycle routes and facilities in Hereford
Action 11 City Centre pedestrian enhancement
Action 12 Behavioural Change Programme

4.6 MONITORING DATA

Nitrogen dioxide concentrations are monitored at one site within Hereford by collocated continuous monitoring and by diffusion tubes at 21 further roadside sites in Hereford.

4.6.1 Continuous monitoring

Location of the continuous monitor
Concentrations of NO_X and NO_2 are recorded by a continuous monitor located at the Edgar Street Island (OS co-ordinates 350776 240224). The inlet port is approximately 3m from the kerbside at a height of 1.2m above the ground. The monitor is a API model 200 NO_2 chemiluminescent analyser. Immediately behind the monitor is a 15m high brick wall. Lights control the traffic flow on this island and traffic idles near the monitor. The traffic flow around the island is not well characterised.

Measurement technique and QA/QC
Ozone chemiluminescence is the reference method specified by the EU NO_2 Directives. The Edgar Street NO_2 chemiluminescent analyser is serviced and calibrated 6 monthly and records are kept of this. Any breakdowns are reported to and repaired by Envirotechnology Ltd. Upgraded software has been installed to download the data daily by telemetry to a PC based in the Council's Bath Street Offices. In addition to site operations, Herefordshire Council also undertake their own data collection and ratification procedures.

In March 2000 span gas calibrations for the chemiluminescent nitrogen dioxide analyser was implemented. This measures the accuracy of the chemiluminescent analyser at two weekly intervals, against a cylinder of nitrous oxide gas at a known concentration. The results of this are used to adjust the chemiluminescent analyser's readings to account for drift. Procedures relating to the span gas calibrations are maintained as controlled documents as part of the Environmental Health and Trading Standard's new ISO 9001 quality assurance system.

Since March 2000 diffusion tube data has been adjusted for bias against triplicate tubes co-located beside the Edgar Street chemiluminescent analyser's inlet port. In 2000, many of the diffusion tubes were also relocated to more meaningful locations on house facades, which correspond to public exposure.

Summary statistics
Table 4.1 shows the measured concentrations in years 2004-2005. The concentrations measured are consistently at or above the annual mean objective for nitrogen dioxide of 40 $\mu g/m^3$.

Table 4.1 Summary of continuous nitrogen dioxide ratified data 2004-2005.

Statistic	Concentration (µgm-3)				
Year:	2004	2005 Estimate based on 2004 monitoring	2010 Estimate based on 2004 monitoring	2005	2010 Estimate based on 2005 monitoring
Annual Mean NO_2	50.1	48.8	40.2	48.1	39.6
Annual Max Hour NO_2	159.7			193.6	
Data Capture (%) NO_2	98			99	

4.6.2 Diffusion tubes

Diffusion tubes at 21 roadside locations in Hereford measure monthly average concentrations of nitrogen dioxide (see Figure 4.1 for locations). The measurement data for 2004 and 2005 for these sites is summarised in Table 4.2 below. Appendix 2 provides a breakdown of the raw monitoring data on a monthly basis, as well as data on the positioning of tubes relative to roads and nearby receptors.

Diffusion tubes can under or over-read and if possible should be referred to the results of continuous monitoring. A diffusion tube triplicate has been co-located with the continuous monitor at Edgar Street Island since January 2001.

The type of diffusion tube supplied to Herefordshire Council by Gradko is an NO_2 Palmes type passive sampler with a 20% TEA / Water absorbent. The method of analysis is colourmetric using a u.v. / vis spectrophotometer and measuring against N.I.S.T. nitrite standards. The Gradko laboratory takes part in the WASP proficiency and netcen NO_2 field inter-comparison schemes.

On the basis of the local co-location study in Hereford, 2004 and 2005 diffusion tube bias adjustment factors of 1.028 and 0.957 respectively were calculated using the netcen diffusion tube precision and accuracy bias adjusting spreadsheet. UWE publish the results of UK-wide collocation studies on their website. Results for Gradko for years 2002-2005 for this preparation method indicate bias adjustment factors in the range of 1.00-0.97, the 2004 and 2005 factors being 0.91 and 0.97 respectively. The local factors have therefore been used to bias adjust the diffusion tube results to provide a conservative estimate for 2004, and a best-case estimate for 2005.

It should be taken into account that diffusion tubes are spot measurements and may be very sensitive to distance from the road as concentrations change rapidly with distance from the kerbside when comparing them with modelled results.

To predict the diffusion tube concentrations in 2010 from measurements in years 2005, the adjustment factors given in LAQM.TG(03) have been applied (Table 4.2). These forward projections do not take into account the possible effect of local traffic growth or of action planning measures.

Table 4.2 Nitrogen dioxide diffusion tube survey 2004 and 2005 results for Hereford monitoring sites corrected for bias with predictions for 2010.

2005 NO_2 Annual Mean Diffusion Tube Data										
X	Y	ID	Site Name	2004 Unadjusted (μgm^{-3})	2004 Adjusted** (μgm^{-3})	2005 Estimate Based on 2004 Adjusted** (μgm^{-3})	2010 Estimate Based on 2004 Adjusted** (μgm^{-3})	2005 Unadjusted (μgm^{-3})	2005 Adjusted*** (μgm^{-3})	2010 Estimate Based on 2005 Adjusted*** (μgm^{-3})
351007	240248	1	Garrick House, HF	38	39	38	32	**40**	38	31
351548	240924	3	*Geoffrey Ave, HF*	20	20	20	16	18	18	15
353106	240559	5	*Heywood Ave, HF*	13	13	13	11	13	13	10
350890	240000	6	*Broad St, HF*	38	39	38	32	39	37	31
351093	240114	7	*Gommond St, HF*	21	22	21	18	20	19	16
350677	240015	10	Victoria St, HF	**44**	**46**	**44**	37	**50**	**47**	39
350948	240905	15	Newtown Rd/Edgar St, HF	35	36	35	29	36	34	28
350740	239122	16	Belmont Rd/Ross Rd, HF	39	**40**	39	32	**44**	**42**	34
350700	238685	17	*Holme Lacy Rd/Ross Rd, HF*	**47**	**48**	**47**	39	**54**	**52**	**43**
351681	240412	19	*Commercial St/RW Bridge, HF*	37	38	37	31	39	38	31
350611	241086	20	Holmer/Newtown Rd Is, HF	33	34	33	28	**42**	**41**	33
350723	239163	53	House Façade, Cross St, Belmont, HF	**42**	**43**	**42**	35	**43**	**41**	34
350602	241097	54	House Façade, Holmer Rd, HF	32	33	32	27	31	30	25
350801	240142	56	Bus Station, HF	**45**	**46**	**45**	38	**45**	**43**	36
350499	240108	57	Shop flat FA, Eign St, HF	33	34	33	28	38	36	30
351258	240136	58	Shop flat FA, Union/Bath St, HF	29	30	29	24	33	31	26
350987	240139	59	*Elgars Restaurant FA, Widemarsh St, HF*	30	31	31	25	31	29	24
350362	238909	64	*106 Belmont Rd FA, HF*					31	29	24
350086	240296	65	*96 Whitecross Rd FA, HF*					**50**	**48**	39
350616	241225	66	House FA Comets A49					27	26	22
349158	242261	67	Roman Rd, HF					26	24	20
			Multiple Tube Average							
350688	239864	8 to 9	Victoria St, HF	**43**	**44**	**43**	36	**48**	**46**	38
350860	240615	21 to 22	Façade Edgar/Moor St, HF	**43**	**44**	**43**	36	**48**	**46**	38
			Collocation							
350776	240224	12 to 14	Edgar St RB, HF	**49**	**51**	**50**	**41**	**50**	**48**	39

** using 1.028 2004 local diffusion tube bias adjustment from netcen spreadsheet
***using 0.957 2005 local diffusion tube bias adjustment from netcen spreadsheet

Figures in **bold** indicate predicted exceedance of the UK objective in 2005, or EU Limit Value in 2010
All sites within Hereford City, Sites NOT within AQMA in *italics*
All locations are roadside

4.6.3 Comparison of monitoring data with AQ objectives

The continuous monitoring shows that the nitrogen dioxide concentrations at the roadside of Edgar Street Island at this location appear to be consistently well above the annual mean NO_2 objective in 2005. However, concentrations may decline sufficiently by 2010 to allow the EU limit value to be met at this site, provided local traffic flow does not increase significantly.

Diffusion tubes at other roadside locations within the AQMA (Table 4.2) indicate concentrations at the roadside in these streets, which were generally well above the annual mean objective for NO_2 in 2005. Some are predicted to be lower by 2010, but may still exceed the EU Limit Value by up to 3$\mu g/m^3$ in some cases. Outside the AQMA, in 2005 sites 3, 5, 6, 7, 19, 59 and 64 are all below the NO_2 annual mean objective but sites 17 and 65 are over the objective. It should be noted both these sites are at kerbside locations where the relevant receptor is significantly further back from the roadside. It is recommended that these sites therefore be moved to the facade of the relevant receptor. Should concentrations in excess of 40 $\mu g/m^3$ then be measured at the facades, the Council may wish to consider extending the AQMA's to encompass these locations. It should be noted that modelling undertaken in this study did not predict exceedances at these locations at relevant receptors (see below).

As the measured concentrations are well below 60$\mu g/m^3$ it is considered unlikely that the hourly mean objective for NO_2 is exceeded and therefore it should not be necessary to further assess concentrations at the kerbside.

4.7 TRAFFIC MODELLING SUMMARY

In this study, the concentrations of NO_2 at receptors close to the roads and junctions of interest have been modelled using ADMS-3.2 as a dispersion kernel model.

The roads were defined as volume sources, 3m deep, and were broken up in to a series of adjoining segments. The length of these segments was dictated by the way in which the OS LandLine data was digitised and varied from one or two metres in length (where the road rapidly changed direction) to hundreds of metres in length (where the road was essentially straight). The OS LandLine data was used to provide the co-ordinates of the centre line of the road, and the road widths. Therefore, the position of the volume sources (here the roads) were accurate to approximately a metre.

Where queuing of vehicles was reported, emissions from stationary vehicles exhausts were estimated on the basis that the engine power output and hence emissions were the same as those at a speed of 5 kph. Queuing vehicles were assumed to be 5 m apart.

4.8 SOURCES OF BACKGROUND (NON-TRAFFIC) EMISSIONS DATA

Background emissions of oxides of nitrogen (NO_x) from sources not modelled in detail have been taken from the UK National Atmospheric Emissions Inventory (www.naei.org.uk) and scaled to the year of interest where necessary following the recommended procedure in LAQM. TG(03). The contribution to emissions from the roads modelled in detail have been omitted where this would lead to double counting of the local impact of emissions.

4.9 MODEL BIAS

A comparison was undertaken between the annual mean NO_2 concentrations predicted at the locations of the automatic monitor and the NO_2 diffusion tubes and those actually measured (Table 4.3 below). Agreement between the model and the automatic monitor was good, with the model over-predicting at this location by 8% in 2005. Agreement with bias corrected diffusion tubes was generally good. Table 4.3 and Figure 4.2 illustrate the agreement between the model and monitor. At nearly two thirds of sites the model predicted within 25% of the monitor and at over half of sites within 10%. As queuing and congestion occurs on the Edgar Street Island, emissions here are

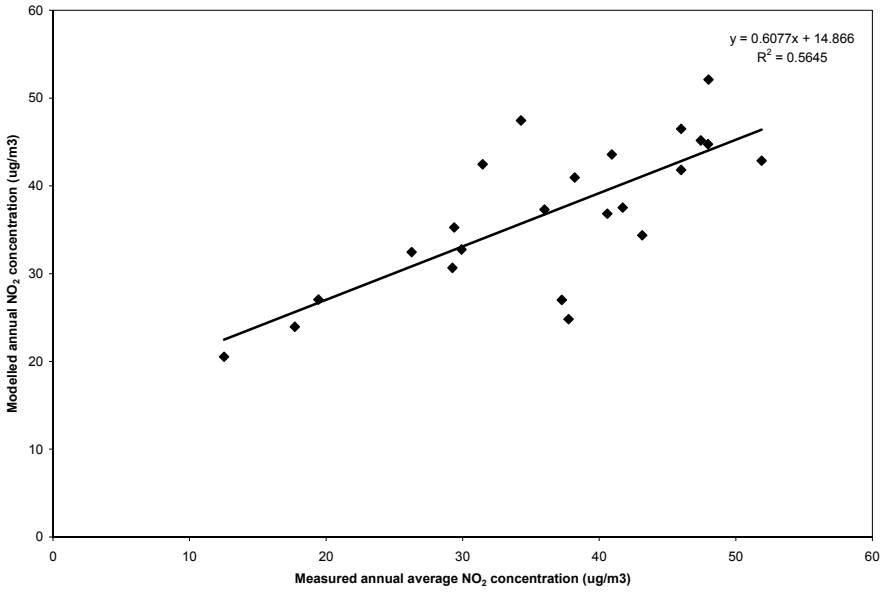
difficult to define. For this reason it was decided not to bias adjust the model according to the automatic monitor, given the generally good level of agreement between the model results and monitoring. This will make the assessment slightly more conservative at some roadside locations. There are a number of possible explanations accounting for the discrepancies in agreement between monitor and model. The automatic monitor is located on a traffic island with idling traffic in queues making prediction of emissions more difficult. At other locations, uncertainty regarding traffic speeds and queuing and congestion are also likely to have lead to some error in the calculation of emissions. The meteorological data used also had to be taken from a non-local site as no sites nearby had good enough data capture over the past 5 years.

Table 4.3: Comparison of modelled and measured concentrations for 2005 (Base Year)

2005 NO_2 Modelled and Measured Concentrations						
X	**Y**	**ID**	**Site Name**	**% Overprediction of model relative to monitor**	**Nitrogen Dioxide Concentration (ug/m^3)**	
				% Difference	**Modelled**	**Measured (Adjusted)**
351007	240248	1	Garrick House, HF	-7%	**41**	**48**
351548	240924	3	*Geoffrey Ave, HF*	20%	24	29
353106	240559	5	*Heywood Ave, HF*	4%	21	36
350890	240000	6	*Broad St, HF*	9%	27	30
351093	240114	7	*Gommond St, HF*	-9%	27	**41**
350688	239864	9	Victoria St (D2), HF	24%	**46**	26
350677	240015	10	Victoria St, HF	-5%	**45**	**47**
350776	240224	12	Edgar St RB, HF	1%	**52**	**46**
350948	240905	15	Newtown Rd/Edgar St, HF	-17%	**47**	**52**
350740	239122	16	Belmont Rd/Ross Rd, HF	7%	38	**41**
350700	238685	17	*Holme Lacy Rd/Ross Rd, HF*	-10%	**43**	**42**
351681	240412	19	*Commercial St/RW Bridge, HF*	9%	25	**48**
350611	241086	20	Holmer/Newtown Rd Is, HF	-20%	37	**43**
350860	240615	21	FA Edgar/Moor St, HF	-9%	**42**	**46**
350723	239163	53	House Façade, Cross St, Belmont, HF	-27%	**44**	37
350602	241097	54	House Façade, Holmer Rd, HF	38%	33	34
350801	240142	56	Bus Station, HF	5%	34	29
350499	240108	57	Shop flat FA, Eign St, HF	7%	37	38
351258	240136	58	Shop flat FA, Union/Bath St, HF	39%	**42**	19
350987	240139	59	*Elgars Restaurant FA, Widemarsh St, HF*	35%	31	31
350362	238909	64	*106 Belmont Rd FA, HF*	35%	35	18
350086	240296	65	*96 Whitecross Rd FA, HF*	-34%	**45**	38
350616	241225	66	House FA Comets A49	64%	32	13

Figures in **bold** indicate predicted exceedance of the UK objective in 2005, or EU Limit Value in 2010
All sites within Hereford City, Sites NOT within AQMA in *italics*
All locations are roadside

Figure 4.2 Regression analysis of modelled and measured nitrogen dioxide



4.10 MODEL VALIDATION

In simple terms, model validation is where the model is tested at a range of locations and is judged suitable to use for a given application. The modelling approach used in this assessment has been validated, and used in numerous **netcen** air quality review and assessments. Statistical techniques have been used to assess the likelihood that there will be an exceedance of the air quality objectives given the modelled concentration. The validation statistics are given in Appendix 3. Confidence limits for the predicted concentrations were calculated based on the validation studies by applying statistical techniques based on Student's t distribution. The confidence limits took account of uncertainties resulting from:

- Model errors at the receptor site;
- Model errors at the reference site;
- Uncertainty resulting from year to year variations in atmospheric conditions.

The confidence limits have been used to estimate the likelihood of exceeding the objectives at locations close to the roads. The following descriptions have been assigned to levels of risk of exceeding the objectives.

It would be recommended that Herefordshire Council generally consider declaring or reconfirming an AQMA where the probability of exceedance in 2005 is greater than 50% ("Probable").

Table 4.4: Uncertainties in the modelled concentrations for NO_2.

Description	Chance of exceeding objective	Modelled annual average concentrations, $\mu g/m^3$	
		Likelihood of exceeding annual average objective	Likelihood of exceeding hourly average objective
Very unlikely	Less than 5%	<28	<38
Unlikely	5-20%	28-34	38-52
Possible	20-50%	34-40	52-67
Probable	50-80%	40-46	67-82
Likely	80-95%	46-52	82-95
Very likely	More than 95%	>52	>95

The confidence limits for the 'probable' and 'likely' annual average and hourly objective concentrations have been set equal to those for 'possible' and 'unlikely', respectively. In reality, the intervals of concentration increase in size as the probability of exceeding the annual and hourly objective increases from 'unlikely' to 'likely'. The advantage to setting symmetrical concentration intervals is that the concentration contours on the maps become simpler to interpret. This is a mildly conservative approach to assessing the likelihood of exceedances of the NO_2 objectives since a greater geographical area will be included using the smaller confidence intervals.

A simple linear relationship can be used to predict the 99.8th hourly percentile concentration of NO_2 from the annual concentration: the 99.8th percentile is three times the annual mean at kerbside/roadside locations. Therefore, plots of the modelled annual mean NO_2 concentrations can be used to show exceedances of both the annual and hourly NO_2 objectives. However, the magnitude of the concentrations used to judge exceedances of the hourly objective need to be adjusted so they may be used directly with the plots of annual concentration. This has been performed by simply dividing the concentrations of the confidence limits by three.

Verification of the model involves comparison of the modelled results with any local monitoring data at relevant locations. Table 4.3 provides a comparison of modelled and measured nitrogen dioxide concentrations.

4.11 RESULTS OF MODELLING

4.11.1 2005 NO_2 modelling results (Base Case)

Figures 4.3-4.6 show the 2005 modelled NO_2 concentrations in Holmer Road/Newtown Road, Eign Street/Edgar Street, Newmarket Street/Blue School Street and Belmont Road/Ross Road.

Under the 2005 base case the following measures have been implemented:

Action 2 Roman Road – Improvement of Road
Action 9 Continue to Implement the Parking Strategy in Hereford
Action 10 Improve and increase number of cycle routes and facilities in Hereford
Action 12 Behavioural Change Programme

1 Holmer Road/Newtown Road

The model predicts that the annual average objective of 40$\mu g/m^3$ for nitrogen dioxide is being exceeded around the junction with Edgar Street in 2005 (Figure 4.3). The 40$\mu g/m^3$ concentration isoplot extends northwards up Newtown Road but this does not encroach on the building façades on Newtown and Holmer Road.

The agreement between the monitoring and modelled NO_2 concentration is good at sites 20 and 54, but with the model overpredicting at sites 15 and 66 (Table 4.3). At location site the model predicts that it is at most ***likely*** (with a probability of 80%-95%) that the annual average objective will be exceeded in 2005 (Table 4.4) at relevant locations.

However, as none of the monitoring locations indicates an exceedance to the north of the Newtown/Edgar Street junction, Herefordshire Council may wish to remove this northern end from the AQMA (Newtown Road/Holmer Road), unless a precautionary approach is required, in which case we recommend no change pending further monitoring. Site 20 is located on a traffic island and is not considered representative of relevant exposure.

2 Eign Street/Edgar Street

In Figure 4.4 the model predicts that the annual average objective for NO_2 is being exceeded at the building façades along:

- Edgar Street
- Eign Street (as far as monitoring location site 57)
- Newmarket Street
- Victoria Street

The agreement between the monitoring and modelled NO_2 concentration at the collocated site (sites 12-14) Edgar Street Island is good, the model overpredicting compared to the monitor by 8% (Table 4.3). An exceedance is predicted at kerbside diffusion tube site 65, which is not predicted by the model. This tube is not located at a relevant receptor.

At this location the model validation predicts that the modelled data is ***very likely*** (with a probability of >95%) to be exceeding the annual average objective (Table 4.4) at relevant locations.

3 Newmarket Street/Blue School Street

For 2005, along Newmarket Street and Blue School Street as far as the junction with Bath Street, the model predicts that the NO_2 annual mean objective is being exceeded at some building façades (Figure 4.5). However, east of the junction with Blue School Street, Widemarsh Street and Commercial Road no exceedances are predicted in 2005.

The agreement between the monitoring and modelled NO_2 concentration is good at sites 2 and 59, but with the model underpredicting at site 56 and overpredicting at sites 7 and 58 (Table 4.3). At this location the model validation predicts that the modelled data is at most ***very likely*** (with a probability of over 95%) to be exceeding the annual average objective (Table 4.4) at relevant receptors.

4 Belmont Road/Ross Road

Figure 4.6 of the modelled results for 2005 for Belmont and Ross Road show that there are exceedances of the 40$\mu g/m^3$ objective at and in the immediate vicinity of the roundabout, with the

40μg/m^3 concentration extending southwards down Ross Road. However, along Ross Road no exceedances are predicted at relevant receptors south of the junction.

The agreement between the monitoring and modelled NO_2 concentration is good at sites 16,17 and 53, but with the model overpredicting at site 62 (Table 4.3). At this location the model validation predicts that the modelled data is at most ***very likely*** (with a probability of over 95%) to be exceeding the annual average objective (Table 4.4) at relevant receptors.

Table 4.5 Probability of exceedance

X	Y	ID	Site	Modelled 2005 NO_2 concentration (ug/m3)	Probability of exceeding annual average objective
351007	240248	1	Garrick House, HF	**41**	Probable 50-80%
351548	240924	3	*Geoffrey Ave, HF*	24	Very unlikely <5%
353106	240559	5	*Heywood Ave, HF*	21	Very unlikely <5%
350890	240000	6	*Broad St, HF*	27	Very unlikely <5%
351093	240114	7	*Gommond St, HF*	27	Very unlikely <5%
350688	239864	9	Victoria St (D2), HF	**46**	Likely 80-95%
350677	240015	10	Victoria St, HF	**45**	Probable 50-80%
350776	240224	12	Edgar St RB, HF	**52**	Very likely >95%
350948	240905	15	Newtown Rd/Edgar St, HF	**47**	Likely 80-95%
350740	239122	16	Belmont Rd/Ross Rd, HF	38	Possible 20-50%
350700	238685	17	*Holme Lacy Rd/Ross Rd, HF*	**43**	Probable 50-80%
351681	240412	19	*Commercial St/RW Bridge, HF*	25	Very unlikely <5%
350611	241086	20	Holmer/Newtown Rd Is, HF	37	Possible 20-50%
350860	240615	21	FA Edgar/Moor St, HF	**42**	Probable 50-80%
350723	239163	53	House Façade, Cross St, Belmont, HF	**44**	Probable 50-80%
350602	241097	54	House Façade, Holmer Rd, HF	33	Unlikely 5-20%
350801	240142	56	Bus Station, HF	34	Possible 20-50%
350499	240108	57	Shop flat FA, Eign St, HF	37	Possible 20-50%
351258	240136	58	Shop flat FA, Union/Bath St, HF	**42**	Probable 50-80%
350987	240139	59	*Elgars Restaurant FA, Widemarsh St, HF*	31	Unlikely 5-20%
350362	238909	64	*106 Belmont Rd FA, HF*	35	Possible 20-50%
350086	240296	65	*96 Whitecross Rd FA, HF*	**45**	Probable 50-80%
350616	241225	66	House FA Comets A49	32	Unlikely 5-20%

Figure 4.3 Predicted annual mean nitrogen dioxide concentrations in Hereford 2005 – Holmer Road/Newtown Road

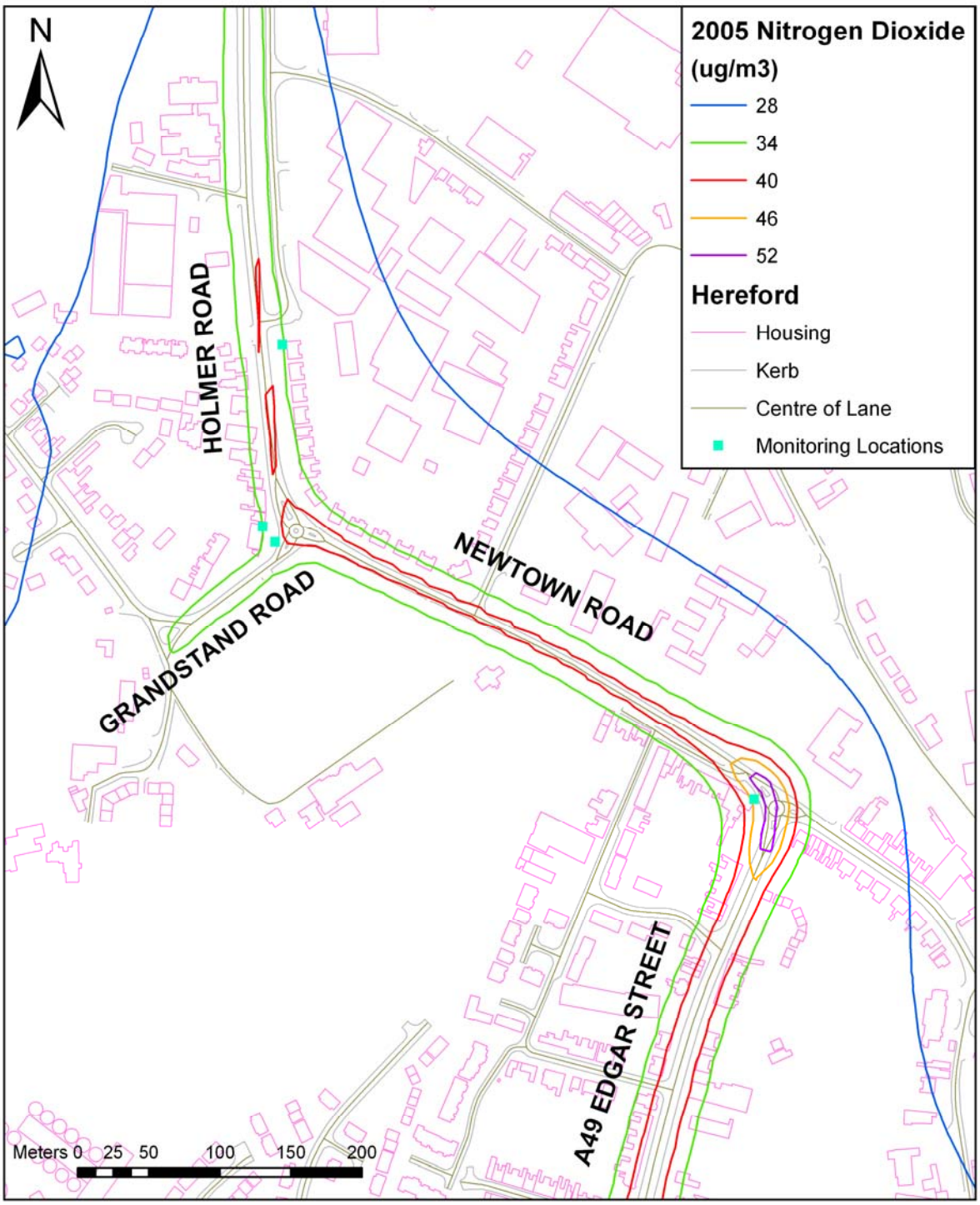


Figure 4.4 Predicted annual mean nitrogen dioxide concentrations in Hereford 2005 – Eign Street/Edgar Street

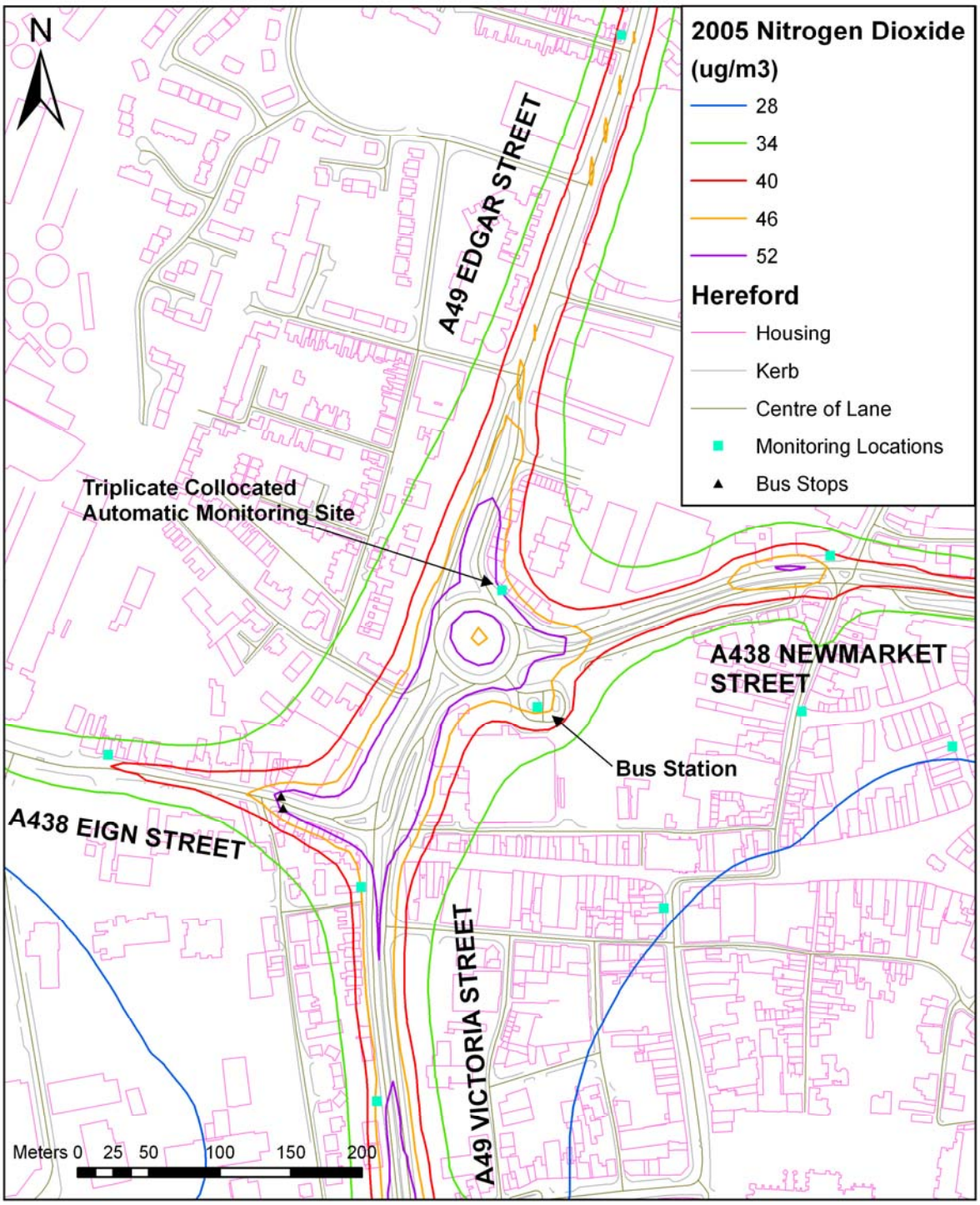


Figure 4.5 Predicted annual mean nitrogen dioxide concentrations in Hereford 2005 – Newmarket Street/Blue School Street

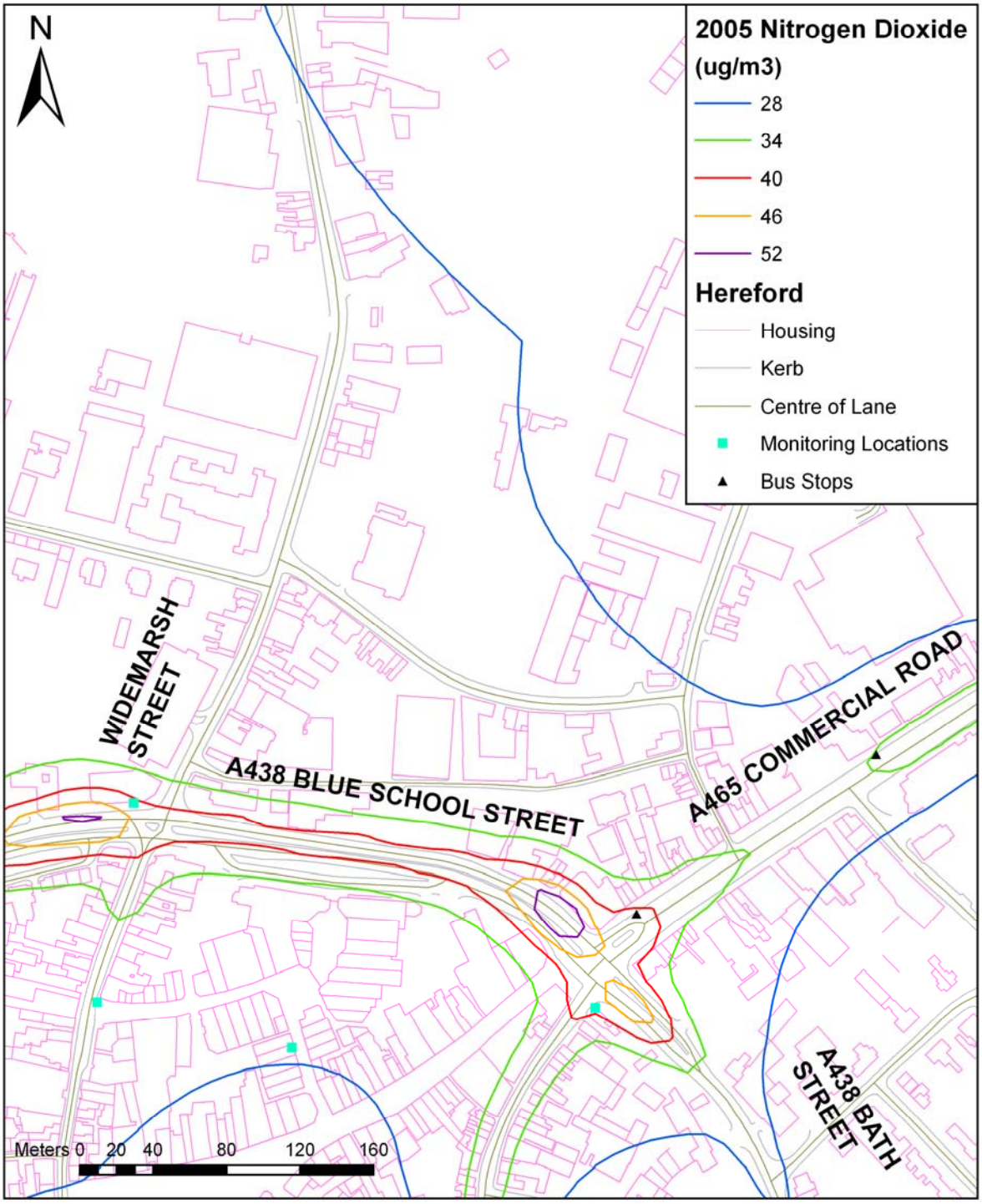
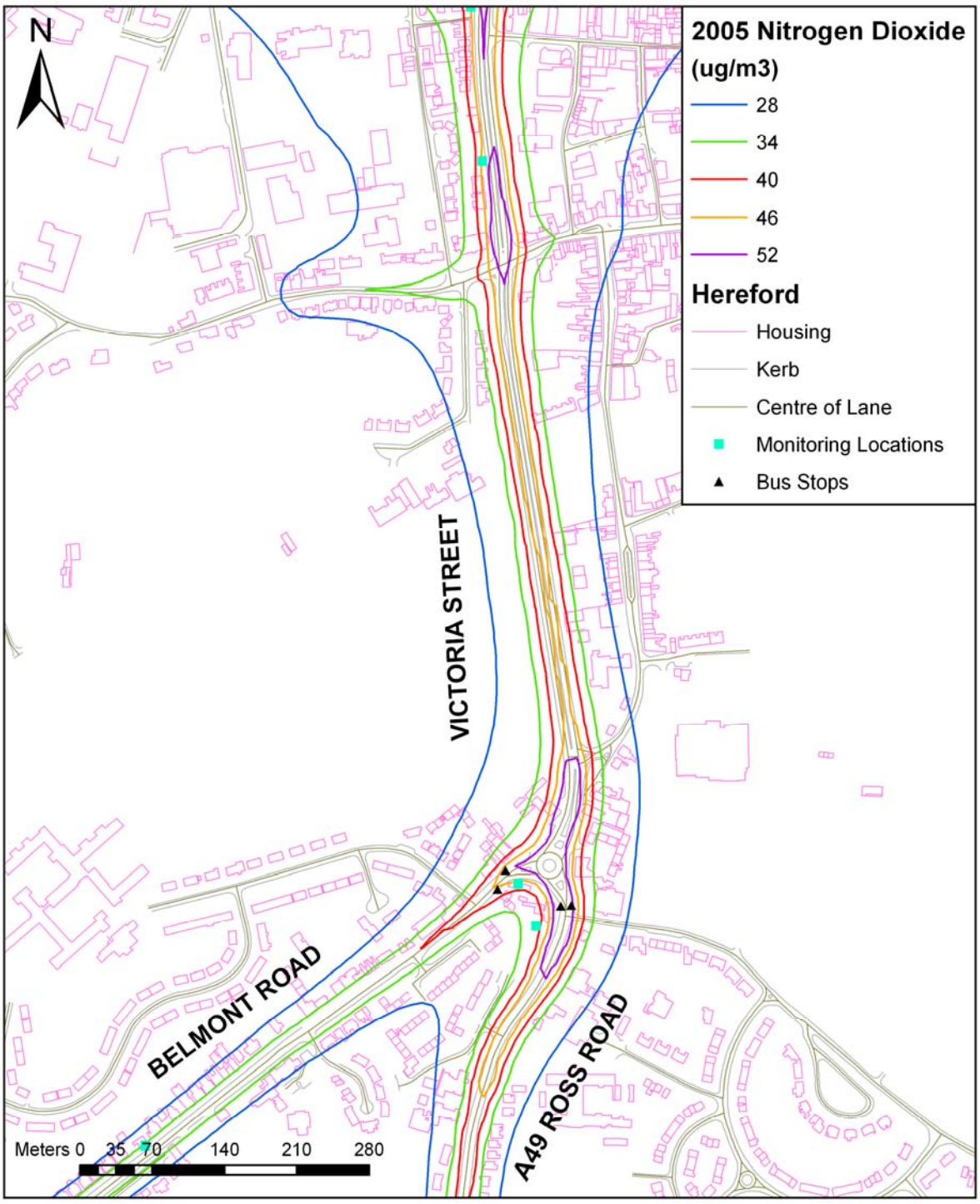


Figure 4.6 Predicted annual mean nitrogen dioxide concentrations in Hereford 2005 – Belmont Road/Ross Road



4.11.2 2010 NO_2 modelling results

In 2010 a series of six traffic measures are proposed to be implemented:

Action 1 Edgar Street Grid Redevelopment
Action 3 New Rotherwas Access Road -1st link of Outer Distributor Road
Action 6 Install and Implement new Hereford ITS on A49 route in Hereford
Action 7 Alteration of traffic management at the Belmont Roundabout
Action 8 Implement **North** Park and Ride scheme for Hereford
Action 11 City Centre pedestrian enhancement

In addition to those already in operation from 2005:

Action 2 Roman Road – Improvement of Road
Action 9 Continue to Implement the Parking Strategy in Hereford
Action 10 Improve and increase number of cycle routes and facilities in Hereford
Action 12 Behavioural Change Programme

It is assumed that the average road speeds, existing bus stops, bus station and bus flows remain the same as in the 2005 base case. Emissions results from queuing and congestions in 2010 have been assumed to vary in proportion to the predicted changes in AADT flow between 2005 and 2010 for each individual road link.

Park and Ride bus movements for the North site were added to the air quality modelling for 2010 as only the resulting changes in car flows were taken into account in the traffic modelling. Herefordshire Council are ISO 14001 accredited, therefore the Park and Ride bus fleet would be the latest Euro Standard available and carbon neutral; most likely using biodiesel. However, this fuel type change has not been modelled, as currently there are no speed-related emission factors for biodiesel. As a result the model can only assume the use of diesel buses, which follow the national fleet mix trend by 2010.

1 Holmer Road/Newtown Road

There is a reduction in the area of exceedance, with exceedances at relevant receptors limited to the Edgar Street/Newtown Road junction. There is also a reduction in the annual mean NO_2 exceedance objective along Holmer Road in 2010 due to the substantial reduction in southbound flow as a result of the implemented actions.

At this location the model predicts that it is at most ***probable*** (with a probability of 50%-80%) to be exceeding the annual average objective at relevant receptors.

2 Eign Street/Edgar Street

The high NO_2 concentration (up to 52$\mu g/m^3$ in 2005) is predicted to reduce at the roundabout. Concentrations are lower than in 2005 with a smaller exceedance area (Figure 4.8). In 2010 it is predicted to no longer extend as far into Eign Street and to no longer connect along Newmarket Street due to the reduction in both AADT and the percentage of HDVs. Edgar Street, Widemarsh Street and Victoria Street still see the 40$\mu g/m^3$ objective exceeded along some building façades.

At this location the model predicts that it is at most ***probable*** (with a probability of 50%-80%) to be exceeding the annual average objective at relevant receptors.

3 Newmarket Street/Blue School Street

The NO_2 annual mean objective now is no longer predicted to extend down Newmarket or Blue School Street (Figure 4.9), compared to 2005 and is only present at the Blue School Street/Commercial Road junction where there are no relevant receptors. This is the result of the large reduction in HDV flows between 2005 and 2010.

At this location the model predicts that it is at most ***possible*** (with a probability of 20%-50%) to be exceeding the annual average objective at relevant receptors.

4 Belmont Road/Ross Road

A significant reduction is predicted at the Belmont/Ross roundabout of the high NO_2 concentration (Figure 4.10). The Belmont exceedances of 2005 are now limited to the junction only. Along Ross Road no exceedances are predicted at relevant receptors south of the junction.

At this location the model predicts that it is at most ***probable*** (with a probability of 50%-80%) to be exceeding the annual average objective at relevant locations.

Figure 4.7 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-3, 6-12) in 2010 - Holmer Road/Newtown Road

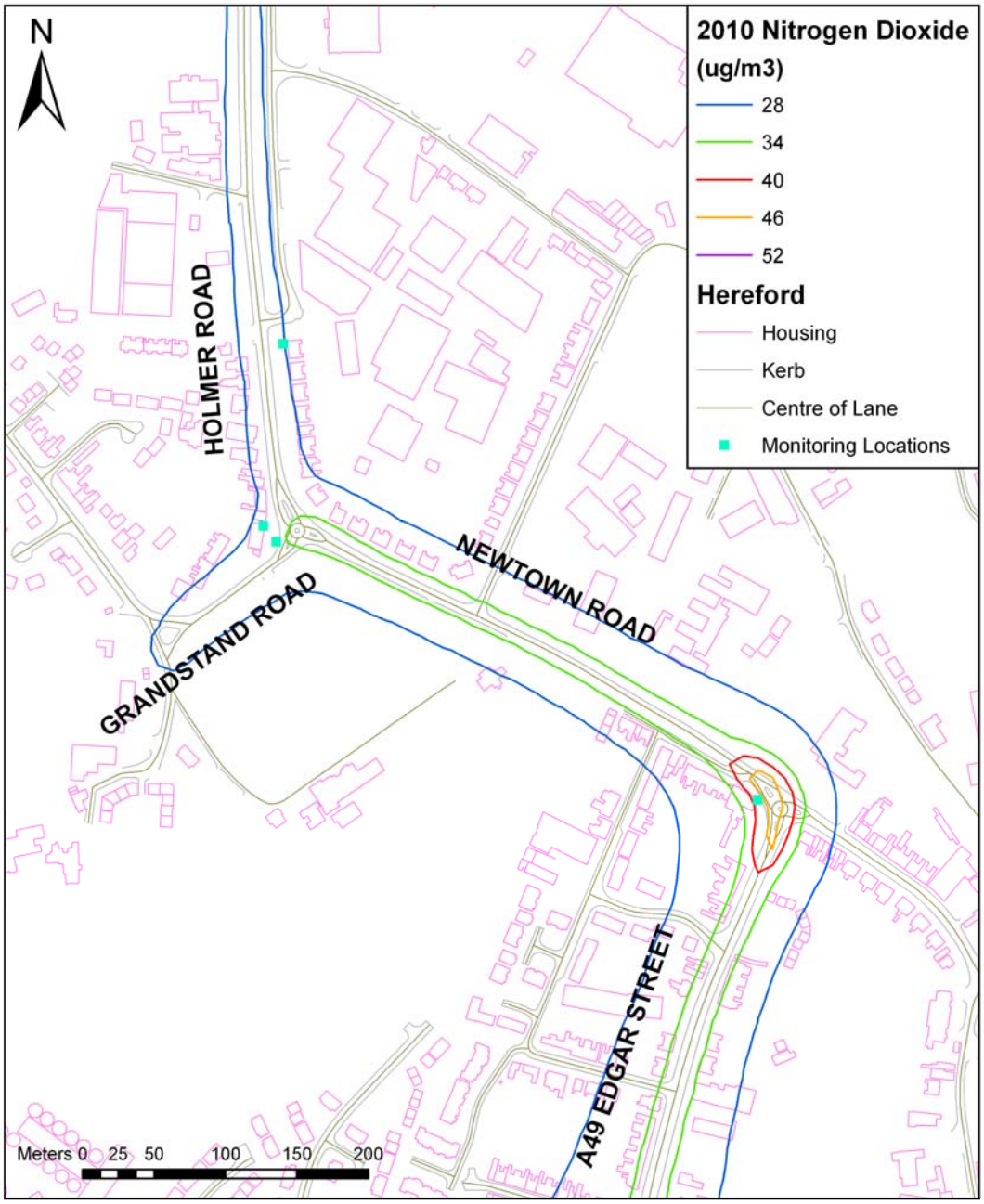


Figure 4.8 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-3, 6-12) in 2010 - Eign Street/Edgar Street

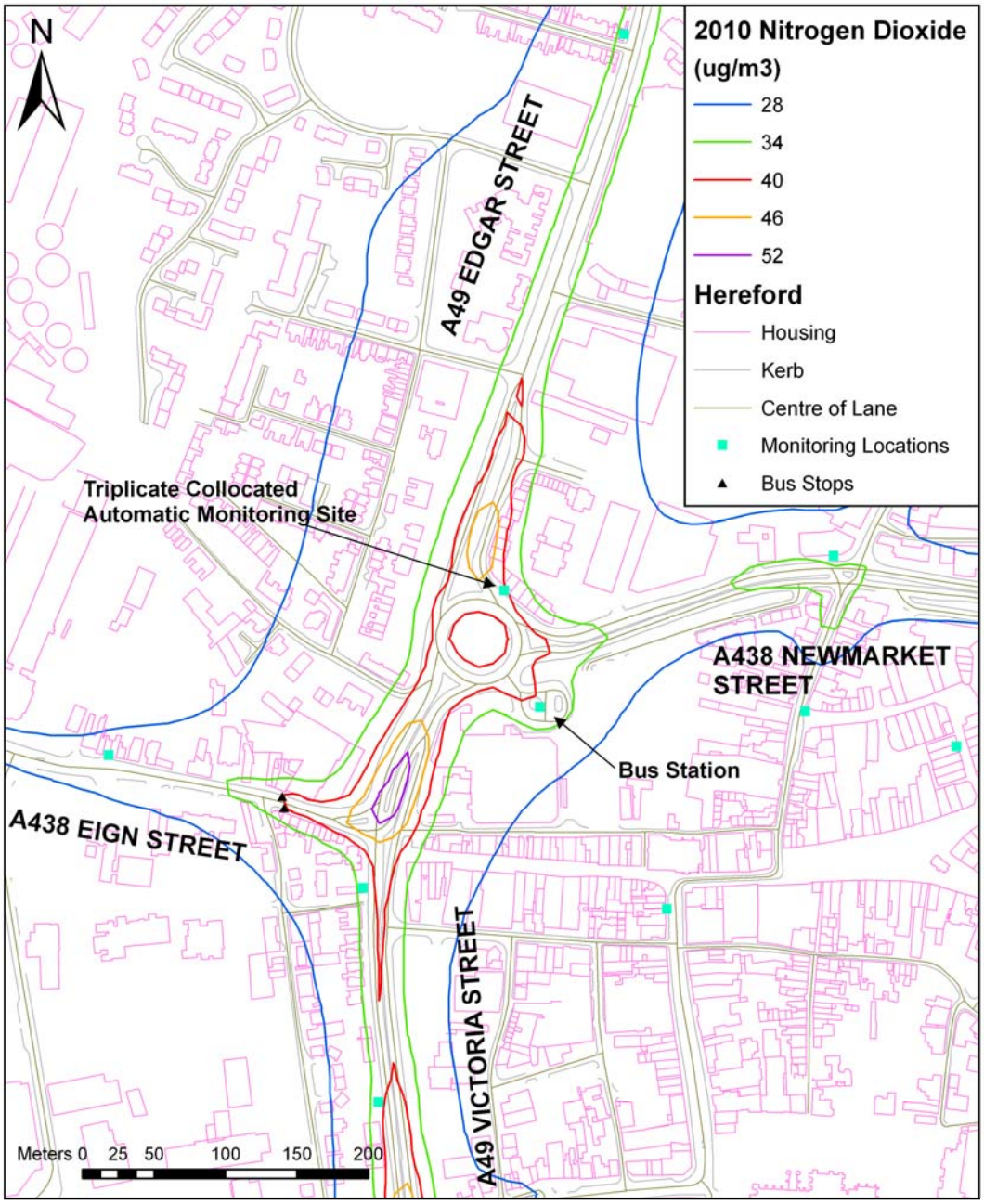


Figure 4.9 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-3, 6-12) in 2010 - Newmarket Street/Blue School Street

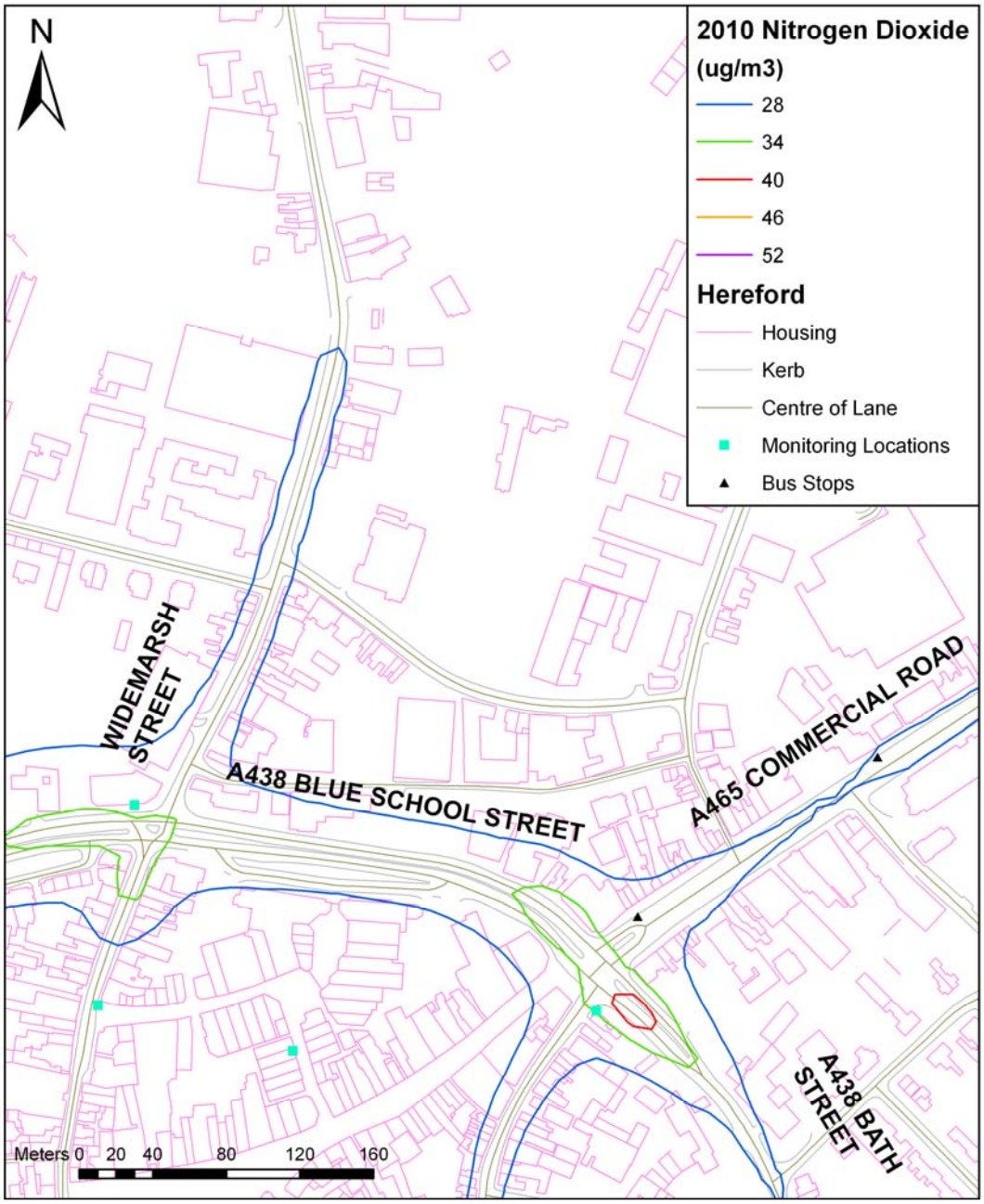
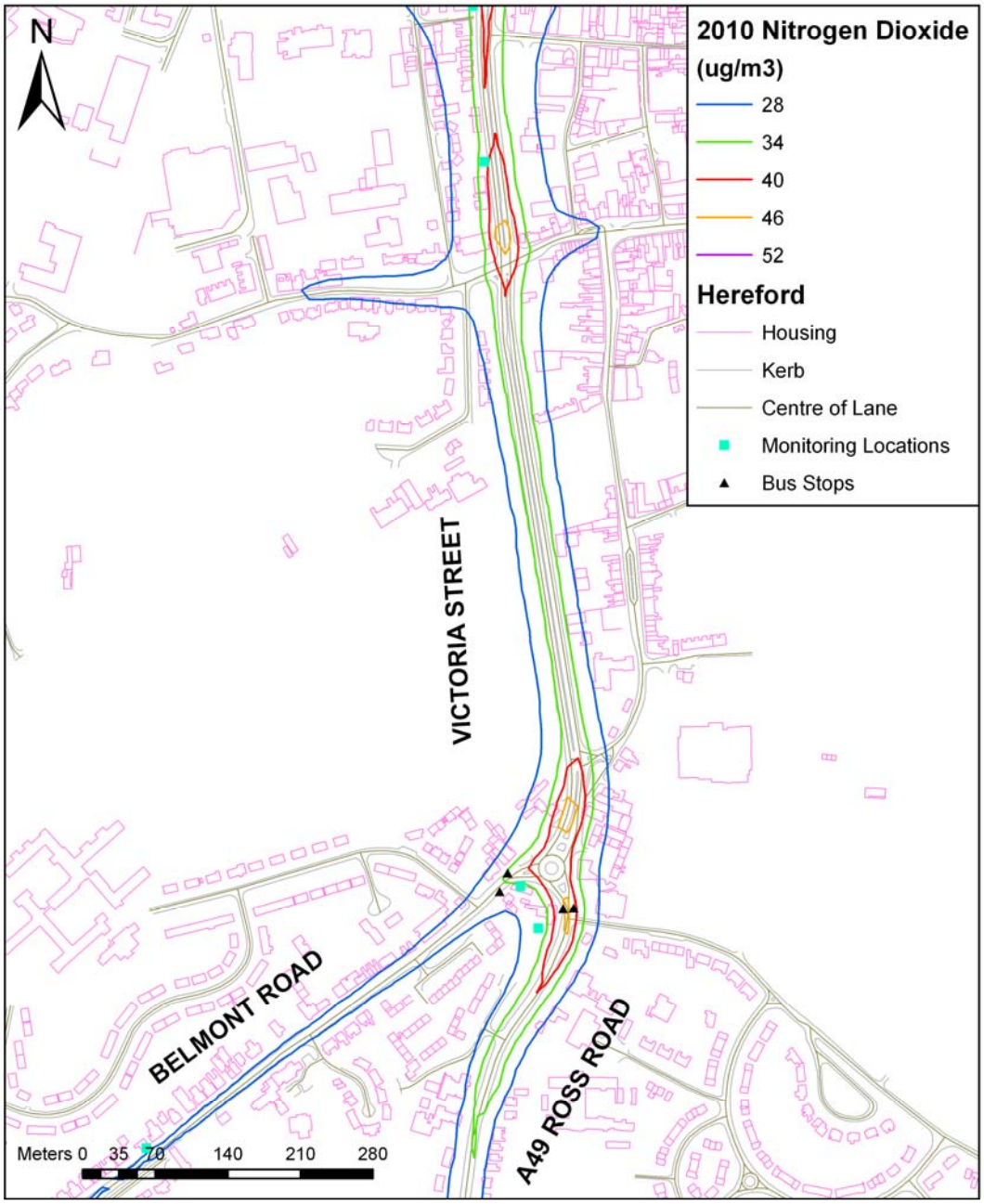


Figure 4.10 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-3, 6-12) in 2010 - Belmont Road/Ross Road



4.11.3 2015 NO_2 modelling results

In 2015 two additional traffic measures:

Action 4 New Outer Distributor Road – 2nd link
Action 8 Implement South Park and Ride scheme for Hereford

- are proposed to have been implemented alongside the nine traffic measures in operation by 2010:

Action 1 Edgar Street Grid Redevelopment
Action 2 Roman Road – Improvement of Road
Action 3 New Rotherwas Access Road -1st link of Outer Distributor Road
Action 6 Install and Implement new Hereford ITS on A49 route in Hereford
Action 7 Alteration of traffic management at the Belmont Roundabout
Action 8 North Park and Ride scheme for Hereford
Action 9 Continue to Implement the Parking Strategy in Hereford
Action 10 Improve and increase number of cycle routes and facilities in Hereford
Action 11 City Centre pedestrian enhancement
Action 12 Behavioural Change Programme

It is assumed that the average road speeds, existing bus stops, bus station and bus flows remain the same as in the 2005 base case. Emissions results from queuing and congestions in 2010 have been assumed to vary proportionately to the predicted changes in AADT flow between 2005 and 2015 for each individual road link.

Park and Ride bus movements for the North and South sites were added to the air quality modelling for 2015 as only changes in car flow were taken into account in the traffic modelling. Herefordshire Council are ISO 14001 accredited, therefore the Park and Ride bus fleet would be the latest Euro Standard available and carbon neutral; most likely using biodiesel. However, this fuel type change has not been modelled, as currently there are no speed-related emission factors for biodiesel. As a result the model can only assume the use of diesel buses, which follow the national fleet mix trend by 2015.

1 Holmer Road/Newtown Road

Under the traffic measures in 2015, the 40$\mu g/m^3$ annual mean contour is limited to the roundabout only, where exceedances at relevant receptors are predicted (Figure 4.11).

At this location the model predicts that it is at most ***probable*** (with a probability of 50%-80%) to be exceeding the annual average objective at relevant receptors.

2 Eign Street/Edgar Street

The 40$\mu g/m^3$ objective is still predicted to be exceeded along some building façades along Edgar Street, Eign Street and Victoria Street. A significant improvement from the roundabout along Newmarket is shown, with no exceedance of the objective.

At this location the model predicts that it is at most ***probable*** (with a probability of 50%-80%) to be exceeding the annual average objective at relevant receptors.

3 Newmarket Street/Blue School Street

A clear reduction in both the extent of the 46$\mu g/m^3$, 40$\mu g/m^3$ and 34$\mu g/m^3$ contours is predicted in 2015 along Newmarket/Blue School Street compared to 2005 and 2010. This is due to a reduction in the percentage of HDVs and the re-direction of traffic to one-way along Widemarsh Street (Figure 4.13). The current 2005 problem along Newmarket/Blue School Street/Bath Street and Commercial Road is predicted to be resolved by the traffic measures to be in operation by 2015.

At this location the model predicts that it is at most ***very unlikely*** (with a probability of less than 5%) to be exceeding the annual average objective at relevant receptors.

4 Belmont Road/Ross Road

The annual mean objective is only being exceeded on some building façades at the Ross arm of the roundabout (Figure 4.14).

At this location the model predicts that it is at most ***probable*** (with a probability of 50%-80%) to be exceeding the annual average objective at relevant receptors.

Figure 4.11 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-4, 6-12) in 2015 - Holmer Road/Newtown Road

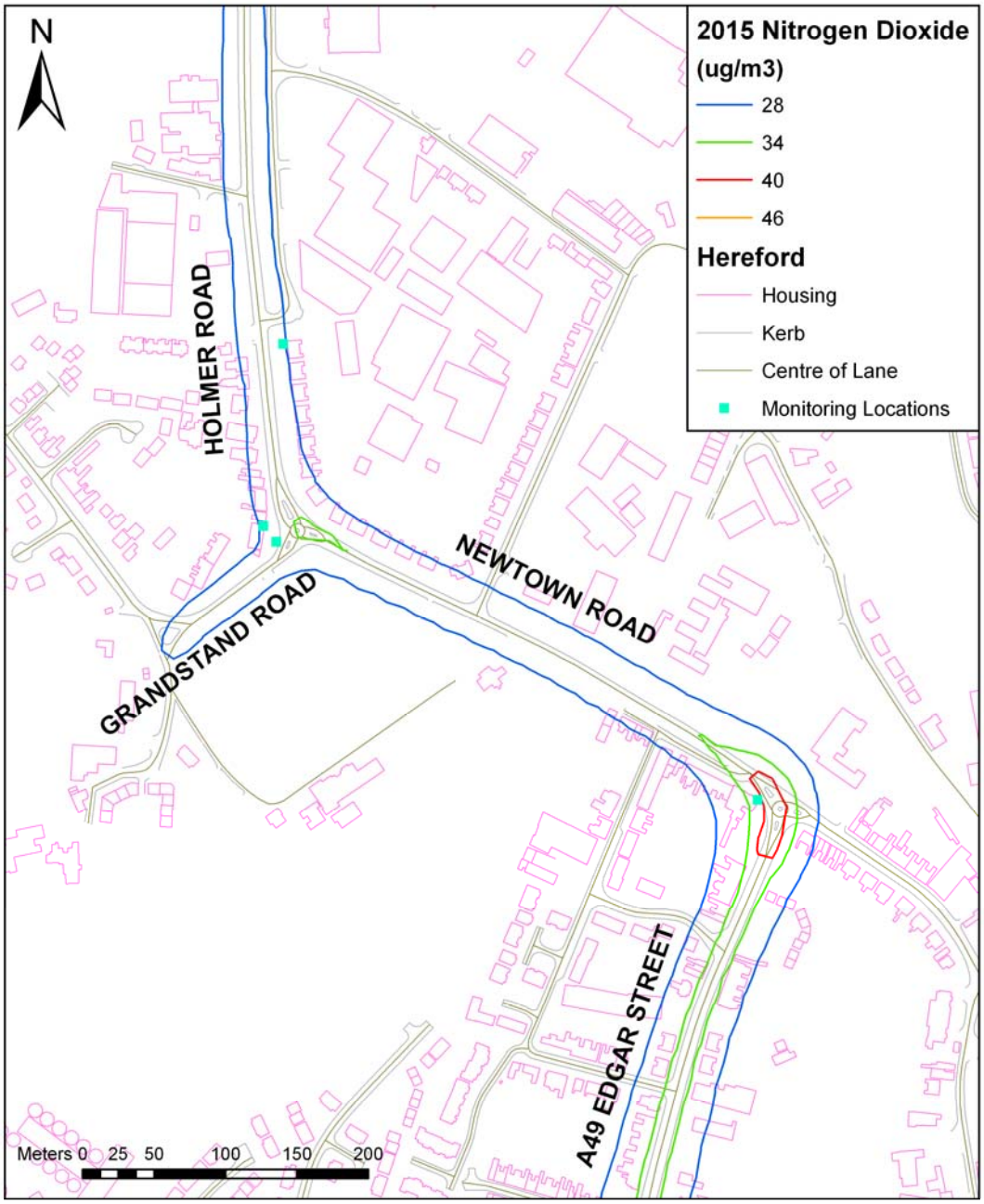


Figure 4.12 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-4, 6-12) in 2015 - Eign Street/Edgar Street

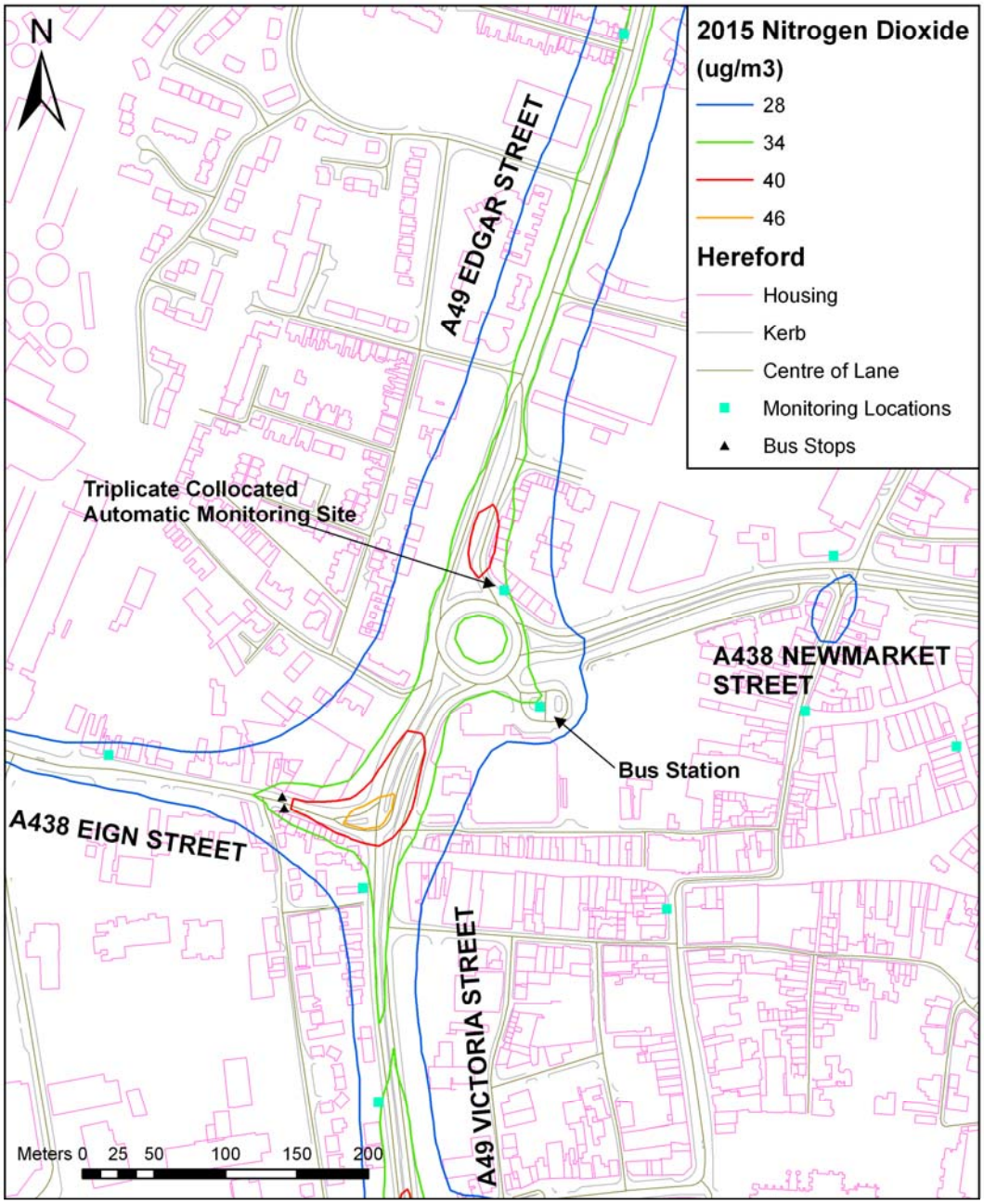


Figure 4.13 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-4, 6-12) in 2015 – Newmarket Street/Blue School Street

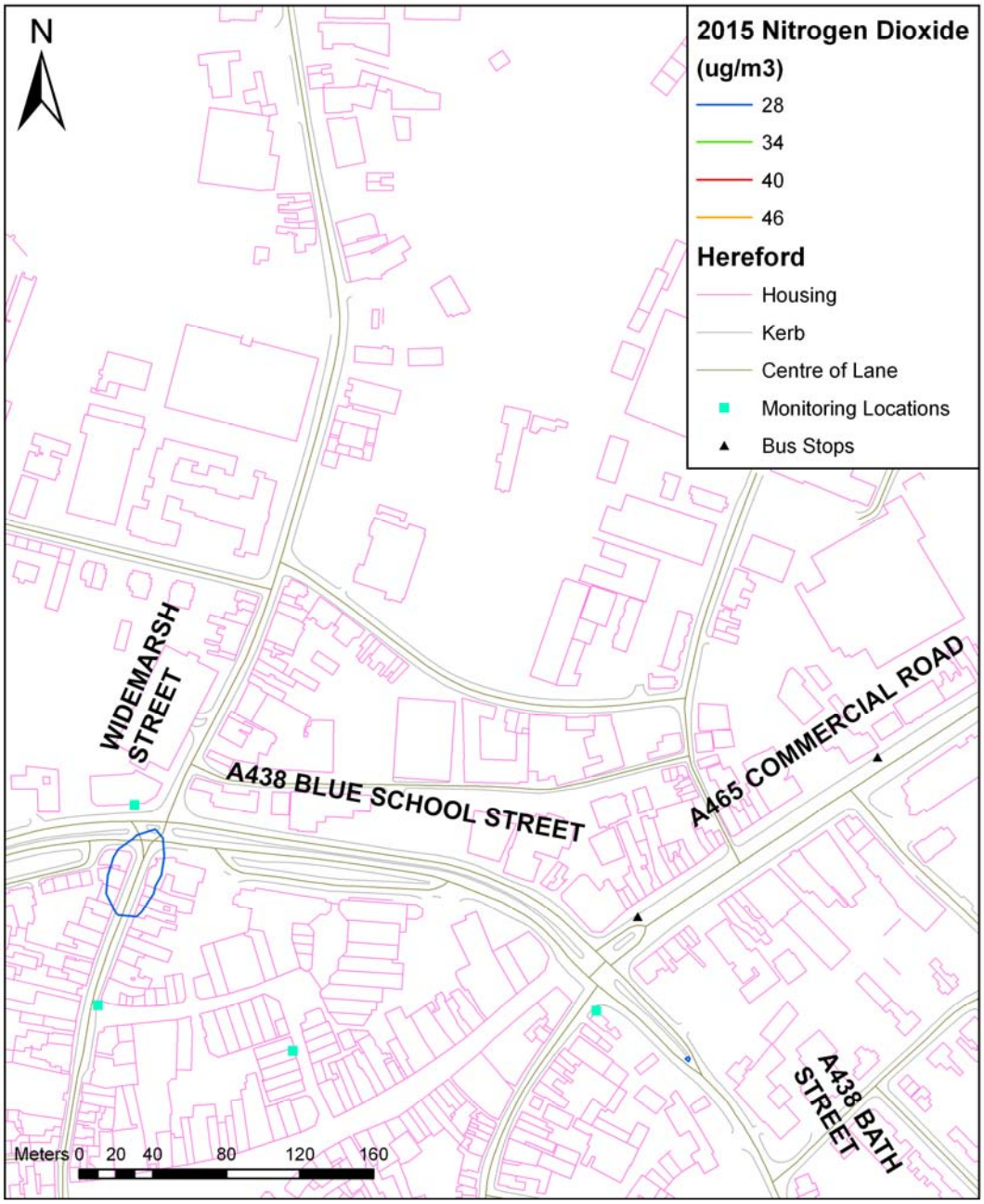
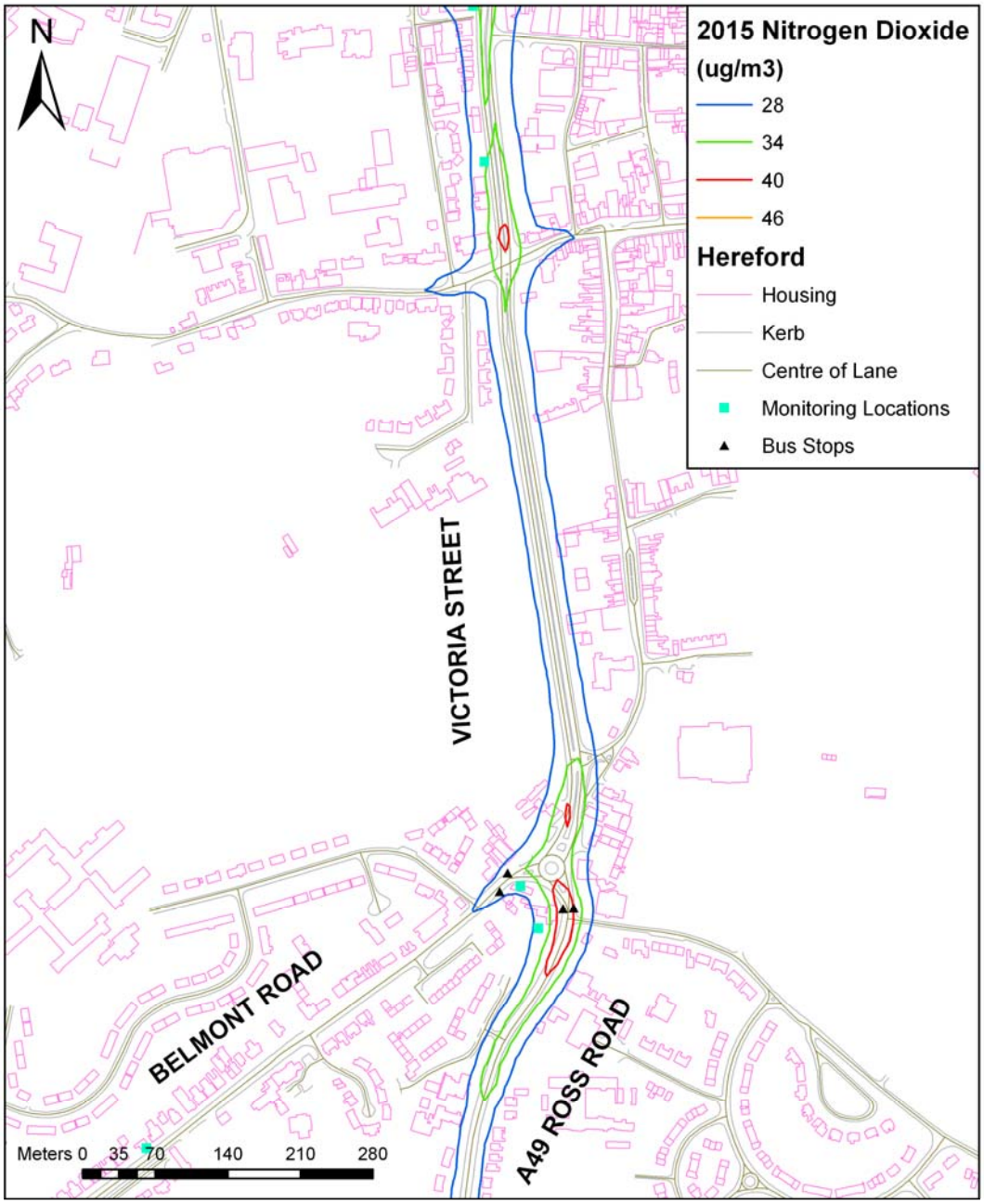


Figure 4.14 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-4, 6-12) in 2015 – Belmont Road/Ross Road



4.11.4 2025 NO_2 modelling results

In 2025 an additional traffic measure:

Action 5 New Outer Distributor Road – 3rd link

- is proposed to have been implemented alongside the eleven traffic measures in operation by 2015:

Action 1 Edgar Street Grid Redevelopment
Action 2 Roman Road – Improvement of Road
Action 3 New Rotherwas Access Road -1st link of Outer Distributor Road
Action 4 New Outer Distributor Road – 2nd link
Action 6 Install and Implement new Hereford ITS on A49 route in Hereford
Action 7 Alteration of traffic management at the Belmont Roundabout
Action 8 Implement North and South Park and Ride scheme for Hereford
Action 9 Continue to Implement the Parking Strategy in Hereford
Action 10 Improve and increase number of cycle routes and facilities in Hereford
Action 11 City Centre pedestrian enhancement
Action 12 Behavioural Change Programme

It is assumed that the average road speeds, existing bus stops, bus station and bus flows remain the same as in the 2005 base case. Emissions results from queuing and congestions in 2010 have been assumed to vary proportionately to the predicted changes in AADT flow between 2005 and 2025 for each individual road link.

Park and Ride bus movements for the North and South sites were added to the air quality modelling for 2025 as only changes in car flow were taken into account in the traffic modelling. Herefordshire Council are ISO 14001 accredited, therefore the Park and Ride bus fleet would be the latest Euro Standard available and carbon neutral; most likely using biodiesel. However, this fuel type change has not been modelled, as currently there are no speed-related emission factors for biodiesel. As a result the model can only assume the use of diesel buses, which follow the national fleet mix trend by 2025.

1 Holmer Road/Newtown Road

The 40$\mu g/m^3$ contour, from 2005, north up Holmer Road, as in 2015, is reduced and is an improvement on the 2005 extent along the A49 North. No exceedances at building are predicted (Figure 4.15).

At this location the model predicts that it is at most ***possible*** (with a probability of 20%-50%) to be exceeding the annual average objective at relevant receptors.

2 Eign Street/Edgar Street

At the central roundabout and junction the area of exceedance is reduced again compared to all previous scenarios

The 40$\mu g/m^3$ objective is exceeding at some of the relevant receptors at the Edgar Street arm of the roundabout (Figure 4.16). The Newmarket Road exceedances of 2005 are significantly reduced compared to 2005 as in 2015.

At this location the model predicts that it is at most ***probable (***with a probability of 50%-80%) to be exceeding the annual average objective at relevant receptors.

3 Newmarket Street/Blue School Street

A significant reduction of the area within both the 34$\mu g/m^3$ and 40$\mu g/m^3$ contours along Newmarket/Blue School/Widemarsh Street is predicted in 2025 when compared with 2005 and 2010 (Figure 4.17).

At this location the model predicts that it is at most ***very unlikely*** (with a probability of less than 5%) to be exceeding the annual average objective at relevant receptors.

4 Belmont Road/Ross Road

Belmont is predicted to retain its 40$\mu g/m^3$ exceedances at receptors on the Ross arm of the roundabout only (Figure 4.18). No other relevant receptors are predicted to see an exceedance of the NO_2 annual mean objective.

At this location the model predicts that it is at most ***probable*** (with a probability of 50%-80%) to be exceeding the annual average objective at relevant receptors.

Figure 4.15 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-12) in 2025 - Holmer Road/Newtown Road

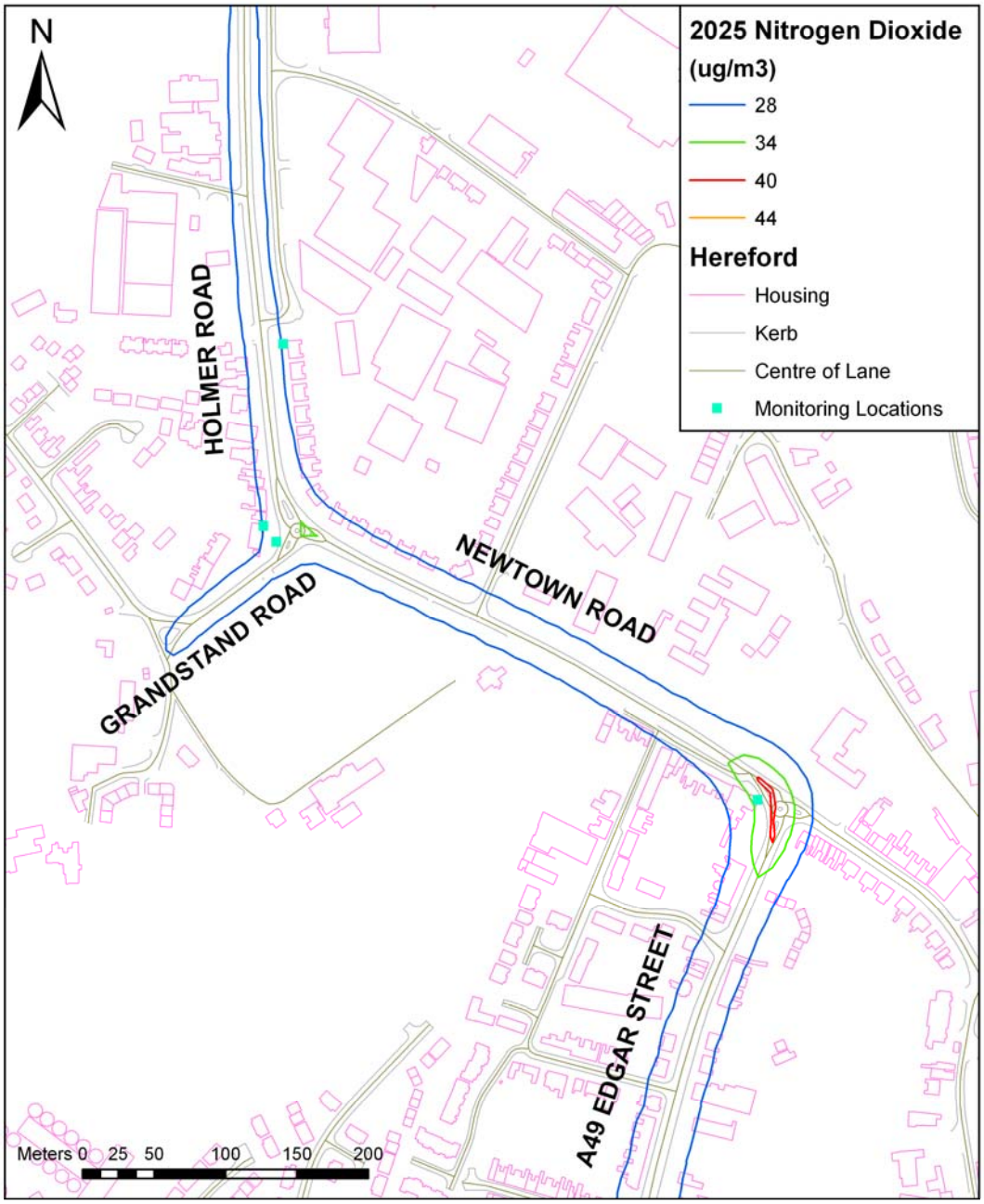


Figure 4.16 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-12) in 2025 - Eign Street/Edgar Street

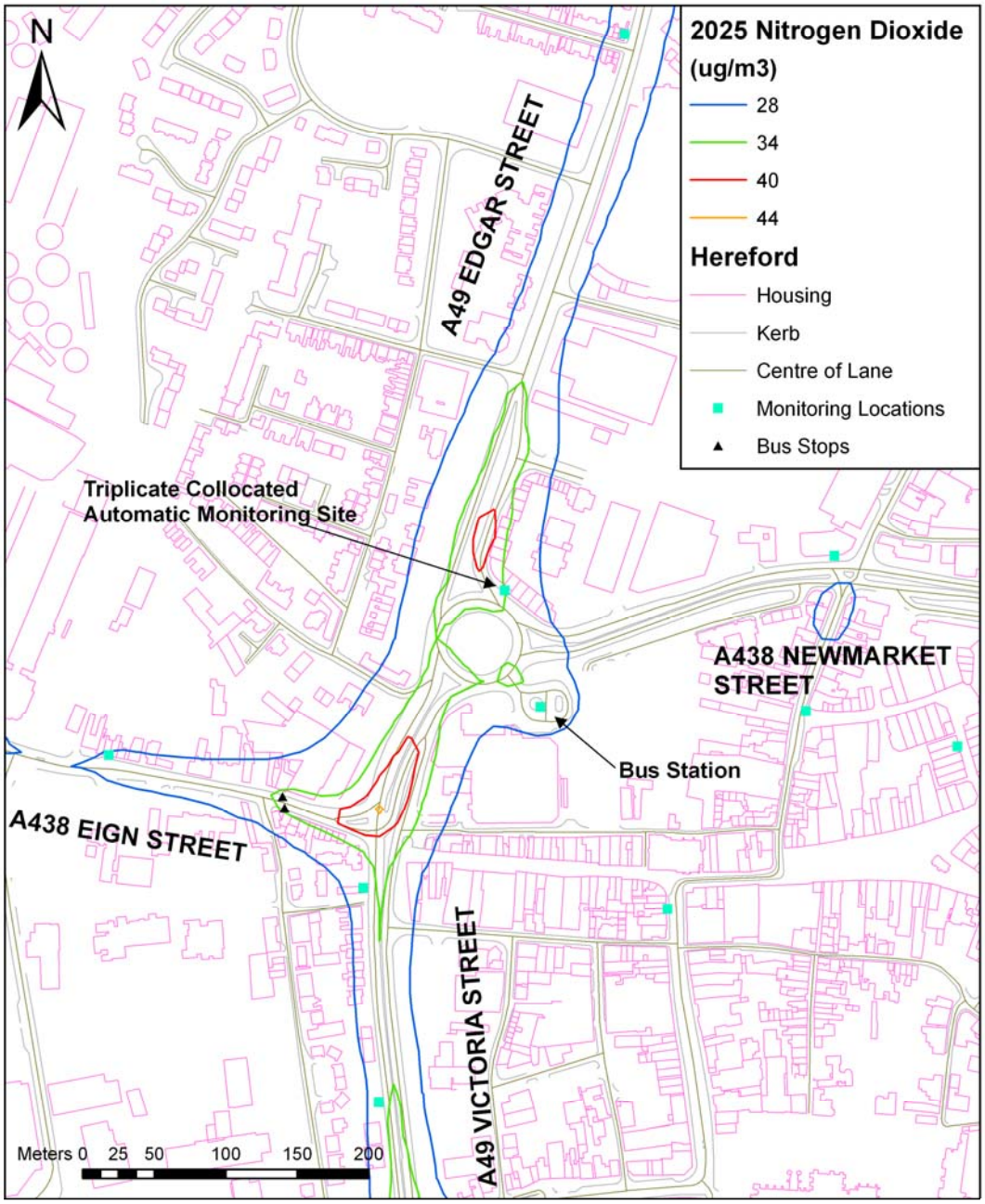


Figure 4.17 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-12) in 2025 – Newmarket Street/Blue School Street

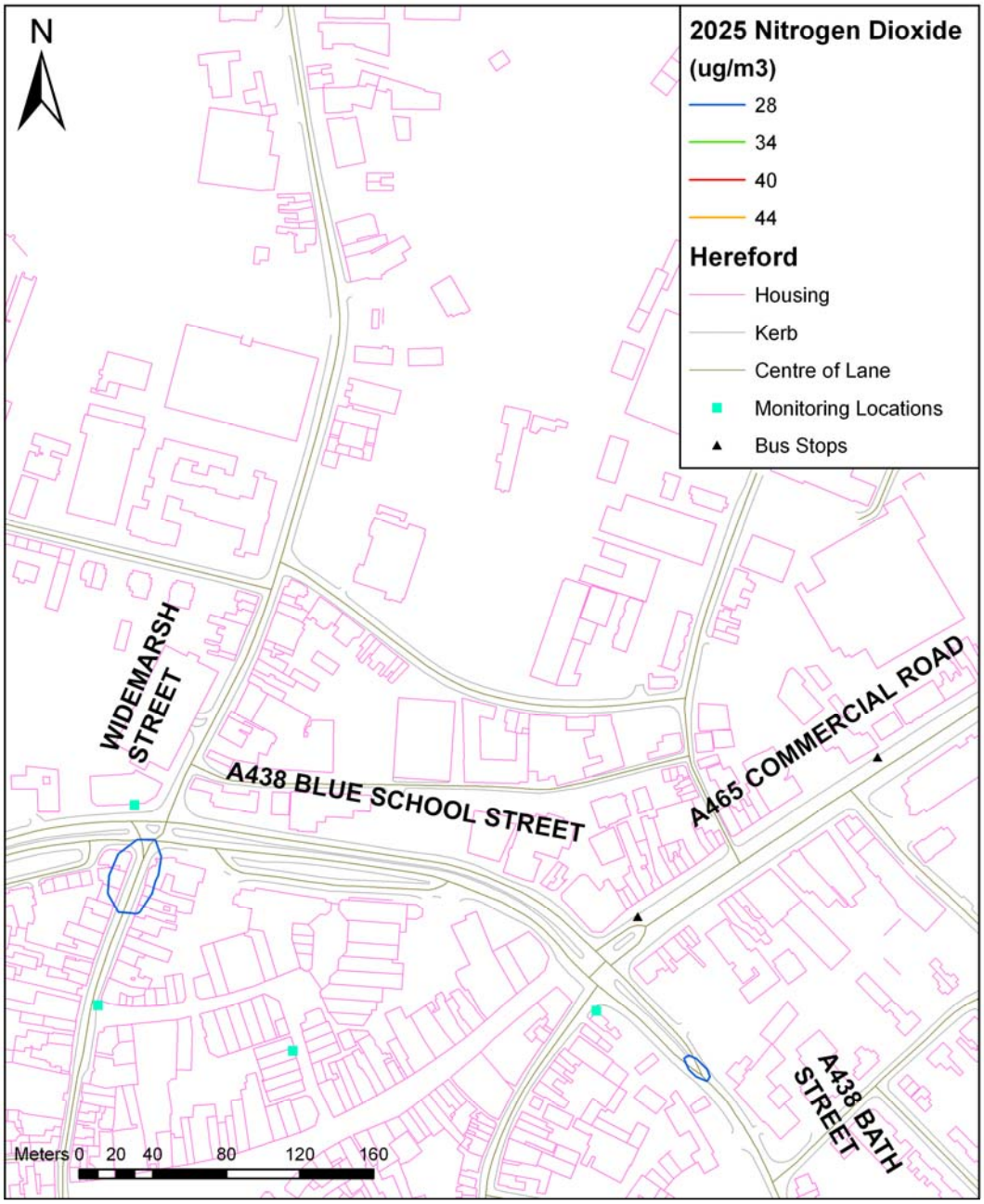
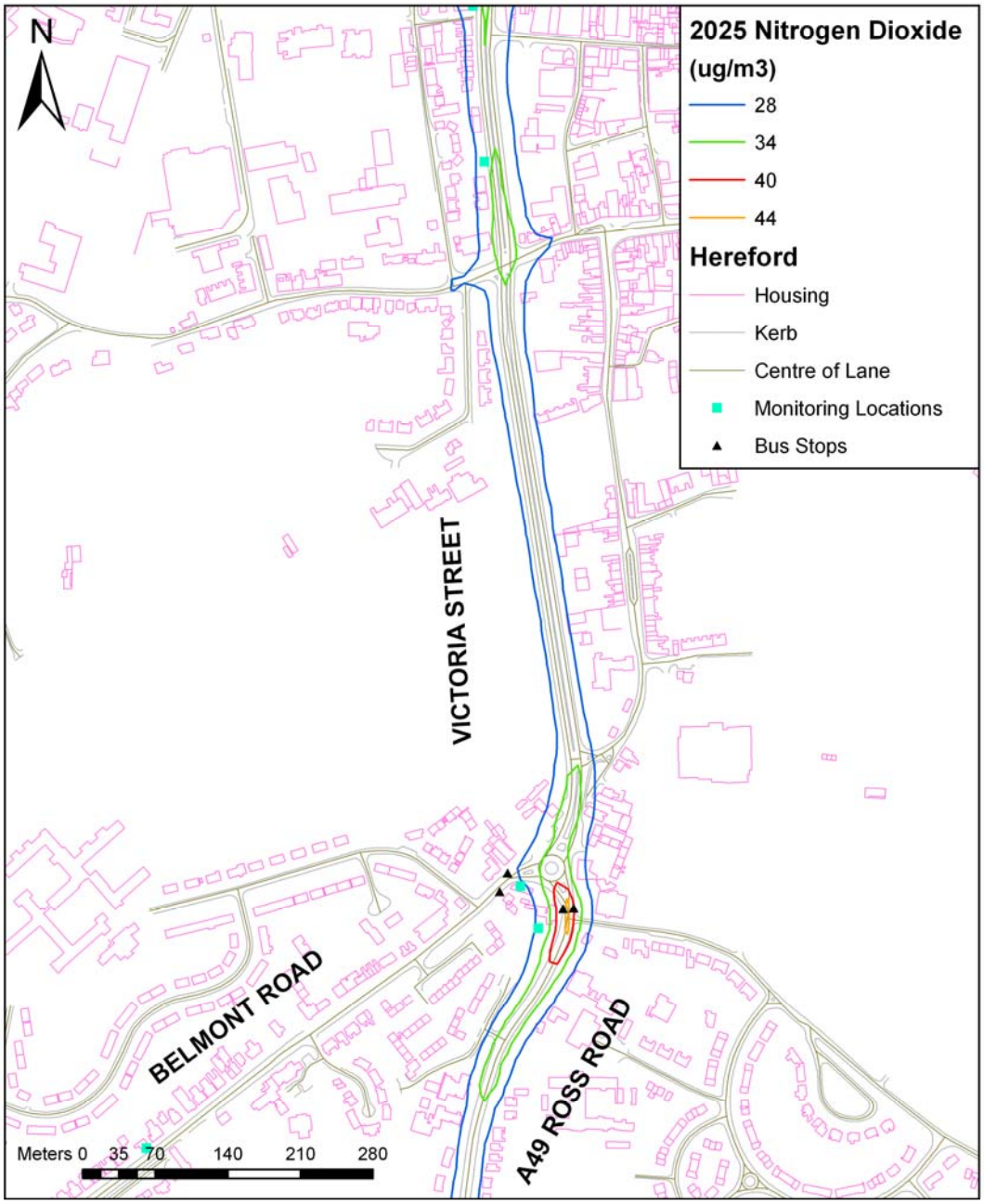


Figure 4.18 Predicted annual mean nitrogen dioxide concentrations with new traffic actions (1-12) in 2025 – Belmont Road/Ross Road



4.12 SUMMARY OF MODELLING PREDICTIONS

In 2005, continued exceedances within the AQMA are predicted by monitoring and modelling. No new exceedance areas just outside the AQMA are expected from the modelling. As a result, Herefordshire Council may wish to remove the Holmer Road/Newtown Road section at the north end of the AQMA; otherwise we recommend no change to the existing AQMA boundary.

Modelling of nitrogen dioxide concentrations in 2010 indicate that a significant decline in nitrogen dioxide concentrations is expected when compared with 2005, with exceedances of the 40$\mu g/m^3$ annual mean objective only seen at Eign Street, Edgar Street and Victoria Street. This is as a result of the reduction in both AADT flow and the percentage of HDVs locally predicted for Hereford.

By 2015, improvement in the area of exceedance for NO_2 is again seen. The nitrogen dioxide exceedances are predicted to be resolved along Widemarsh Street, Newmarket Street and Blue School Street. The reduction along the A438 East seen as a result of the traffic measures.

By 2025, only one exceedance will remain, this being at the A49 'Asda Roundabout' (i.e. a flat above a public house). Projected breaches at the Edgar Street Roundabout should not be relevant, as the environmental scoping exercises being undertaken during the planning process for the Edgar Street Grid development should ensure that all new house facades are constructed far enough away from the road. Concentrations on Newmarket Street, Blue School and Widemarsh Street remain significantly reduced.

Impacts of the traffic measure actions
In summary the actions planned are predicted to have positive effects in reducing the extent of exceedance in the AQMA by 2010 compared with 2005.

By 2015 exceedances are reduced but remain at the major junctions on the A49 through Hereford. Exceedances are however predicted to be resolved along the A438, where an overall reduction in NO_2 concentration is seen.

By 2025 a very slight exceedance still remains at one relevant receptor on the A49 'Asda Roundabout'. The traffic measures elsewhere still dramatically reduce the NO_2 concentrations, leaving no exceedance of the nitrogen dioxide annual mean objective at all other locations

4.13 SOURCE APPORTIONMENT OF PREDICTED EXCEEDANCES

Source apportionment is the process whereby the contributions from different sources of a pollutant are determined. In local air quality, the relevant sources could include: traffic; local background; industrial and domestic. Contributions from the different types of vehicles (for example, cars, lorries and buses) can also be considered to highlight which class of vehicle is contributing most to the emissions from traffic. Source apportionment allows the most important source or sources to be identified and options to reduce ambient concentrations of pollutants can then be considered and assessed. The concentrations have been calculated using the new traffic emission factors.

The source apportionment should:

- Confirm that exceedances of NO_2 are due to road traffic
- Determine the extent to which different vehicle types are responsible for the emission contributions to NO_2 within predicted areas of exceedance. This will allow traffic management scenarios to be modelled/tested to reduce the exceedances
- Quantify what proportion of the exceedances of NO_2 is due to background emissions, or, local emissions from busy roads in the local area. This will help determine whether local traffic management measures could have a significant impact on reducing emissions in the area of exceedance, or, whether national measures would be a suitable approach to achieving the air quality objectives

4.13.1 Receptors considered

Source apportionment has been considered at those locations in Hereford where the model has predicted the highest concentration of NO_2 in 2005 at or near to a relevant receptor. These are points on the 10m x 10m receptor point grid used in the modelling, and have not been reasonably selected owing to their proximity to monitoring points. Figure 4.19 indicates the locations in question.

4.13.2 Sources of pollution considered

We have considered the effect of the following sources in this assessment at the receptor considered:

- Background concentrations used in the assessment;
- Traffic - Light Duty Vehicles on main roads in the 1 km square local area;
- Traffic - Heavy Duty Vehicles on main roads in the 1 km square local area.

It should be noted that the modelling has particularly considered traffic on the busiest roads in Hereford, that is, the main roads through the town. Reference in Tables 4.10 and 4.11 to 'traffic' refers to the contribution to pollutant concentrations of traffic movements on these roads. Emissions from traffic movements on other roads in Hereford and outside Hereford have not been explicitly modelled. However, their contribution to pollutant concentrations in Hereford is included in the modelled background concentrations. Background concentrations in Tables 4.10 and 4.11 therefore include further contributions from traffic on roads other than those modelled in this study.

There is a complex relationship between oxides of nitrogen and nitrogen dioxide concentrations. The modelling assumed that the contribution to nitrogen dioxide concentration from road traffic could be estimated by using the relationships provided in LAQM.TG(03) and the AQEG report of 2004 (AQEG(2004)): the same relationships have been applied for source apportionment calculations.

The concentrations apportioned to each source category and the fractions of the total concentrations are shown in Tables 4.6 – 4.11.

Table 4.6: Edgar Street North, Hereford: Source apportionment of concentrations of NO_2 and NO_x in 2005 (Site 1)

EDGAR STREET NORTH (350912.57 240788.96) Source category	NO_2 concentration, Contribution		NOx concentration, Contribution	
	$\mu g\ m^{-3}$	%	$\mu g\ m^{-3}$	%
Light Duty Vehicles	7.7	19%	22.0	26%
Heavy Duty Vehicles	7.0	17%	19.9	24%
Total traffic	14.7	36%	44.5	50%
Background	26.5	64%	44.0	50%
Total	41.2	100%	88.6	100%

% Figures are rounded to the nearest whole number

Table 4.7: Edgar Street South, Hereford: Source apportionment of concentrations of NO_2 and NO_x in 2005 (Site 2)

EDGAR STREET SOUTH (350778.15 240226.07) Source category	NO_2 concentration, Contribution		NOx concentration, Contribution	
	$\mu g\ m^{-3}$	%	$\mu g\ m^{-3}$	%
Light Duty Vehicles	10.0	24%	24.2	29%
Heavy Duty Vehicles	11.3	27%	27.3	33%
Total traffic	26.5	52%	72.6	62%
Background	24.9	48%	44.7	38%
Total	51.4	100%	117.3	100%

% Figures are rounded to the nearest whole number

Table 4.8: Victoria Street, Hereford: Source apportionment of concentrations of NO_2 and NO_x in 2005 (Site 3)

VICTORIA STREET (350721.57 239789.44) Source category	NO_2 concentration, Contribution		NOx concentration, Contribution	
	$\mu g\ m^{-3}$	%	$\mu g\ m^{-3}$	%
Light Duty Vehicles	7.8	19%	18.9	23%
Heavy Duty Vehicles	12.8	31%	31.1	37%
Total traffic	23.4	50%	60.7	60%
Background	23.7	50%	40.3	40%
Total	47.1	100%	101.0	100%

% Figures are rounded to the nearest whole number

Table 4.9: Eign Street, Hereford: Source apportionment of concentrations of NO_2 and NO_x in 2005 (Site 4)

EIGN STREET (350662.37 240052.51) Source category	NO_2 concentration, Contribution		NOx concentration, Contribution	
	$\mu g\ m^{-3}$	%	$\mu g\ m^{-3}$	%
Light Duty Vehicles	9.4	23%	22.6	27%
Heavy Duty Vehicles	12.7	31%	30.5	37%
Total traffic	27.8	53%	76.9	64%
Background	24.2	47%	43.6	36%
Total	52.0	100%	120.5	100%

% Figures are rounded to the nearest whole number

Table 4.10: Blue School Street, Hereford: Source apportionment of concentrations of NO_2 and NO_x in 2005 (Site 5)

BLUE SCHOOL STREET (351232.73 240202.15) Source category	NO_2 concentration, Contribution		NOx concentration, Contribution	
	$\mu g\ m^{-3}$	%	$\mu g\ m^{-3}$	%
Light Duty Vehicles	11.1	27%	26.5	32%
Heavy Duty Vehicles	12.5	30%	29.7	36%
Total traffic	30.1	57%	84.8	67%
Background	22.8	43%	41.0	33%
Total	52.9	100%	125.8	100%

% Figures are rounded to the nearest whole number

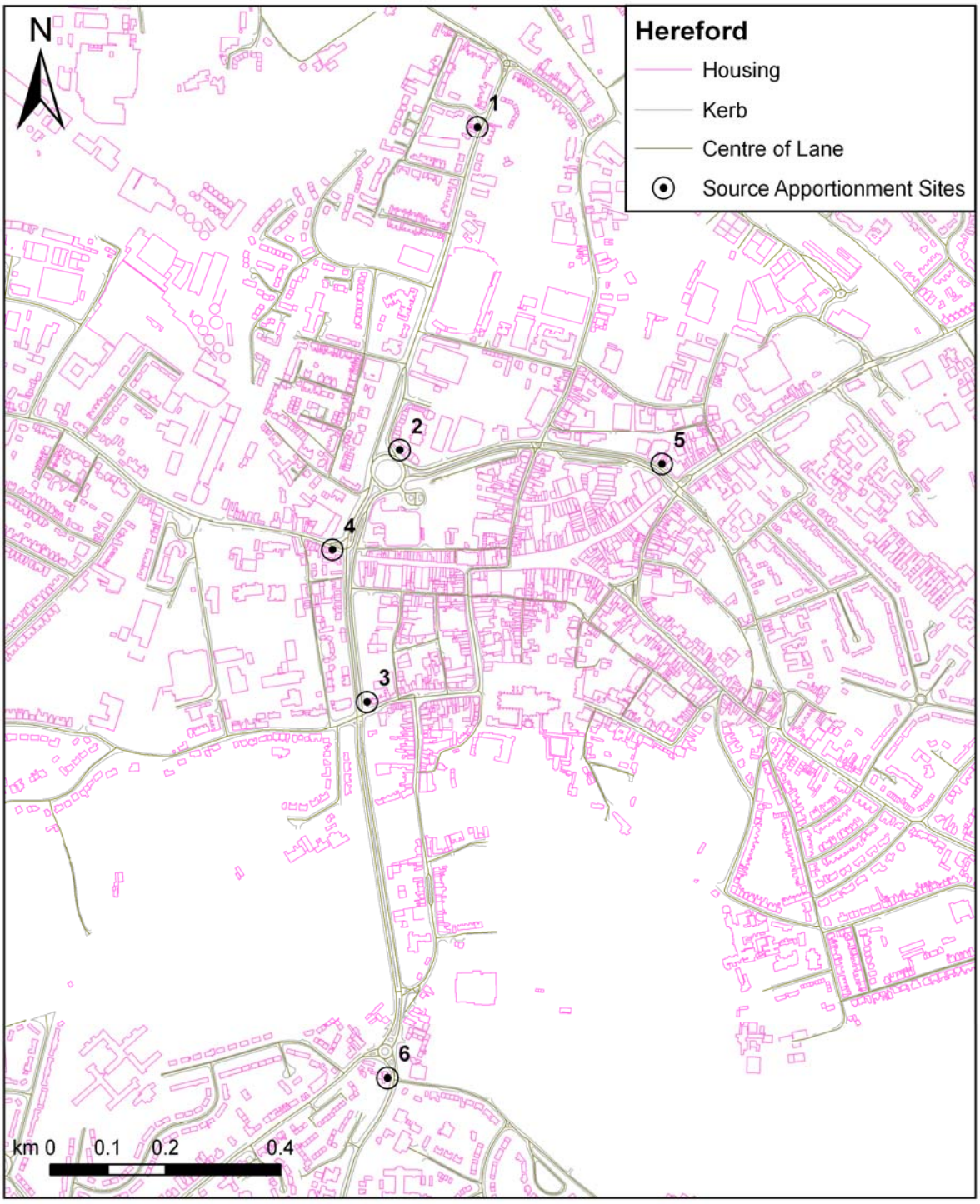
Table 4.11: Ross Road, Hereford: Source apportionment of concentrations of NO_2 and NO_x in 2005 (Site 6)

ROSS ROAD (350757.10 239135.20) Source category	NO_2 concentration, Contribution		NOx concentration, Contribution	
	$\mu g\ m^{-3}$	%	$\mu g\ m^{-3}$	%
Light Duty Vehicles	9.2	22%	21.4	26%
Heavy Duty Vehicles	17.8	43%	41.2	49%
Total traffic	36.6	65%	108.4	75%
Background	19.5	35%	35.8	25%
Total	56.1	100%	144.2	100%

% Figures are rounded to the nearest whole number

From the above source apportionment, it can be seen that at the 6 locations, traffic accounts for at least half of the local NO_x concentrations. At all source apportionment locations, HDVs account for well over 50% of this total traffic contribution. HDV traffic therefore generally contributes between a quarter and a third to the local NO_2 concentrations, and at the A49(T) (Ross Road) HDVs account for nearly half of both the local total NO_2 and total NOx concentrations.

Figure 4.19 Source Apportionment locations in Hereford



4.14 SUMMARY OF THE LIKELIHOOD OF EXCEEDING THE OBJECTIVES FOR NITROGEN DIOXIDE

In 2005, continued exceedances within the AQMA are predicted by the modelling. No new exceedance areas just outside the AQMA are expected. Monitoring location 65, a kerbside diffusion tube has recorded an exceedance in 2005. This is not at a relevant receptor and modelling did not predict an exceedance at this location. We recommend that this site be moved to be in line with the nearest relevant receptor. Should exceedances continue to be recorded here then the Council may wish to extend the AQMA to include this site. Herefordshire Council may also wish to remove the Holmer Road/Newtown Road section at the north end of the AQMA; otherwise we recommend no change to the existing AQMA boundary.

In 2010, action planning scenario modelling results also showed that it is at most ***probable*** (with probability between 50% and 80%) that an exceedance of the EU annual mean limit value would occur in 2010 at each of the relevant locations in Hereford modelled, and that the risk of the limit value for hourly NO_2 in 2010 being exceeded was at most ***unlikely*** (with probability between 5% and 20%).

Both 2015 and 2025 action planning scenario modelling results also showed that it is at most ***probable*** (with probability between 50% and 80%) that an exceedance of the EU annual mean limit value would occur in 2015 and 2025 at each of the relevant locations in Hereford modelled, and that the risk of the limit value for hourly NO_2 in 2015 and 2025 being exceeded was at most ***very unlikely*** (with probability between of less than 5%).

4.15 RECOMMENDATIONS

Following the previous round of Review and Assessment, Herefordshire Council have declared 1 AQMA for nitrogen dioxide encompassing the following streets in Hereford City:

- Belmont Road
- Ross Road A49(T)
- Victoria Street A49(T)
- Eign Street A438
- New Market Street A438
- Widemarsh Street
- Blue School Street A438
- Commercial Road A465
- Bath Street A438
- Edgar Street A49(T)
- Newtown Road
- Grandstand Road
- Holmer Road A49(T)

Below are our recommendations for the area assessed in this report.

Herefordshire Council may wish to consider removing Holmer Road and Newtown Road from the AQMA. Otherwise, it is recommended that Herefordshire Council maintain their air quality management area for NO_2 at the above locations in Hereford.

Herefordshire Council should now begin to review the 15 proposed action plan measures, which are needed to reduce or eliminate exceedances of the annual mean objective for NO_2 in 2010, 2015 and 2025. This study has demonstrated the potential effects of possible traffic management scenarios. Measures proposed include traffic flow and queuing improvements along the A49 and city centre pedestrianisation. From the modelling results of these measures, it is predicted that these will have positive effects on air quality in 2010, 2015 and 2025.

Therefore it is recommended that, in particular, these action plan measures focus on reducing HDV flows and junction congestion on the A49 corridor in Hereford City.

5 RECOMMENDATIONS AND CONCLUSIONS

Following the previous round of Review and Assessment, Herefordshire Council have declared 1 AQMA for nitrogen dioxide encompassing the following streets in Hereford City:

- Belmont Road
- Ross Road A49(T)
- Victoria Street A49(T)
- Eign Street A438
- New Market Street A438
- Widemarsh Street
- Blue School Street A438
- Commercial Road A465
- Bath Street A438
- Edgar Street A49(T)
- Newtown Road
- Grandstand Road
- Holmer Road A49(T)

Below are our recommendations for the area assessed in this report.

Herefordshire Council may wish to consider removing Holmer Road and Newtown Road from the AQMA. Otherwise, it is recommended that Herefordshire Council maintain their air quality management area for NO_2 at the above locations in Hereford.

Herefordshire Council should now begin to review the 15 proposed action plan measures, which are needed to reduce or eliminate exceedances of the annual mean objective for NO_2 in 2010, 2015 and 2025. This study has demonstrated the potential effects of possible traffic management scenarios. Measures proposed include traffic flow and queuing improvements along the A49 and city centre pedestrianisation. From the modelling results of these measures, it is predicted that these will have positive effects on air quality in 2010, 2015 and 2025.

Therefore it is recommended that, in particular, these action plan measures focus on reducing HDV flows and junction congestion on the A49 corridor in Hereford City.

5.1 FURTHER ACTIONS TO BE TAKEN

Should Herefordshire Council be satisfied and in agreement with the contents of this report, it should be then be forwarded to DEFRA for approval. DEFRA will then forward the report to their external assessors who will comment on the work. DEFRA will then return the critique of the work to Herefordshire Council.

Herefordshire Council should then forward a copy of this critique to **netcen**. Herefordshire Council should also consider if they could answer any of the questions directly.

6 REFERENCES

Annual Air Quality Progress Report for Herefordshire (2005) Environmental Health and Trading Standards, Herefordshire Council, April 2005

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Appendices

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Appendix 1

Traffic Data

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Table A1.1 - Traffic data for Hereford.

Location	2005 AADTs	% HDV	2010 AADTs	%HDV	2015 AADTs	%HDV	2025 AADTs	%HDV
A49 Holmer Rd (northbound)	6969	7	6578	7	6913	7	7144	5
A49 Holmer Rd (southbound)	7315	7	776	8	8002	7	7837	6
A49 Newtown Rd (northbound)	7876	6	8662	5	10224	5	10670	3
A49 Newtown Rd (southbound)	9675	5	12265	5	11550	4	12271	4
A49 Edgar Street (northbound)	11628	5	8701	5	13376	4	8283	3
A49 Edgar Street (southbound)	10390	8	11830	7	13024	6	13750	6
A49 Victoria St (northbound)	16841	7	10516	7	9647	7	9944	9
A49 Victoria St (southbound)	12815	9	16225	5	11803	6	11748	6
A438 Eign Street (eastbound)	7898	7	6149	4	8459	6	8310	4
A438 Eign Street (westbound)	7728	7	6286	7	3657	10	3586	15
Newmarket St / Blue School St (eastbound)	10582	5	7650	1	0	0	0	0
Newmarket St / Blue School St (westbound)	12364	4	12336	1	3514	2	3778	2
A49 Ross Rd (northbound)	10698	8	10455	7	12353	8	11676	13
A49 Ross Rd (southbound)	9323	9	6292	8	6105	8	6704	10
Grandstand Road (eastbound)	5968	4	6171	4	5923	4	6748	5
Grandstand Road (westbound)	4516	6	3630	6	5439	5	5351	4
A465 Belmont Rd (northbound)	9741	5	7062	3	6237	3	4229	4
A465 Belmont Rd (southbound)	9032	5	5252	3	4856	3	3773	3
Barton Rd (eastbound)	5687	3	6176	3	6495	3	6358	3
Barton Rd (westbound)	5957	4	4477	3	4174	3	3118	7
St Nicholas St (eastbound)	2685	4	5318	2	6352	2	6325	2
St Nicholas St (westbound)	3009	4	4482	2	4884	3	4823	3
St Martins St (northbound)	2866	0.4	2926	1	2887	2	2937	3
St Martins St (southbound)	2211	4	4372	2	4268	2	4158	2
Bath Street (eastbound)	4917	5	5307	2	2271	2	2282	2
Bath Street (westbound)	3218	2	9168	2	5978	2	6407	2
Commercial Rd (northbound)	6397	6	6710	1	5978	2	5252	2
Commercial Rd (southbound)	6584	6	6319	0	1974	2	2106	1
North part of Widemarsh St (northbound)	3977	1	940	0	4933	6	5192	3
North part of Widemarsh St (southbound)	0	0	4829	2	5500	2	4669	3
South part of Widemarsh St (northbound)	171	0	1276	1	0	0	0	0
South part of Widemarsh St (southbound)	0	0	4103	2	4554	2	4405	3
Whitecross Rd (eastbound)	8756	6	6193	2	9586	4	9509	3
Whitecross Rd (westbound)	7732	4	2343	1	2403	2	2057	1

Appendix 2

Monitoring Data

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Table A1 - Diffusion Tube Locations in Hereford

X	Y	ID	Site Name
351007	240248	1	Garrick House, HF
351548	240924	3	Geoffrey Ave, HF
353106	240559	5	Heywood Ave, HF
350890	240000	6	Broad St, HF
351093	240114	7	Gommond St, HF
350688	239864	8	Victoria St (D1), HF
350688	239864	9	Victoria St (D2), HF
350677	240015	10	Victoria St, HF
350776	240224	12	Edgar St RB (T1), HF
350776	240224	13	Edgar St RB (T2), HF
350776	240224	14	Edgar St RB (T3), HF
350948	240905	15	Newtown Rd/Edgar St, HF
350740	239122	16	Belmont Rd/Ross Rd, HF
350700	238685	17	Holme Lacy Rd/Ross Rd, HF
351681	240412	19	Commercial St/RW Bridge, HF
350611	241086	20	Holmer/Newtown Rd Is, HF
350860	240615	21	FA Edgar/Moor St (D1), HF
350860	240615	22	FA Edgar/Moor St (D2), HF
350723	239163	53	House Façade, Cross St, Belmont, HF
350602	241097	54	House Façade, Holmer Rd, HF
350801	240142	56	Bus Station, HF
350499	240108	57	Shop flat FA, Eign St, HF
351258	240136	58	Shop flat FA, Union/Bath St, HF
350987	240139	59	Elgars Restaurant FA, Widemarsh St, HF
350362	238909	64	106 Belmont Rd FA, HF
350086	240296	65	96 Whitecross Rd FA, HF
350616	241225	66	House FA Comets A49

Sites 12-14 are collocated with automatic monitor

Table A2 - Raw Monthly diffusion tube data for Hereford 2004 ($\mu g/m^3$)

RAW & UNADJUSTED NO2 DIFFUSION TUBE DATA FOR 2004 Roadside Monitoring														
Ref No	**Grid Ref**	**Location**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean**
1	351007 240248	**Garrick House,Hereford**	38	44	42	36		36	23	34	34	34	50	49	**38**
3	351548 240924	**Geoffrey Ave, Hereford**	26	23	14	16	12	27	10	11		18	25	32	**20**
5	353106 240559	**Heywood Ave, Hereford**	19	17	16	11	8	7	7	8	10	15	19	20	**13**
6	350890 240000	**Broad St, Hereford**	48	46	44	43	35	38	29	30	28	37	41	40	**38**
7	351093 240114	**Gommond St, Hereford**	22	28	26	20	17	15	15	15	17	21	30	29	**21**
8	350688 239864	**Victoria St (duplicate 1), Hereford**	56	49	44	42	36	33	39	40	29	41	49	52	**43**
9	350688 239864	**Victoria St (duplicate 2), Hereford**	50	48	53	54	46	34	39	37	32	46	41	46	**44**
10	350677 240015	**Victoria St (house façade), Hereford**	44	41	46	45	40	39	39	42	41	47	57	50	**44**
12	350776 240224	**Edgar St Roundabout (Triplicate 1), Hfd**	46	46	57	57	40	72	51	46	42	43	57	54	**51**
13	350776 240224	**Edgar St Roundabout (Triplicate 2), Hfd**	44	48	48	56	41	51	53	51	46	52	47	49	**49**
14	350776 240224	**Edgar St Roundabout (Triplicate 3), Hfd**	44	44	48	57	38	53	52	51	47	50	53	49	**49**
15	350948 240905	**Newtown Rd/Edgar St, Hereford**		34	37	40	35	29	24	30	29	39	40	46	**35**
16	350740 239122	**Belmont Rd/Ross Rd, Hereford**	39	41	41	43	34	28	30	37	32	42	46	53	**39**
17	350700 238685	**Holme Lacy Rd/Ross Rd traf.lights, Hfd**	44	43	44	50	44	49	46	44	35		63	55	**47**
19	351681 240412	**Commercial St/Railway Bridge, Hfd**	39	32	36	31			32	37	36	43	43	40	**37**
20	350611 241086	**Holmer Rd/Newtown Rd island, Hfd**		28	32		27	34	17	25	37	38	47	48	**33**
21	350860 240615	**Façade Edgar/Moor St(Duplicate 1),Hfd**	38	44	39	39	41	28	31	31	33	43	39	48	**38**
22	350860 240615	**Façade Edgar/Moor St(Duplicate 2),Hfd**	36	38	40	50	31	29	33	37		46	41	48	**39**
53	350723 239163	**House façade, Cross St, Belmont, Hfd**	41	38	46	48	42	38	39	41	40	44	43	46	**42**
54	350602 241097	**House façade, Holmer Rd, Hereford**	29	28	43		52	20	29	34	23	30	27	37	**32**
56	350801 240142	**Bus Station (adj to Tesco), Hereford**			44	48	45	44	41	47	38		48	50	**45**
57	350499 240108	**Shop flat façade, Eign Street, Hereford**	33	29	29	57	41	28	29	22	15	39	36	39	**33**
58	351258 240136	**Shop flat façade, Union St/ Bath St, Hfd**	31	28	31	37	39	22	26	21	18	26	37	36	**29**
59	350987 240139	**Bill's (Elgar's) Restaurant, Widemarsh Street, Hfd**	33	29	29										**30**

All locations are roadside

Table A3 - Raw Monthly diffusion tube data for Hereford 2005 ($\mu g/m^3$)

RAW & UNADJUSTED NO2 DIFFUSION TUBE DATA FOR 2005			Results shown as '0' means no data available												
Roadside Monitoring			All data in ug/m3 unless otherwise stated												
Ref No	**Grid Ref**	**Location**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Mean**
1	351007 240248	**Garrick House,Hereford**	40	57	49	35	32	34	35	30	29	34	52	52	**40**
3	351548 240924	**Geoffrey Ave, Hereford**	21	27	19	16	12	10	12	12	16	23	25	28	**18**
5	353106 240559	**Heywood Ave, Hereford**	14	18	15	12	7	7	6	7	12	17	20	22	**13**
6	350890 240000	**Broad St, Hereford**	44	48	47	45	28	30	30	27	34	42	45	47	**39**
7	351093 240114	**Gommond St, Hereford**	20	29	26	22	15	14	13	13	17	19	25	29	**20**
8	350688 239864	**Victoria St (duplicate 1), Hereford**	42	51	53	46	42	44	45	30	44	55	57	57	**47**
9	350688 239864	**Victoria St (duplicate 2), Hereford**	45	68	56	44	45	40	40	36	42	65	49	60	**49**
10	350677 240015	**Victoria St (house façade), Hereford**	49	67	61	51	49	40	47	32	36	56	56	51	**50**
12	350776 240224	**Edgar St Roundabout (Triplicate 1), Hfd**	52	59	55	48	53	48	50	44	49	50	56	54	**51**
13	350776 240224	**Edgar St Roundabout (Triplicate 2), Hfd**	44	59	52	48	53	52	46	38	47	51	55	53	**50**
14	350776 240224	**Edgar St Roundabout (Triplicate 3), Hfd**	45	61	55	52	47	49	48	43	47	49	49	55	**50**
15	350948 240905	**Newtown Rd/Edgar St, Hereford**	36	51	40		29	31	29	22	30	42	38	46	**36**
16	350740 239122	**Belmont Rd/Ross Rd, Hereford**	40	48	49	44	37	40	35	23	43	58	56	51	**44**
17	350700 238685	**Holme Lacy Rd/Ross Rd traf.lights, Hfd**	48	66	61	54	53	47	50	45	46	53	66	61	**54**
19	351681 240412	**Commercial St/Railway Bridge, Hfd**	38	49	38	39			35	31	35	45	44	41	**39**
20	350611 241086	**Holmer Rd/Newtown Rd island, Hfd**	39	56	55	44	34	31	35		40	36	50	47	**42**
21	350860 240615	**Façade Edgar/Moor St(Duplicate 1),Hfd**	40	53	47	43	33	38	32	27	38	51	47	52	**42**
22	350860 240615	**Façade Edgar/Moor St(Duplicate 2),Hfd**	38	53	47	38	41	35	35	29	33	53	50	52	**42**
53	350723 239163	**House façade, Cross St, Belmont, Hfd**	37	44	49	47	44	41	44	32	36	46	47	45	**43**
54	350602 241097	**House façade, Holmer Rd, Hereford**	25	52	32	29	22	25	22		28	43	32	34	**31**
56	350801 240142	**Bus Station (adj to Tesco), Hereford**	40	58	54	44	44		47	40	32	41	44	51	**45**
57	350499 240108	**Shop flat façade, Eign Street, Hereford**	34		60	34	33	32	35	25	32	45	39	46	**38**
58	351258 240136	**Shop flat façade, Union St/ Bath St, Hfd**	29	41	39	33	31	26		25	26	35	38	38	**33**
59	350987 240139	**Elgars Restaurant (façade), Widemarsh St, Hfd**	39	42	36	35	21	21	24	22	24	31	32	40	**31**
64	350362 238909	**106 Belmont Road (façade), Hereford**		41	34	30	27	36	25	23	26	31	29	35	**31**
65	350086 240296	**96 Whitecross Road (façade), Hereford**	52	72	63	50	47	0	43	32	39			52	**45**
66	350616 241225	**House façade by Comets road junction on A49**			35	21	25	20	19		27	27	35	37	**27**
67	349158 242261	**Roman Road, Hereford**									22	23	25	33	**26**

All locations are roadside

Appendix 3

Model validation
Nitrogen dioxide roadside concentrations

CONTENTS

INTRODUCTION

The dispersion model ADMS-3 was used to predict nitrogen dioxide concentrations at roadside locations. ADMS-3 is a PC-based model that includes an up-to-date representation of the atmospheric processes that contribute to pollutant dispersion.

The model was used to predict

- the local contribution to pollutant concentrations from roads; and
- The contribution from urban background sources.

The contribution from urban background sources was calculated from the ADMS-3 output using the NETCEN Local Area Dispersion System (LADS) model. The LADS model provides efficient algorithms for applying the results of the dispersion model over large areas.

The model was verified by comparison with monitoring data obtained at a number of roadside, kerbside or near-road monitoring sites in London.

- London Marylebone
- Camden Roadside
- Haringey Roadside
- London Bloomsbury
- London North Kensington
- London A3 Roadside

London Marylebone site is located in a purpose built cabin on Marylebone Road opposite Madame Tussauds. The sampling point is located at a height of 3 m, around 1 m from the kerbside. Traffic flows of over 80,000 vehicles per day pass the site on six lanes. The road is frequently congested. The surrounding area forms a street canyon and comprises of education buildings, tourist attractions, shops and housing

Camden Roadside site (TQ267843) is located in a purpose built cabin on the north side of the Swiss Cottage Junction. The site is at the southern end of a broad street canyon. Sampling points are approximately 1 m from the kerbside of Finchley Road at a height of 3 m. Traffic flows of 37,000 vehicles per day pass the site and the road is often congested. Pedestrian traffic is also high. The surrounding area mainly consists of shops and offices.

London North Kensington site (TQ240817) is located within the grounds of Sion Manning School. The sampling point is located on a cabin, in the school grounds next to St Charles Square, at a height of 3 m. The surrounding area is mainly residential.

London A3 monitoring station (TQ193653) is within a self-contained, air-conditioned housing immediately adjacent to the A3 Kingston Bypass (6 lane carriageway). Traffic flow along the bypass is approximately 112,000 vehicles per day and is generally fast and free flowing with little congestion. The manifold inlet is approximately 2.5 m from the kerbside at a height of approximately 3 m. The surrounding area is generally open and comprises residential dwellings and light industrial and commercial properties.

London Bloomsbury monitoring station (TQ302820) is within a self-contained, air-conditioned housing located at within the southeast corner of central London gardens. The gardens are generally laid to grass with many mature trees. All four sides of the gardens are surrounded by a busy (35,000 vehicles per day), 2/4 lane one-way road system which is subject to frequent congestion. The nearest road lies at a distance of approximately 35 metres from the station. The manifold inlet is approximately 3 metres high. The area in the vicinity of the manifold is open, but there are mature trees within about 5 metres.

London Haringey site (TQ339906) is located in a purpose built cabin within the grounds of the Council Offices. The sampling point is at a height of 3 m located 5 m from High Road Tottenham (A1010) with traffic flows of around 20,000 vehicles per day. The road is frequently congested. The surrounding area consists of shops, offices and housing.

MODEL APPLICATION

Study area

Two study areas were defined- a local study area and an urban background study area. The local study area was defined for each of the monitoring sites extending 200 m in each direction (NSEW) from the monitoring site. Roads in the study area were identified. Each road in the study are was then treated as a quadrilateral volume source with depth 3 m, with spatial co-ordinates derived from OS maps. The urban background study area extended over an 80 km x 80 km area covering the London area. The background study area was divided into 1 km x 1 km squares-each 1 km square was then treated as a square volume source with depth 10 m.

Traffic flows in the local study area

Traffic flows, by vehicle category, on each of the roads within the local study area for 1996 were obtained from the DETR traffic flow database. The traffic flows were scaled to 1998 by factors shown in Table A3.1 obtained by linear interpolation from Transport Statistics GB, 1997.

Table A3.1 Traffic growth 1998:1996

	Growth factor
Cars	1.05
Light goods vehicles	1.05
Heavy goods vehicles	1.04
Buses	1.00
Motorcycles	1.00

Traffic flows follow a diurnal variation. Table A3.2 shows the assumed diurnal variation in traffic flows.

Table A3.2 Assumed diurnal traffic variation

Hour	Normalised traffic flow
0	0.20
1	0.11
2	0.10
3	0.07
4	0.08
5	0.18
6	0.49
7	1.33
8	1.97
9	1.50
10	1.33
11	1.46
12	1.47
13	1.51
14	1.62
15	1.74
16	1.94
17	1.91
18	1.53
19	1.12
20	0.88
21	0.68
22	0.46
23	0.33

Vehicle speeds in the local study area

Vehicle speeds were estimated on the basis of TSGB, 1997 data for central area, inner area and outer area average traffic speeds in London, 1968-1995 and for non-urban and urban roads for 1996. Table A3.3 shows the traffic speeds applied to each of the sites. The low speeds in Central London reflect the generally high levels of congestion in the area.

Table A3.3 Traffic speeds used in the modelling

Site	Road class	Vehicle speed, kph
London Marylebone	Central London	17.5
Camden Roadside	Central London	17.5
London Bloomsbury	Central London	17.5
London A3 Roadside	Non-urban dual carriageway	88
London Haringey	Outer London	32
London North Kensington	Background site	Not applicable

Vehicle emissions in the local study area
Vehicle emissions of oxides of nitrogen were estimated using the Highways Agency Design Manual for Roads and Bridges, 1999 (DMRB). DMRB provides a series of nomograms that allow the effect on emission rates of the proportion of heavy goods vehicles and the average vehicle speed to be taken into account. The estimated emissions are based on average speeds and take account of the variations in emissions that follow from normal patterns of acceleration and deceleration. DMRB provides estimates of the emissions of particulate material from vehicle exhausts.

Emissions in the urban background study area
Emission estimates for each 1 km square in the urban background study area were obtained from two emission inventories. The London inventory for 1995/6 (LRC, 1997) was used for most of the urban background study area: the National Atmospheric Emission Inventory, 1996 was used for areas within the urban background study area not covered by the London inventory.

The emission estimates for each square for 1996 were scaled to 1998 using factors taken from DMRB.

Meteorological data
Meteorological data for Heathrow Airport 1998 was used to represent meteorological conditions. The data set included wind speed and direction and cloud cover for each hour of the year. It was assumed that a surface roughness of 0.5 m was representative of the suburban area surrounding Heathrow Airport.

The meteorological conditions over London are affected by heat emissions from buildings and vehicles. This "urban heat island" effect reduces the frequency and severity of the stable atmospheric conditions that often lead to high pollutant concentrations. In order to take this into account the Monin-Obukhov length (a parameter used to characterise atmospheric stability in the model) has been assigned a lower limit as shown in Table A3.4.

Table A3.4: Monin-Obukhov limits applied

Site	Limit, m	Note
London Marylebone	100	Large conurbation
Camden Roadside	100	Large conurbation
London Bloomsbury	100	Large conurbation
London A3 Roadside	30	Mixed urban/industrial
London Haringey	30	Mixed urban/industrial
London North Kensington	100	Large conurbation
Small towns <50,000	10	
Urban background area	100	
Rural	1	

Surface roughness
The surface roughness is used in dispersion modelling to represent the roughness of the ground. Table A3.5 shows the surface roughness values applied.

Table A3.5 Surface roughness

Site	Surface roughness, m	Note
London Marylebone	2	Street canyon
Camden Roadside	1	City
London Bloomsbury	1	City
London A3 Roadside	0.5	Suburban
London Haringey	1	City
London North Kensington	1	Suburban
Urban background area	1	

Model output
The local model was used to estimate:

- Annual average road contribution of oxides of nitrogen ;
- road contribution to oxides of nitrogen concentrations for each hour of the year.

The urban background model was used to estimate:

- the contribution from urban background sources to annual average oxides of nitrogen concentrations;
- the contribution from roads considered in the local model to urban background concentrations;
- the contribution from urban background sources to oxides of nitrogen concentrations for each hour of the year.

Background concentrations
A rural background concentration of 20 $\mu g\ m^{-3}$ was added to the urban background oxides of nitrogen concentration.

Calculation of annual average nitrogen dioxide concentrations
Nitrogen dioxide is formed as the result of the oxidation of nitrogen oxides in air, primarily by ozone. The relationship between oxides of nitrogen concentrations and nitrogen dioxide concentrations is complex; an empirical approach has been adopted.

The contribution from locally modelled roads to urban background oxides of nitrogen concentrations was first subtracted from the calculated urban background concentration. The annual average urban background nitrogen dioxide concentration was then calculated from the corrected annual average urban background oxides of nitrogen concentration using the following empirical relationship based on monitoring data from AUN sites:

For NO_x>23.6 μg m^{-3}

$$NO_2 = 0.348.NO_x + 11.48 \ \mu g\ m^{-3}$$

For NO_x<23.6 μg m^{-3}

$$NO_2 = 0.833.NO_x \ \mu g\ m^{-3}$$

The contribution of road sources to nitrogen dioxide concentrations was then calculated using the following empirical relationship (Stedman):

$$NO_2 = 0.162.NO_x$$

The contributions from road and background sources to annual average nitrogen dioxide concentrations were then summed.

The calculated value was then corrected so that there was agreement between modelled and measured concentrations at a reference site (London North Kensington (LNK)):

NO_2(corrected, site)= NO_2(modelled, site)+ NO_2(measured, LNK)- NO_2(modelled, LNK)

Calculation of 99.8th percentile hourly average concentrations

A simple approach has been used to estimate 99.8th percentile values. The approach relies on an empirical relationship between 99.8th percentile of hourly mean nitrogen dioxide and annual mean concentrations at kerbside/roadside sites, 1990-1998:

NO_2(99.8th percentile)=3.0 NO_2(annual mean)

99.8 th percentile values were calculated on the basis of the modelled annual mean.

The calculated value was then corrected so that there was agreement between modelled and measured concentrations at a reference site (London North Kensington (LNK)):

NO_2(corrected, site)= NO_2(modelled, site)+ NO_2(measured, LNK)- NO_2(modelled, LNK)

RESULTS

Modelled results are shown in Table A3.6. Fig. A3.1 shows modelled annual average nitrogen dioxide concentrations plotted against the measured values. Similarly Fig. A3.2 shows modelled 99.8th percentile average nitrogen dioxide concentrations plotted against measured values.

Table A3.6 Comparison of modelled and measured concentrations

Site	Nitrogen dioxide concentration, ppb			
	Annual average		99.8th percentile hourly	
	Modelled	Measured	Modelled	Measured
London A3	32	30	94	73
North Kensington	24	24	70	70
Bloomsbury	28	34	83	78
Camden	32	33	95	89
London Marylebone	45	48	134	121
Haringey	22	28	65	77

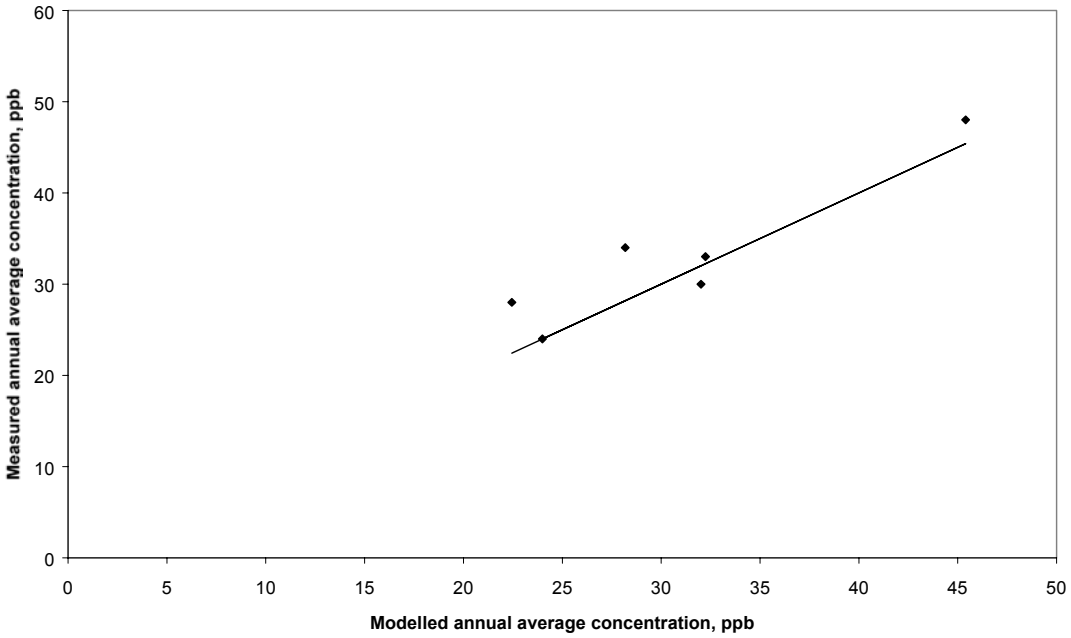

Fig. A3.1 Comparison of modelled and measured annual average nitrogen dioxide concentrations

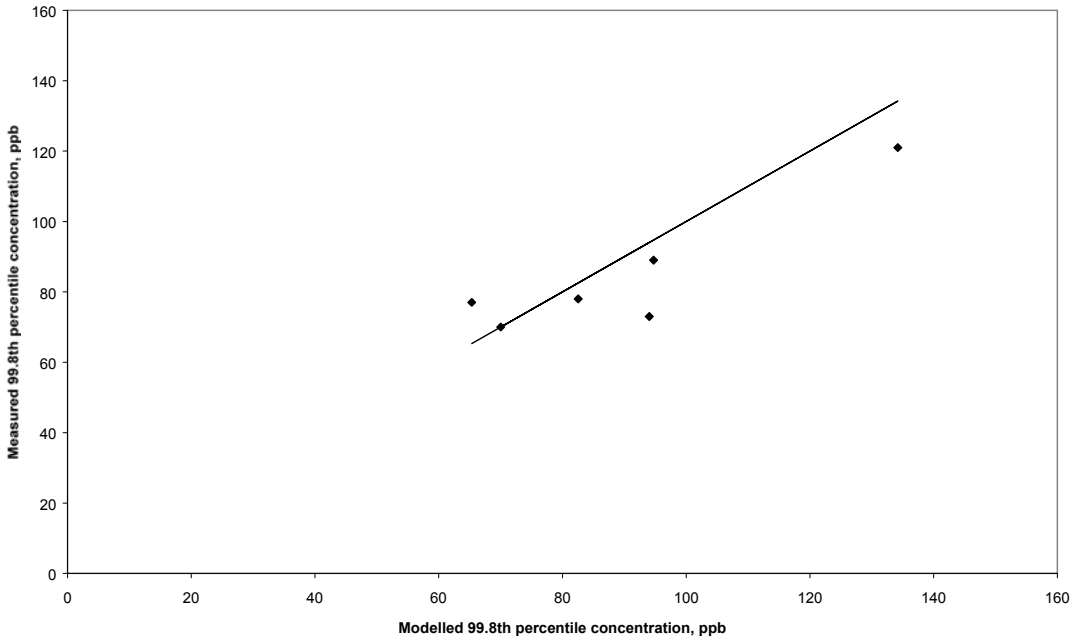

Fig. A3.2 Comparison of modelled and measured 99.8th percentile hourly average nitrogen dioxide concentrations

DISCUSSION

Model errors
The error in the modelled annual average at each site was calculated as a percentage of the modelled value. The standard deviation of the errors was then calculated: it was 12% with five degrees of freedom.

The error in the 99.8 th percentile concentration at each site was calculated as a percentage of the modelled value. The standard deviation of the errors was then calculated: it was also 12% with five degrees of freedom.

Year to year variation in background concentrations
Nitrogen dioxide concentrations at monitoring sites show some year to year variations. Reductions in emissions in the United Kingdom are responsible for some of the variation, but atmospheric influences and local effects also contribute to the variation.

In order to quantify the year to year variation monitoring data from AUN stations with more than 75% data in the each of the years 1996-1998 was analysed using the following procedure.

First, the expected concentrations in 1997 and 1996 were calculated from the 1998 data.

$$c_e = \frac{d_{1998}}{d_y}.c_{1998}$$

where c_{1996} is the concentration in 1998;
d_{1998}, d_y are correction factors to estimate nitrogen dioxide concentrations in future years (1996=1, 1997=0.95, 1998=0.91) from DETR guidance;

The difference between the measured value and the expected value was then determined for each site and normalised by dividing by the expected value. The standard deviation of normalised differences was determined for each site. A best estimate of the standard deviation from all sites was then calculated. The standard deviation of the annual mean was 0.097 with 2 degrees of

freedom. The standard deviation of the 99.8th percentile hourly concentration was 0.21 with 2 degrees of freedom.

Short periods of monitoring data
Additional errors can be introduced where monitoring at the reference site (used to calibrate the modelling results against) takes place over periods less than a complete year, typically of three or six months.

In this case, a whole year of data was available at the monitoring site (1999 in Glasgow Centre), and so no correction was necessary for short periods of monitoring.

Confidence limits
Upper confidence limits for annual mean and 99.8th percentile concentrations were estimated statistically from the standard deviation of the model error and the year to year standard deviation:

$$u = c + \sqrt{(t_m s_m)^2 . \left(1 + \frac{1}{k}\right) + (t_y s_y)^2 + \sum (t_p s_p)^2 / k}$$

where:

s_m, s_y, s_p are the model error standard deviation , the year to year standard deviation and the standard error introduced using part year data;

c is the concentration calculated for the modelled year;

t_m, t_y, t_p are the values of Student's t distribution for the appropriate number of degrees of freedom at the desired confidence level;

k is the number of reference sites used in the estimation of the modelled concentration.

In many cases, the concentration estimate is based on a single reference site (k=1). However, improved estimates can be obtained where more than one reference site is used.

Table A3.7 shows confidence levels for predictions as a percentage of modelled values

Table A3.7 Upper confidence levels (k=1) for modelled concentrations for future years

Confidence level	Annual mean	99.8th percentile
80 %	+19%	+27%
90%	+31%	+47%
95%	+44%	+70%

In practical terms,

- there is less than 1:5 chance (i.e.100-80=20%) that the 40 μg m^{-3} objective will be exceeded if the modelled annual average concentration in 2005 is less than 34 μg m^{-3} (i.e. 40/1.19);
- there is less than 1:20 (i.e. 100-5=5%) chance that the objective will be exceeded if the modelled roadside concentration is less than 28 μg m^{-3} (i.e. 40/1.44).

- Similarly, there is less than 1:5 chance that the 200 μg m^{-3} 99.8th percentile concentration will be exceeded if the modelled concentration for 2005 is less than 157 μg m^{-3};
- there is less than 1:20 chance that the objective will be exceeded if the modelled concentration in 2005 is less than 117 μg m^{-3}.

In the figures shown in the report, the intervals of confidence limits for the 'probable' and 'likely' annual average and hourly objective concentrations have been set equal to those for 'possible' and 'unlikely', respectively. In reality, the intervals of concentration increase as the probability of exceeding the annual and hourly objective increases from 'unlikely' to 'likely'. The advantage to setting symmetrical concentration intervals is that the concentration contours on the maps become simpler to interpret. This is a mildly conservative approach to assessing the likelihood of exceedances of the NO_2 objectives since a greater geographical area will be included using the smaller confidence intervals.

A simple linear relationship can be used to predict the 99.8th percentile concentration of NO_2 from the annual concentration: the 99.8th percentile is three times the annual mean at kerbside/roadside locations. Therefore, plots of the modelled annual mean NO_2 concentrations can be used to show exceedances of both the annual and hourly NO_2 objectives. However, the magnitude of the concentrations used to judge exceedances of the hourly objective need to be adjusted so they may be used directly with the plots of annual concentration. This has been performed by simply dividing the concentrations of the confidence limits by three.

The following table shows the difference between assigning symmetrical confidence intervals and assigning intervals based directly on the statistics.

Table A3.8a Confidence levels for modelled concentrations for future years based on symmetrical concentration intervals and concentration intervals derived purely from the statistics

Description	Chance of exceeding objective	Confidence limits for the modelled annual average concentrations ($\mu g\ m^{-3}$)			
		Annual average objective (symmetrical intervals)	Symmetrical intervals	Annual average objective (intervals based on statistics)	Interval
Very unlikely	Less than 5%	< 28		< 28	
Unlikely	5 to 20%	28 to 34	6.0	28 to 34	6.0
Possible	20 to 50%	34 to 40	6.3	34 to 40	6.3
Probable	50 to 80%	40 to 46	6.3	40 to 47	7.5
Likely	80 to 95%	46 to 52	6.0	47 to 58	10.3
Very likely	More than 95%	> 52		> 58	

Table A3.8b Confidence levels for modelled concentrations for future years based on symmetrical concentration intervals and concentration intervals derived purely from the statistics

Description	Chance of exceeding objective	Confidence limits for the modelled annual average concentrations ($\mu g\ m^{-3}$)			
		Hourly average objective (symmetrical intervals)	Symmetrical intervals	Hourly average objective (intervals based on statistics)	Interval
Very unlikely	Less than 5%	< 39		< 39	
Unlikely	5 to 20%	39 to 52	13.2	39 to 52	13.2
Possible	20 to 50%	52 to 67	14.3	52 to 67	14.3
Probable	50 to 80%	67 to 81	14.3	67 to 85	18.1
Likely	80 to 95%	81 to 94	13.2	85 to 113	28.7
Very likely	More than 95%	> 94		> 113	