Environment Newport City Council January 2015

Caerleon AQMA Source Apportionment and Transport Intervention Study

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Newport - Air Quality Assessment

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1 Introduction

AECOM was commissioned by Newport City Council to provide an assessment of Caerleon High Street Air Quality Management Area (AQMA) and to identify the causes of traffic congestion and poor air quality.

This report details the work undertaken and recommendations resulting from the analysis of the site data. The information reviewed and considered includes:

- Site visit information;
- Previous air quality monitoring data and reports;
- Existing air quality monitoring data; and
- Traffic survey data commissioned for this assessment.

Following this introduction, the report is structured as follows:

- Section 2: Legislative Framework;
- Section 3: Baseline Conditions;
- Section 4: Source Apportionment; and
- Section 5: Improvement Options and Recommendations.

2 Legislative Framework

2.1 National and European Air Quality Legislation and Policy

2.1.1 Local Air Quality Management

The provisions of Part IV of the Environment Act 1995 establish a national framework for air quality management, which requires all local authorities in England, Scotland and Wales to conduct local air quality reviews. Section 82(1) of the Act requires these reviews to include an assessment of the current air quality in the area and the predicted air quality in future years. Should the reviews indicate that the objectives prescribed in the UK Air Quality Strategy[1] and the Air Quality (England) Regulations[2][3] will not be met, the local authority is required to designate an Air Quality Management Area (AQMA). Action must then be taken at a local level to ensure that air quality in the area improves. This process is known as 'local air quality management' or LAQM.

2.1.2 UK Air Quality Strategy

The UK Air Quality Strategy (AQS) identifies nine ambient air pollutants that have the potential to cause harm to human health and two for the protection of vegetation and ecosystems. These objectives aim to reduce the impacts of the pollutants to negligible levels. The objectives are not mandatory but targets that local authorities should try to achieve. The objectives are provided in Appendix 1.

2.1.3 European Air Quality Directives

The Air Quality Framework Directive (96/62/EC) on ambient air quality assessment and management defines the policy framework for 12 air pollutants known to have a harmful effect on human health and the environment. The limit values for the specific pollutants are set through a series of Daughter Directives. The limit values have been transposed into The Air Quality Standards Regulations 2010 (SI 2010 No. 1001). The limit values are provided in Appendix 1.

2.2 Nitrogen Dioxide (NO_2)

The Government and Devolved Administrations adopted two Air Quality Objectives for NO_2 to be achieved by the end of 2005. These are:

- An annual mean concentration of 40 µg/m^3; and
- A one-hour mean concentration of 200 µg/m^3, not to be exceeded more than eighteen times per year.

In practice, meeting the annual mean objective has proved to be considerably more challenging than attaining the one-hour objective. The EU First Daughter Directive also sets limit values for NO_2 to be achieved by 1st January 2010, which have been incorporated into UK legislation. The Directive also set a one-hour limit value of 200 µg/m^3, not to be exceeded more than eighteen times per year and an annual mean limit value of 40 µg/m^3.

NO_2 and nitric oxide (NO) are collectively known as oxides of nitrogen, or NO_x. All combustion processes produce NO_x emissions, predominantly in the form of NO, which then undergoes conversion in the atmosphere to NO_2, mainly as a result of its reaction with ozone (O_3). It is NO_2 that has been most strongly associated with adverse effects upon human health. Nitrogen dioxide can irritate the lungs and lower resistance to respiratory infections such as influenza.

The annual mean objective of 40 µg/m^3 is currently widely exceeded at roadside sites throughout the UK, with exceedances also reported at urban background locations in major conurbations. The number of exceedances of the 1-hour objective show considerable year-to-year variation, driven by meteorological conditions, which give rise to winter episodes of poor dispersion and summer oxidant episodes.

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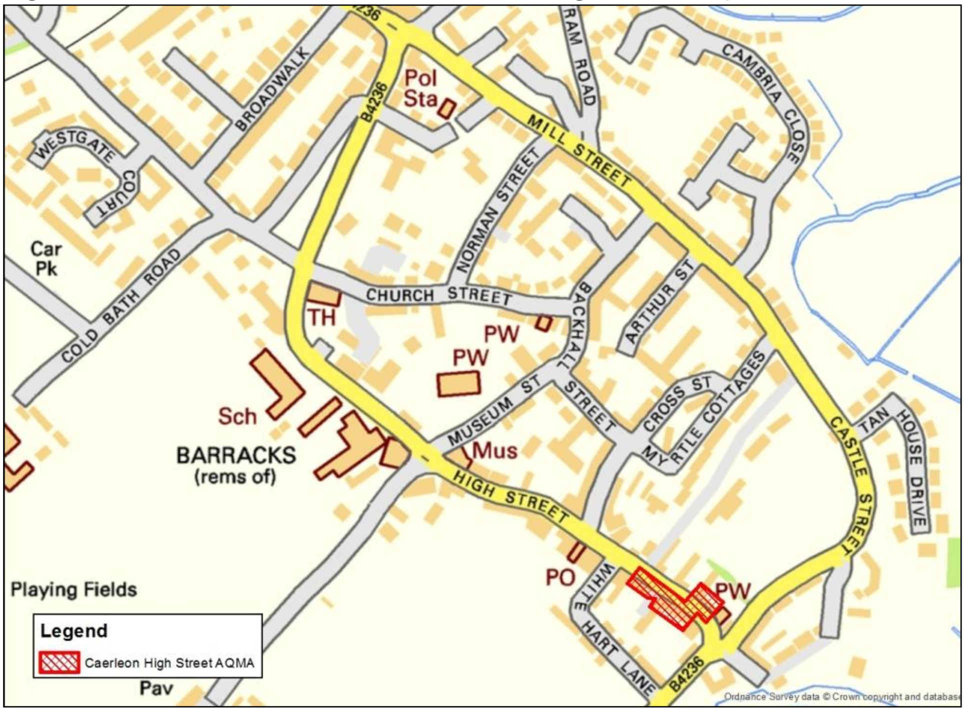
[1] Defra (2007). The Air Quality Strategy for England, Scotland, Wales and Northern Ireland.
[2] Defra (2000). The Air Quality (England) Regulations, 2000 (SI 2000/928).
[3] Defra (2000). The Air Quality (England) Regulations, 2000 (SI 2000/928).

3 Baseline Conditions

3.1 Summary of Local Air Quality Management in Newport City Council

Newport City Council completed their first round of local air quality review and assessment in 2001 and since then has declared nine AQMAs, including one along Caerleon High Street, which is the focus of this study. All nine AQMAs were declared due to exceedances of the annual mean objective for nitrogen dioxide. The location and extent of the Caerleon High Street AQMA is shown in Figure 1.

Figure 1: Location and Extent of Caerleon High Street AQMA



3.2 Site Visit Data

AECOM conducted a site visit on 21/10/2014 prior to the surveys being carried out, the findings of which were reported in a technical note included in Appendix 2. Traffic conditions observed on site involved many interactions between vehicles, pedestrians and parked vehicles during the busier periods. Most notably this coincided with the school arrival and departure times.

The AQMA itself is within a narrow uphill section of road with tall buildings on either side. These three factors, along with the heavy vehicle flow and sometimes queuing conditions, all contribute to the poor air quality.

3.3 Newport City Council Air Quality Monitoring

Newport City Council has a network of 55 NO_2 diffusion tubes at locations within the nine declared AQMAs, in addition to other areas where potential exceedances of the NO_2 objective may occur. Table 1 presents the bias-adjusted diffusion tube results obtained in recent years for those diffusion tube sites located within the study area. The locations of these diffusion tubes are illustrated in Figure 2.

Capabilities on project:
Environment

Figure 2: Locations of Newport City Council Diffusion Tubes in Study Area

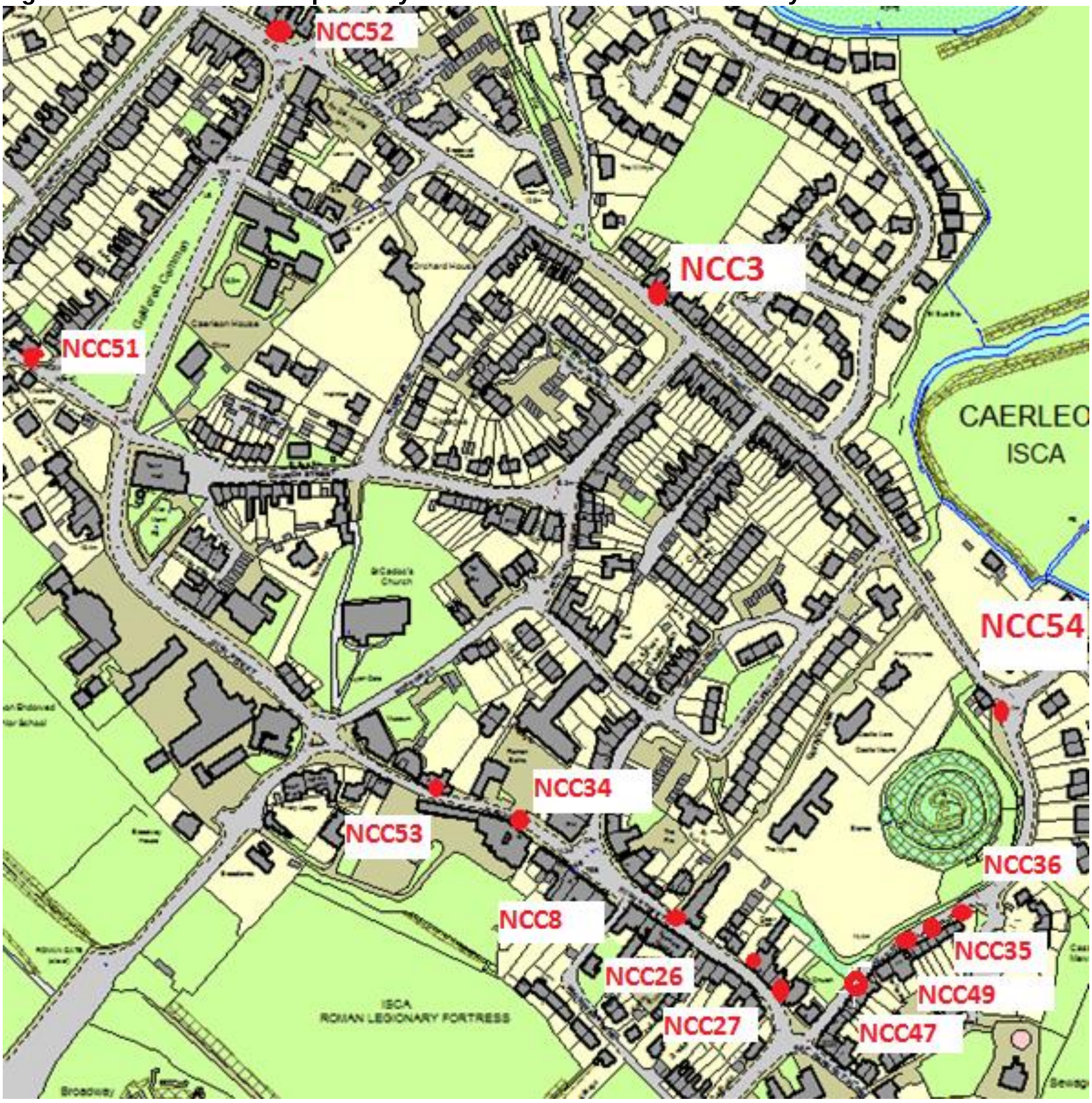


Table 1: Annual Mean NO_2 Concentrations at Diffusion Tube Sites in Study Area

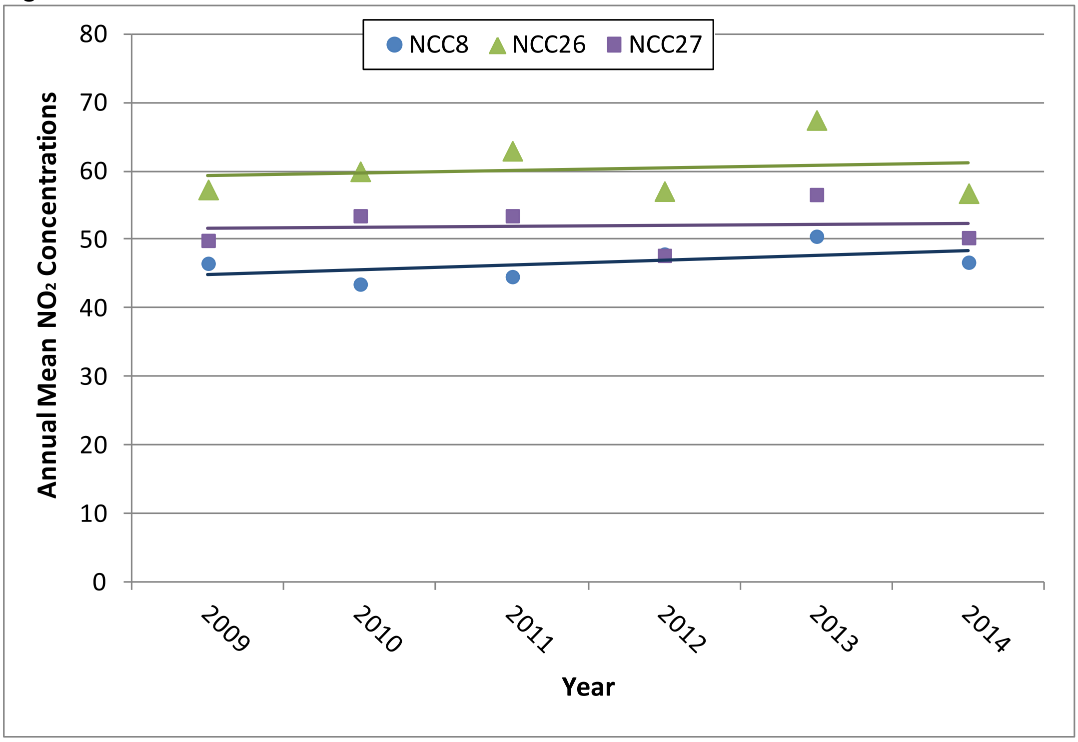
Tube ID	Site Name	Site Type	Within AQMA?	Bias Adjusted Annual Mean NO_2 Concentrations ($\mu g/m^3$)					
				2009	2010	2011	2012	2013	2014[a]
NCC3	13 Mill Street	Kerbside	No	ND	ND	ND	21.6	23.5	21.3
NCC8	High Street, Caerleon	Kerbside	Yes	**46.5**	**43.5**	**44.6**	**47.9**	**50.5**	**46.7**
NCC26	15 High Street Caerleon	Kerbside	Yes	**57.3**	**60.0**	**63.0**	**57.1**	**67.5**	**56.8**
NCC27	18 High Street Caerleon	Kerbside	Yes	**49.9**	**53.5**	**53.5**	**47.7**	**56.6**	**50.3**
NCC34	The Priory Caerleon	Kerbside	No	ND	20.5	24.0	32.0	37.3	37.8
NCC35	6 Castle Street	Kerbside	No	ND	20.7	22.5	30.7	35.8	33.8
NCC36	1 Castle Street	Kerbside	No	ND	21.1	21.4	29.4	35.6	32.0
NCC43	7 Castle Street	Kerbside	No	ND	31.7	38.7	34.5	36.9	35.8
NCC47	9 Castle Street	Kerbside	No	ND	39.9	**44.5**	38.9	**43.4**	**41.0**
NCC51	19 Goldcroft Road	Kerbside	No	ND	21.7	21.5	20.3	20.8	19.2
NCC52	9 Station Road	Roadside	No	ND	25.2	25.6	24.5	26.9	32.6
NCC53	5 High Street Caerleon	Roadside	No	ND	30.4	30.2	23.8	28.4	28.7
NCC54	96/98 Mill Street	Kerbside	No	ND	22.0	24.4	18.9	22.3	20.0

NOTES: Values in bold indicate exceedances of the annual mean air quality objective / EU limit value (40 $\mu g/m^3$).
ND = No Data
[a] Data for 2014 should be considered provisional as they are based on 10 months of data and have been bias-adjusted using a bias adjustment factor from 2013 (0.87).

The results in Table 1 indicate that the annual mean air quality objective of 40 $\mu g/m^3$ was exceeded in all years between 2009 and 2014 at locations NNC8, NCC26, NCC27, within the Caerleon High Street AQMA.

Figure 3 illustrates estimated trends in annual mean NO_2 concentrations between 2009 and 2014 for those locations in the Caerleon High Street AQMA. The interpolated trend lines appear to show a slight increase in concentrations over time, although it should be noted that annual mean NO_2 concentrations in 2014 were significantly lower than those in 2013.

Figure 3: Trends in Pollutant Concentrations between 2009 and 2014



3.4 Environment Agency Monitoring

In 2012 a temporary continuous monitoring station (Mobile Monitoring Facility (MMF)) was located on the edge of the Caerleon High Street AQMA, which was provided by Natural Resources Wales (formerly known as the Environment Agency). The station monitored NO_2, PM_{10} and $PM_{2.5}$ between February 2012 and October 2012. The location of the MMF in relation to the Caerleon High Street AQMA is illustrated in Figure 4.

Figure 4: Location of MMF in Relation to Caerleon High Street AQMA

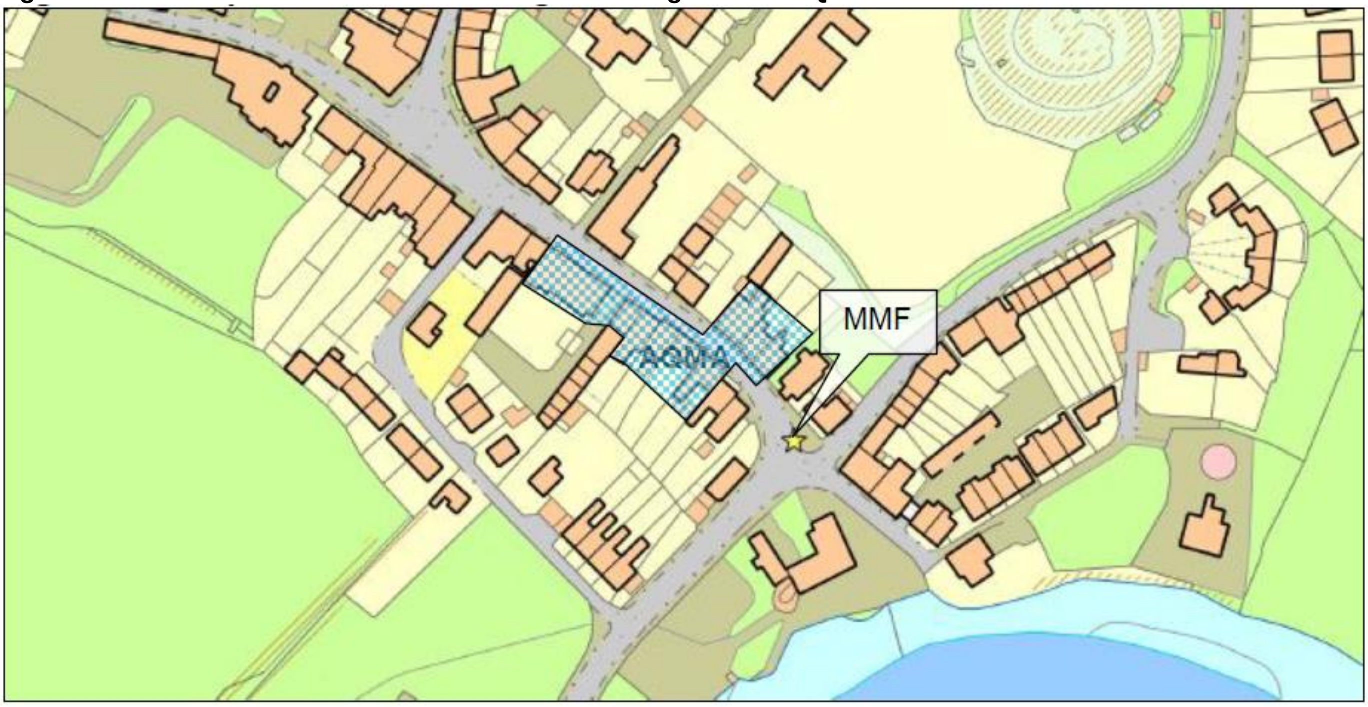


Table 2: Measured NO_2 Concentrations at EA Mobile Monitoring Facility in 2012

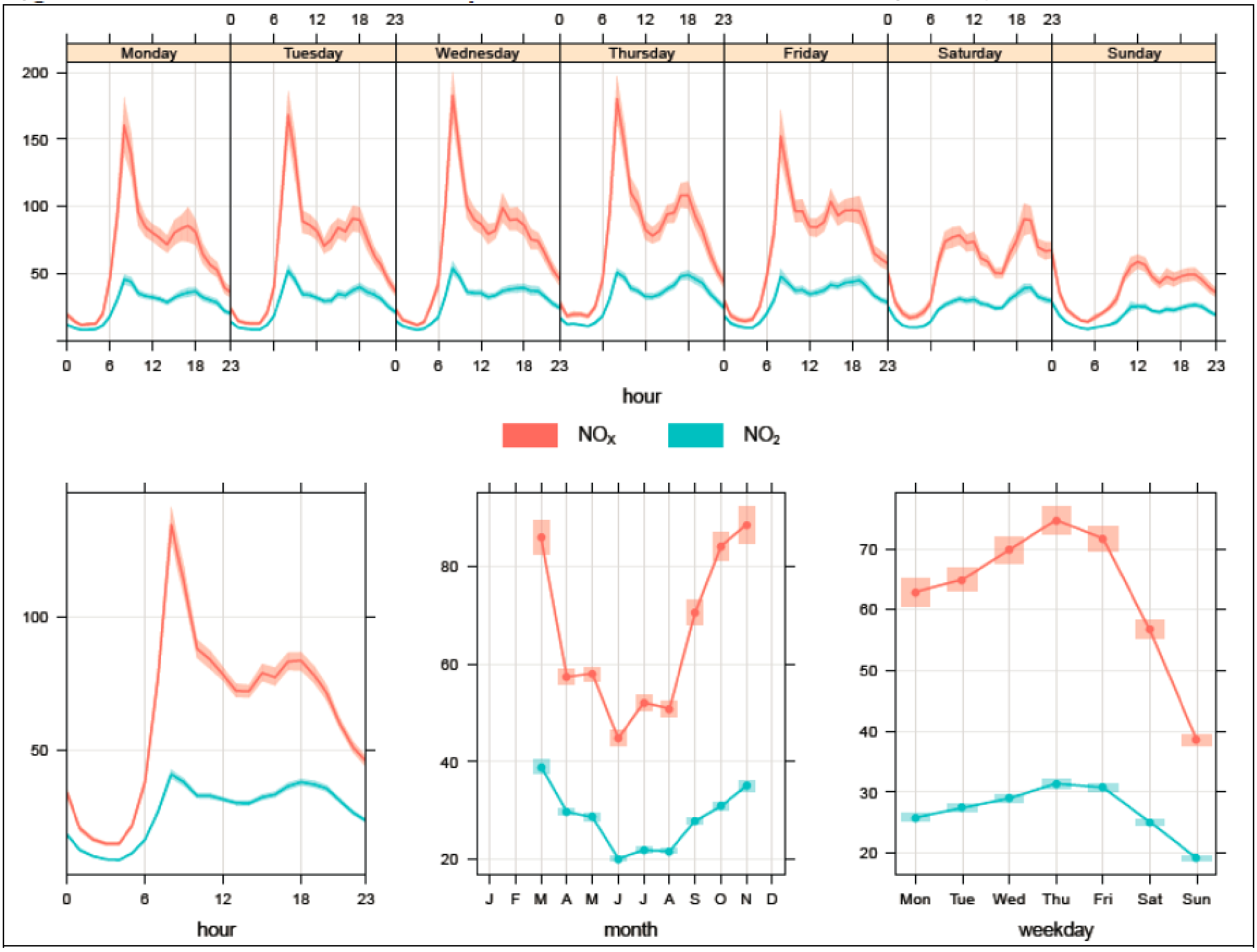
Site Name	Site Type	Annual Mean NO_2 Concentration ($\mu g/m^3$)	No. of Exceedances of 1 hour Mean NO_2 Standard
Caerleon High Street MMF	Kerbside	27.0	0

The results in Table 2 indicate that annual mean NO_2 concentrations in 2012 at the location of the MMF, i.e. just outside the Caerleon High Street AQMA are well below the air quality objective. This suggests that the street canyon nature of the High Street, and the resulting effect on reducing pollutant dispersion, has a significant effect on pollutant concentrations within the AQMA.

The Environment Agency also undertook diurnal analysis of monitored concentrations at the MMF site[4], as shown in Figure 5, which indicates a double peaked pattern in NO_X concentrations suggesting that emissions from road traffic were the main source of NO_X at the monitoring site with the morning peak being particularly pronounced.

[4] Environmental Agency, Study of Ambient Air Quality at Caerleon, 2012

Figure 5: Monitored NOx and NO_2 Time Variation Plot at EA Mobile Monitoring Facility in 2012



3.5 Background Pollutant Concentrations

A large number of small sources of air pollutants exist, which individually may not be significant, but collectively, over a large area, need to be considered in this assessment.

Defra has produced mapped background concentrations[5] covering the whole of the UK for use by local authorities in the completion of their Review & Assessment (R&A) reports in the absence of local monitoring or where insufficient monitoring data is available. These maps provide background pollutant concentrations for each 1 km by 1 km grid square within the UK.

[5] Defra, LAQM Support, Background Maps, http://uk-air.defra.gov.uk/data/laqm-background-home

Table 3 shows the mapped background NO_2 concentration in the study area. The background NO_2 concentration is less than 65% of the objective which suggests that the high measured concentrations in the AQMA are due primarily to vehicle emissions.

Table 3: Background NOx and NO_2 Concentration in Study Area

Pollutant	Background Concentration ($\mu g/m^3$)	Source
NOx	25.2	Defra mapped background
NO_2	18.3	Defra mapped background

3.6 Estimated Contribution of Road Traffic Emissions to Monitored NO_2 Concentrations in AQMA

Table 4 summarises the estimated contributions from background and road traffic sources respectively to monitored NO_2 concentrations in 2014 within the Caerleon High Street AQMA. The estimated road NOx contributions were calculated using the Defra NO_X to NO_2 conversion tool (Version 4.1, June 2013). The "All UK Traffic" traffic mix option was used with Newport selected as the Local Authority. The corresponding approximate percentage reduction in NO_x emissions required in order to meet the annual mean objective of $40\mu g/m^3$ has also been estimated for each site.

Table 4: Estimated Contributions of Road Traffic Emissions to Monitored NO_2 Concentrations

Site	2014 Annual Mean NO_2 Concentration ($\mu g/m^3$)	Background NOx Contribution ($\mu g/m^3$)	Road-NO_x Contribution ($\mu g/m^3$)	Road-NOx Contribution as % of Total	% Reduction in Road-NOx Required to Meet Objective
NCC8	**46.7**	25.2	66.0	72%	26%
NCC26	**56.8**	25.2	95.0	79%	49%
NCC27	**50.3**	25.2	75.9	75%	36%

The results in Table 4 indicate that road traffic NOx emissions contribute between 72% and 79% of NO_x concentrations at the monitoring locations in the Caerleon High Street AQMA. Furthermore, significant reductions in emissions (between 26% and 49%) will be required in order to meet the objective. In order to achieve the objective at the diffusion tube site with the highest concentration, a reduction of 49% to the vehicle NO_x emissions is required.

4 Source Apportionment

4.1 Scope of the Assessment

A source apportionment analysis was carried out in order to quantify the contribution of different vehicle types to total NO_x emissions within the Caerleon High Street AQMA and wider study area. Weekly and diurnal profiles of emissions were also analysed to determine the pattern of emissions throughout the week and day.

Traffic data was provided by a specialist survey company for High Street and Mill Street, in the form of total vehicle flow, the proportions of cars, LGVs, rigid HGVs, articulated HGVs, motorcycles, buses and coaches, and average vehicle speeds (km/hr), at 15 minute intervals between 19/11/2014 and 03/12/2014.

The Emission Factor Toolkit (EFT) (Version 6.0.2, Defra, November 2014), which incorporates the latest NO_x emission factors, was subsequently used to calculate the relative contribution to Road-NO_x emissions at each site. The year 2014 was selected in the EFT and the area was specified as “Wales”.

4.2 Analysis of Traffic Data

The diurnal traffic profile in High Street and Mill Street for week days and weekend days has been analysed in order to understand traffic patterns. Graphs illustrating total vehicle flows on each day of the survey are shown in Figure 6 and Figure 7 for weekdays and Figure 8 and Figure 9 for weekend days.

Figure 6 and Figure 7 shows the diurnal profile during week days in High Street and Mill Street, respectively. The profile for the two roads is similar, with two traffic flow peaks: one in the morning between 07:00 and 08:00, and one in the afternoon between 16:00 and 17:00.

Figure 8 and Figure 9 shows the diurnal profile during weekend days. In this case, the peak in traffic flow is shown between 11:00 and 12:00 in the morning.

Figure 10 and Figure 11 shows the traffic profile split by vehicle class in High Street and Mill Street during the two-week period survey. Graphs indicate that light duty vehicles are the major component of the fleet composition, however in early hours in the morning, heavy duty vehicle represents approximately 10% of the total vehicle composition.

Figure 12 summarises average vehicle speeds over a fortnight on High Street within the AQMA. Average vehicle speeds are lowest at about 08:30 and 15:30 on weekdays, corresponding to school start and finishing times. It should be noted that lower vehicle speeds can result in increased emissions as vehicle engines and emissions reduction technology (e.g. SCR) do not operate as efficiently or effectively at lower speeds. Analysis of corresponding video footage through Caerleon High Street supports evidence of these low speeds: in particular during the school drop off (08:30 – 09:00) and school pick up (03:15 – 03:45) times of the day. The low speeds are caused by multiple pinch points along the corridor, including parked vehicles, zebra crossings, and the roundabout junction at the northern end of High Street. These are discussed in more detail in Section 5.

Figure 6: Diurnal Profile of Total Traffic Flow in High Street - Weekdays

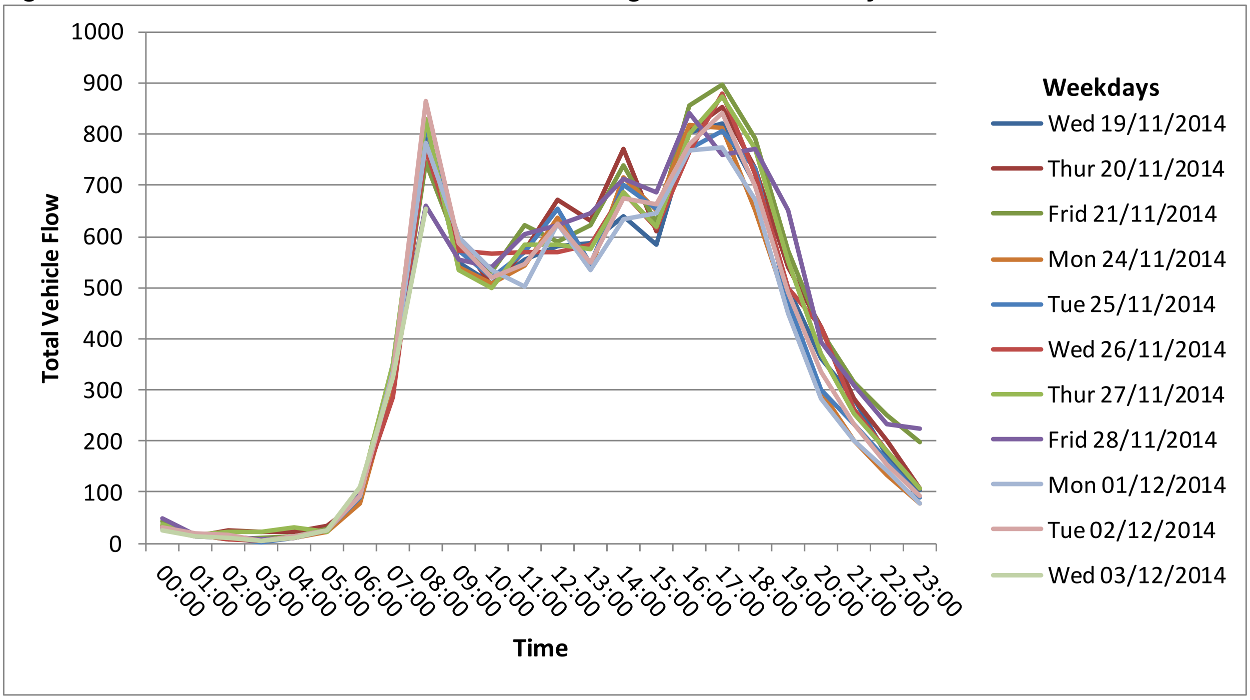


Figure 7: Diurnal Profile of Total Traffic Flow in Mill Street - Weekdays

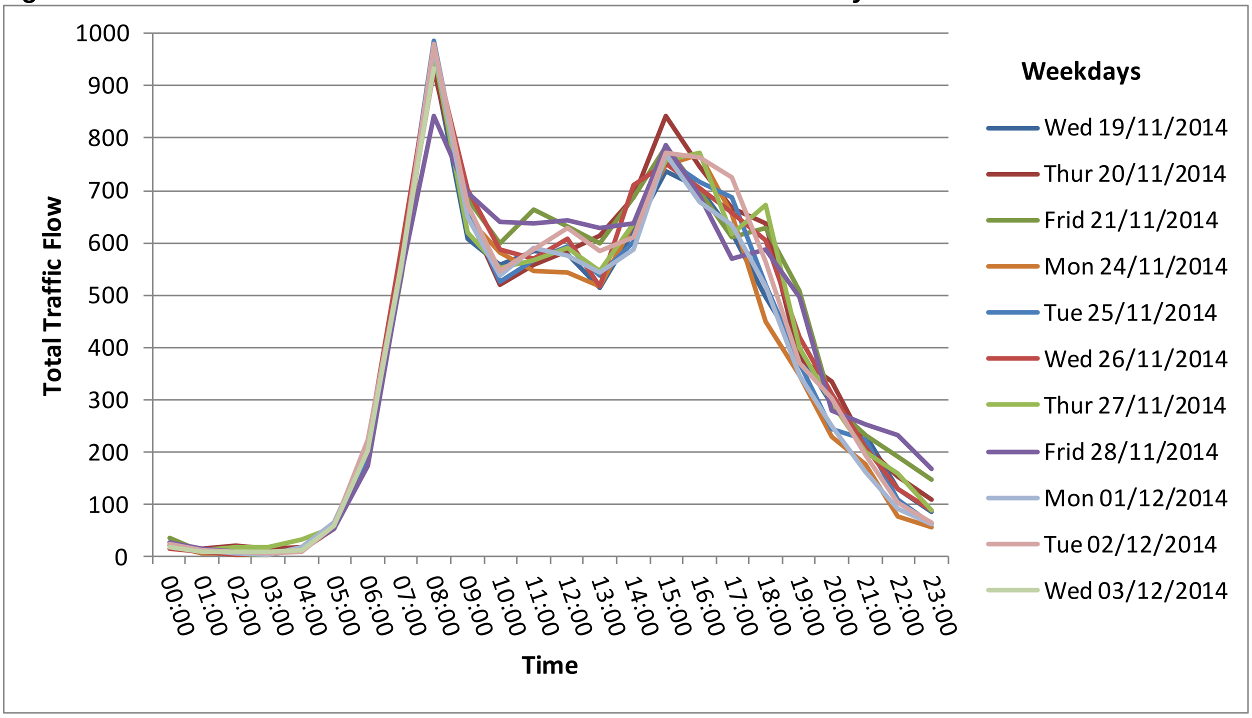


Figure 8: Diurnal Profile of Total Traffic Flow in High Street - Weekend Days

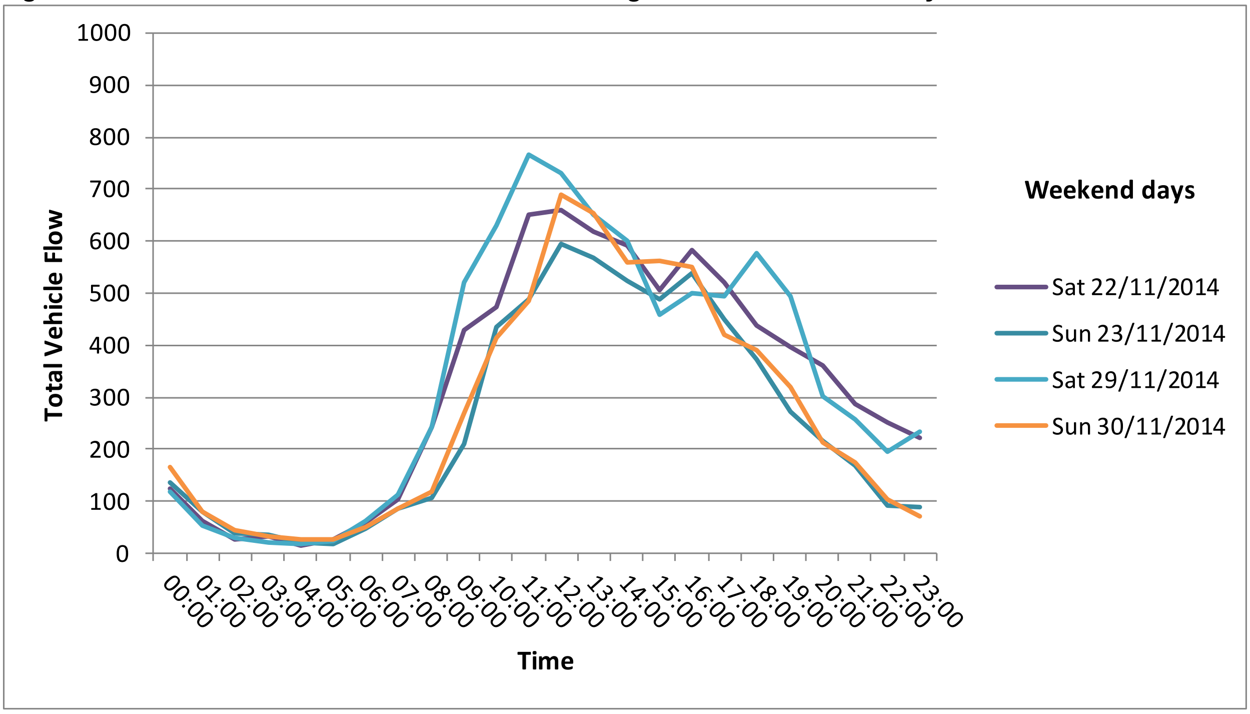


Figure 9: Diurnal Profile of Total Traffic Flow in Mill Street - Weekend Days

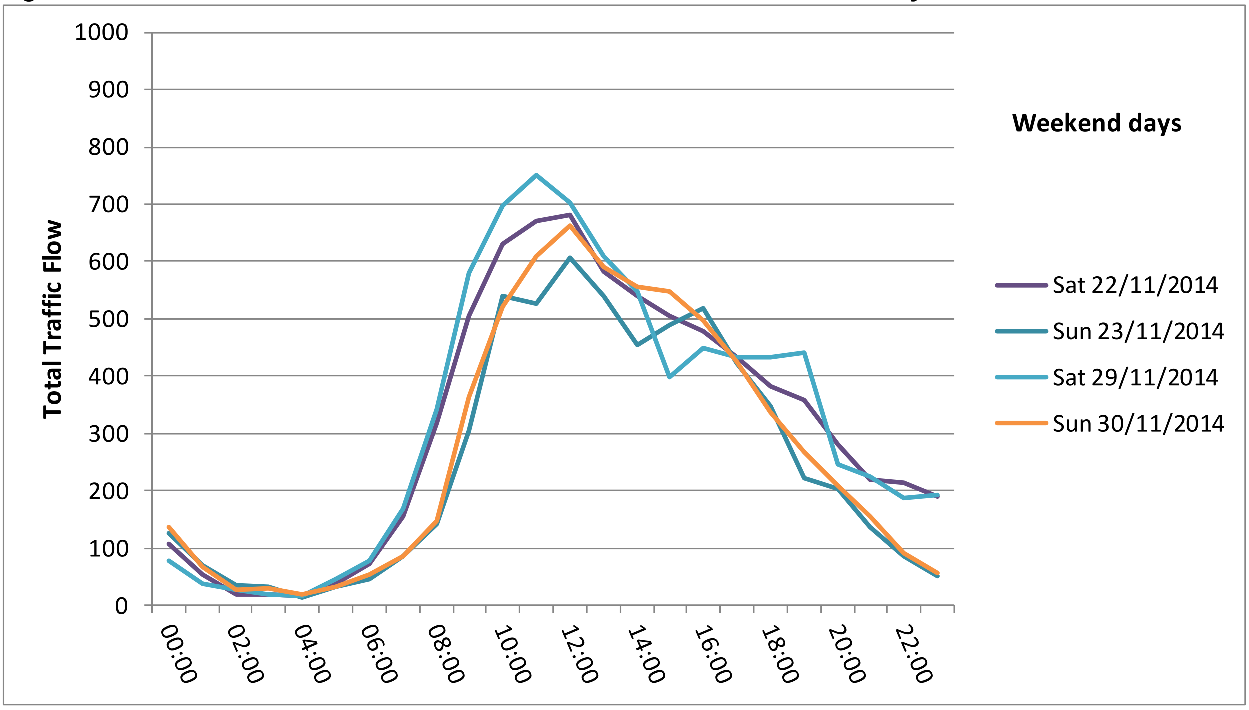


Figure 10: Traffic Flow Split by Vehicle Class – High Street

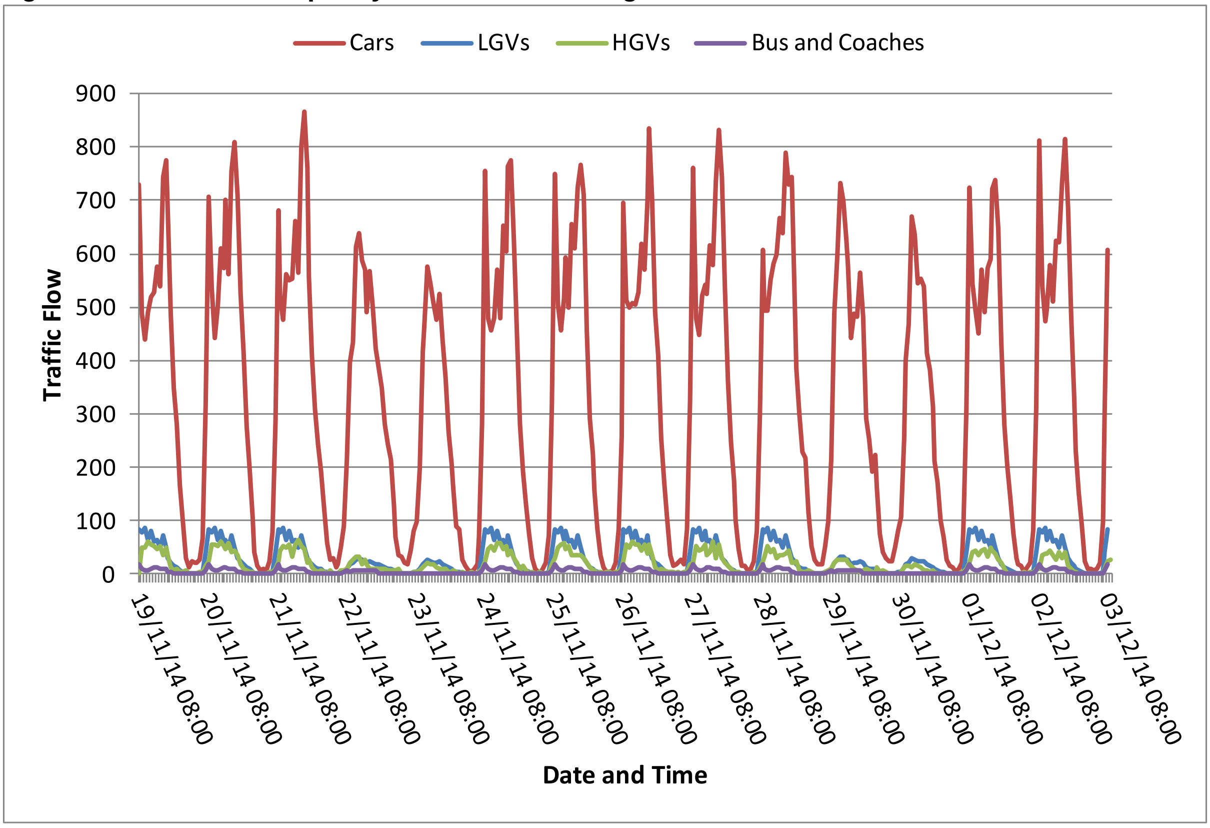


Figure 11: Traffic Flow Split by Vehicle Class - Mill Street

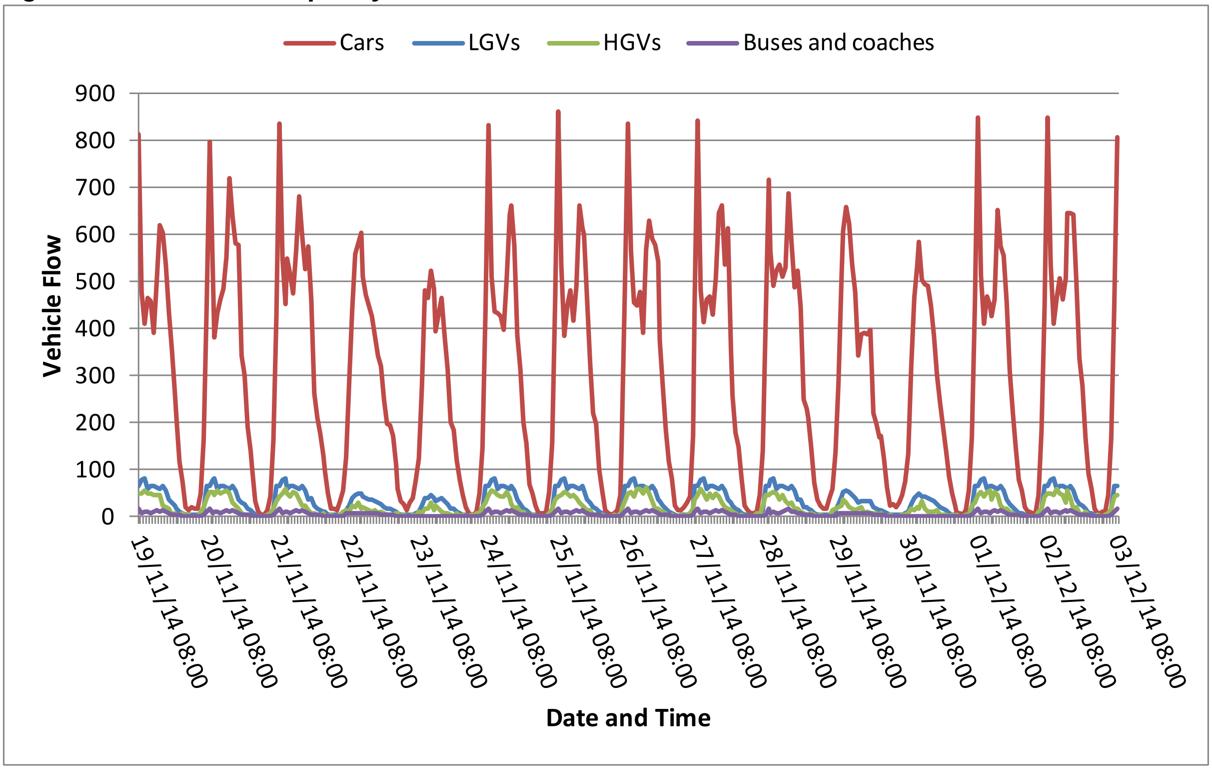
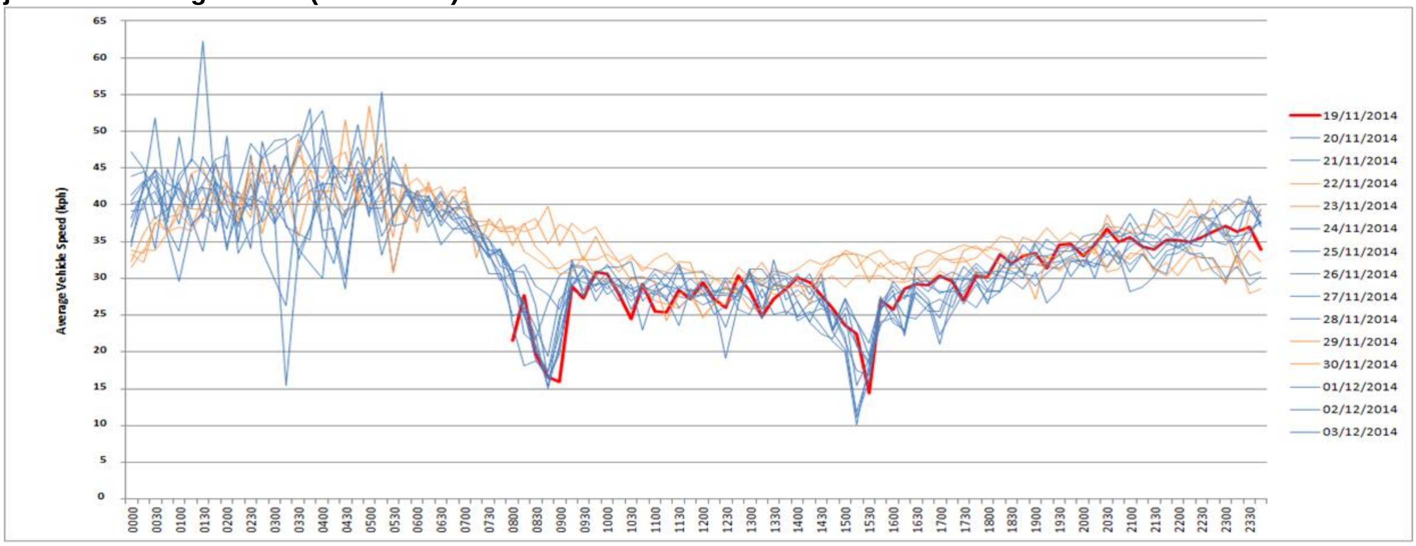


Figure 12: Average Weekday Vehicle Speed High Street (kph) – red line is the day of the video survey and junction turning counts (19/11/2014)



4.3 Traffic and NO_x Emissions

The Emission Factor Toolkit has been used to estimate NO_x emission rates associated with the vehicles travelling along High Street and Mill Street on an hourly basis. The proportion of emissions from each vehicle class has also been calculated in order to determine which vehicle class is responsible for the highest contribution to road-NOx emissions on which day of the week and at what time of day.

Table 5 and Table 6 summarise the estimated daily contributions to Road-NO_x emissions from each vehicle class in High Street and Mill Street. The two tables show a similar pattern, with the most significant contribution made by emissions from cars (approximately 45% on weekdays and up to 68% on weekends); however rigid HGVs are estimated to contribute up to 35% of Road-NOx emissions in High Street and 32% of Road-NOx emissions in Mill Street during weekdays and approximately 20% at weekends. It should also be noted that this relatively large contribution from rigid HGVs is despite the fact that these emissions are associated with a relatively small number of vehicles (see Figure 10 and Figure 11) when compared to the number of cars for example.

Figure 13 and Figure 14 show daily NOx emission rates (in g/km) on a daily basis along High Street and Mill Street, respectively. The contribution to emissions is mainly due to cars and rigid HGVs. It should be noted that diesel-engined cars are estimated to be responsible for the majority of NOx emissions from cars, as shown in Figure 15, which is attributable to the failure of the Euro 5 emission standard to adequately control NOx emissions from diesel vehicles under urban driving conditions. This is a problem faced nationally, and will only be remedied once Euro 5 diesel cars are phased out and replaced with Euro 6 vehicles over time. Note this diesel proportion is based on the national average proportion of diesel and petrol cars in the car fleet using the proportions in Defra's Emissions Factor Toolkit rather than local data.

Table 5: Estimated Daily Contributions to Total NO_x Emissions – High Street

Day	% Contribution to Total Road NOx Emissions					
	Cars	LGVs	Motorcycles	Rigid HGVs	Artic. HGVs	Buses and Coaches
Monday	43.1	11.8	0.1	31.9	1.5	11.5
Tuesday	45.6	11.9	0.1	28.8	1.7	11.9
Wednesday	41.4	11.0	0.1	34.6	1.7	11.2
Thursday	43.1	11.0	0.1	32.8	1.9	11.1
Friday	45.1	11.2	0.1	31.1	1.4	11.1
Saturday	59.2	6.8	0.1	22.8	1.1	10.0
Sunday	67.7	7.7	0.2	19.2	1.0	4.1
Average	47.1	10.6	0.1	30.0	1.5	10.7

Table 6: Daily Contribution of Total NO_x Emissions – Mill Street

Day	% Contribution to Total Road NOx Emissions					
	Cars	LGVs	Motorcycles	Rigid HGVs	Artic. HGVs	Buses and Coaches
Monday	44.4	12.5	0.1	30.6	1.2	11.3
Tuesday	45.7	12.3	0.1	29.5	1.3	11.1
Wednesday	44.2	11.8	0.1	31.8	1.5	10.7
Thursday	45.2	12.0	0.1	30.4	1.5	10.8
Friday	47.1	12.3	0.1	28.4	1.2	10.9
Saturday	57.0	11.6	0.1	20.5	0.6	10.1
Sunday	63.9	12.9	0.2	19.3	1.1	2.5

Figure 13: Daily NOx Emissions (g/km) - High Street

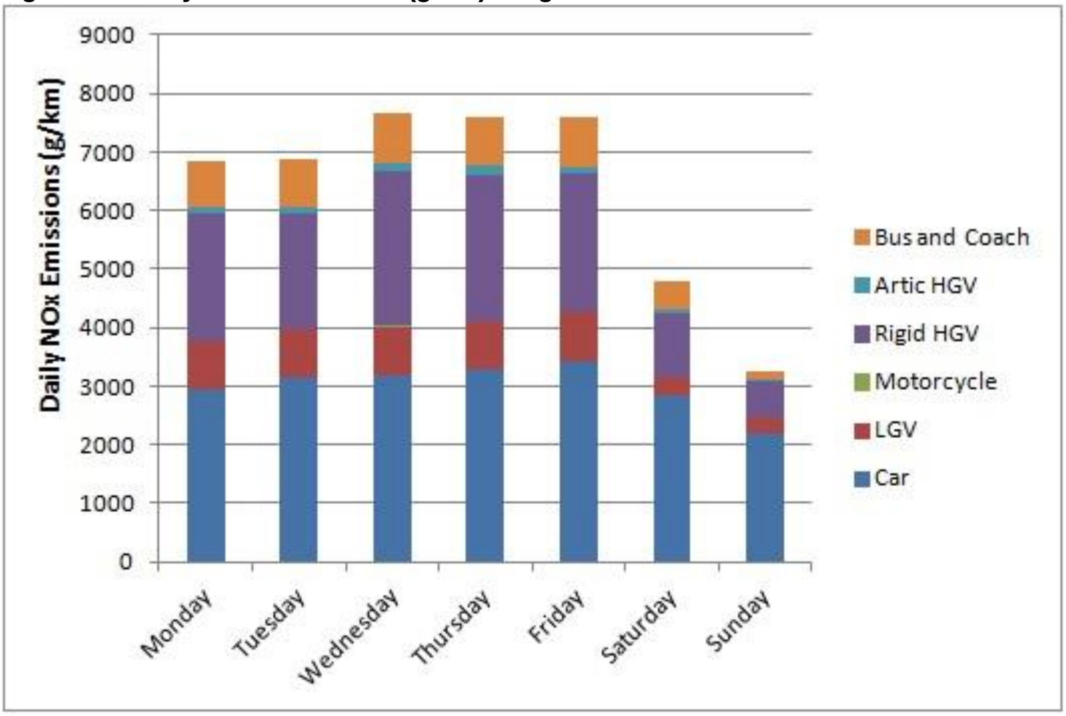


Figure 14: Daily NOx Emissions (g/km) - Mill Street

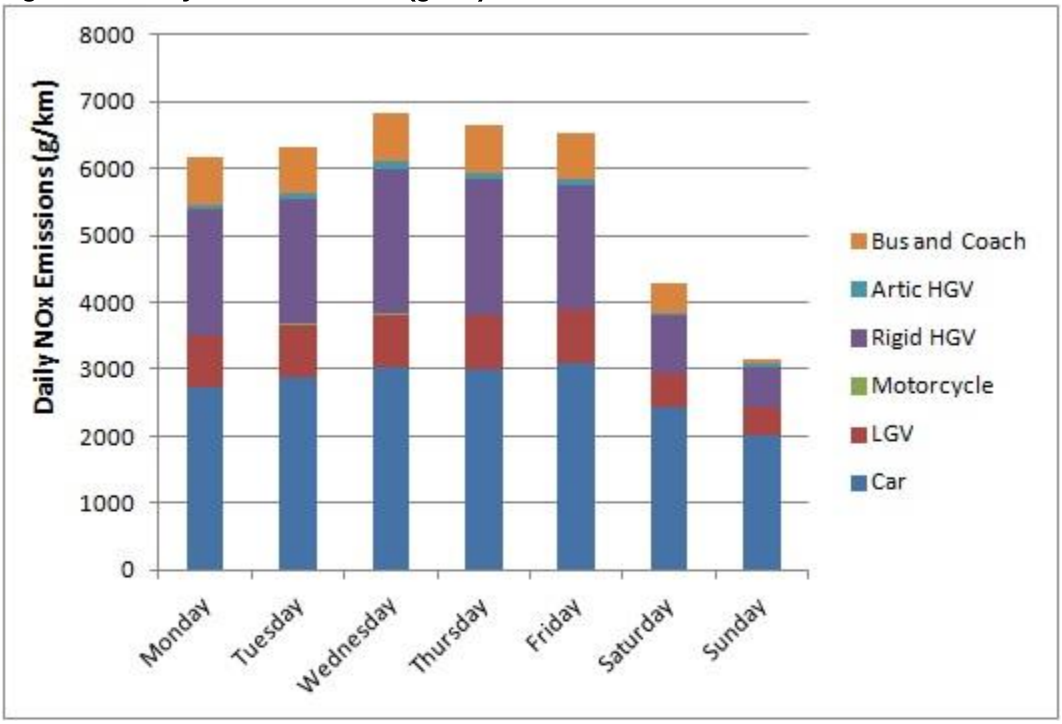


Figure 15: Petrol and Diesel Cars NOx Emissions (using Defra's emissions factor toolkit, not local data)

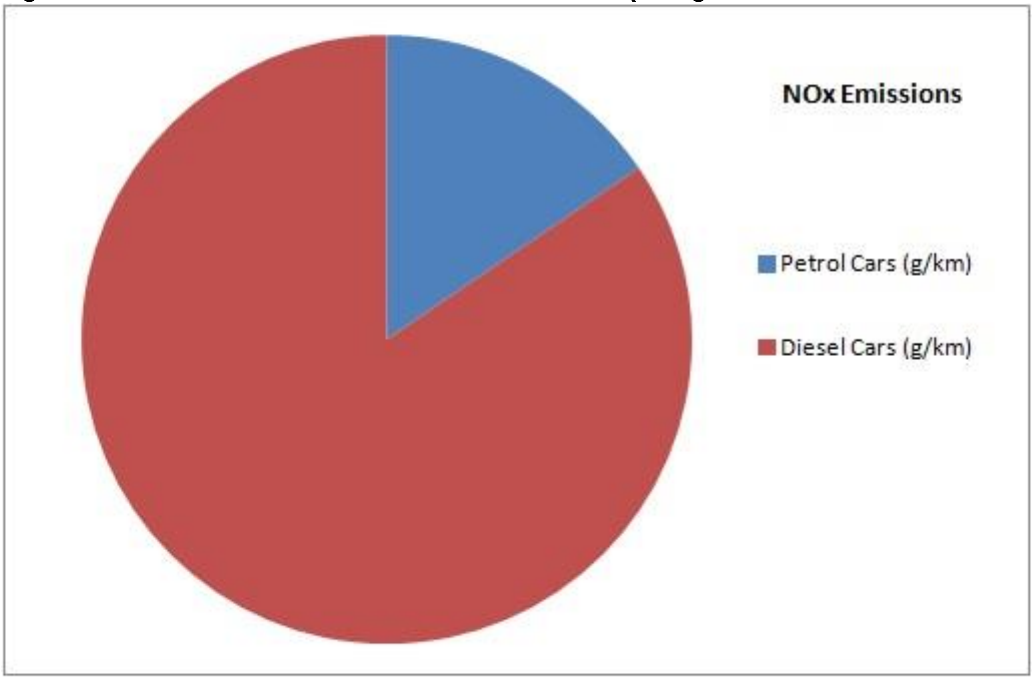


Figure 16 to Figure 19 illustrate the estimated diurnal profile of Road-NO_x emissions during weekdays and weekend days by vehicle class in High Street and Mill Street.

Again, High Street and Mill Street show a similar pattern. During week days, the majority of NO_x is emitted between 08:00 and 19:00, with two distinct peaks between 08:00 to 9:00 and in the afternoon around 16:00 which are thought to relate to both commuters and in particular school drop-offs and pick-ups. Emissions from Rigid HGVs are highest between 09:00 and 18:00.

During weekend days, emissions are much lower and the majority of NO_x is emitted between 11:00 and 18:00 with a more rounded profile. Cars are also estimated to make a relatively higher contribution to total Road-NOx emissions on weekend days, whilst HGV emissions are much lower than on weekdays.

Figure 16: Week day Diurnal Profile of NOx Emissions (g/km) - High Street

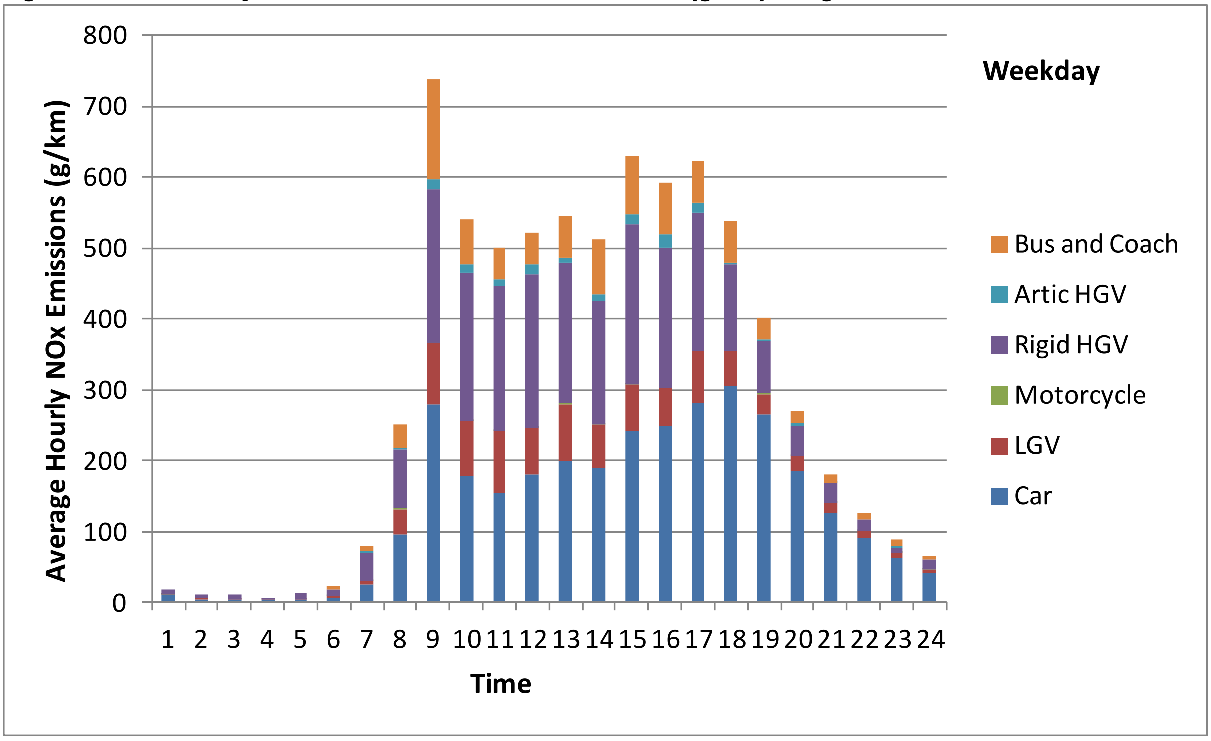


Figure 17: Week day Diurnal Profile of NOx Emissions (g/km) - Mill Street

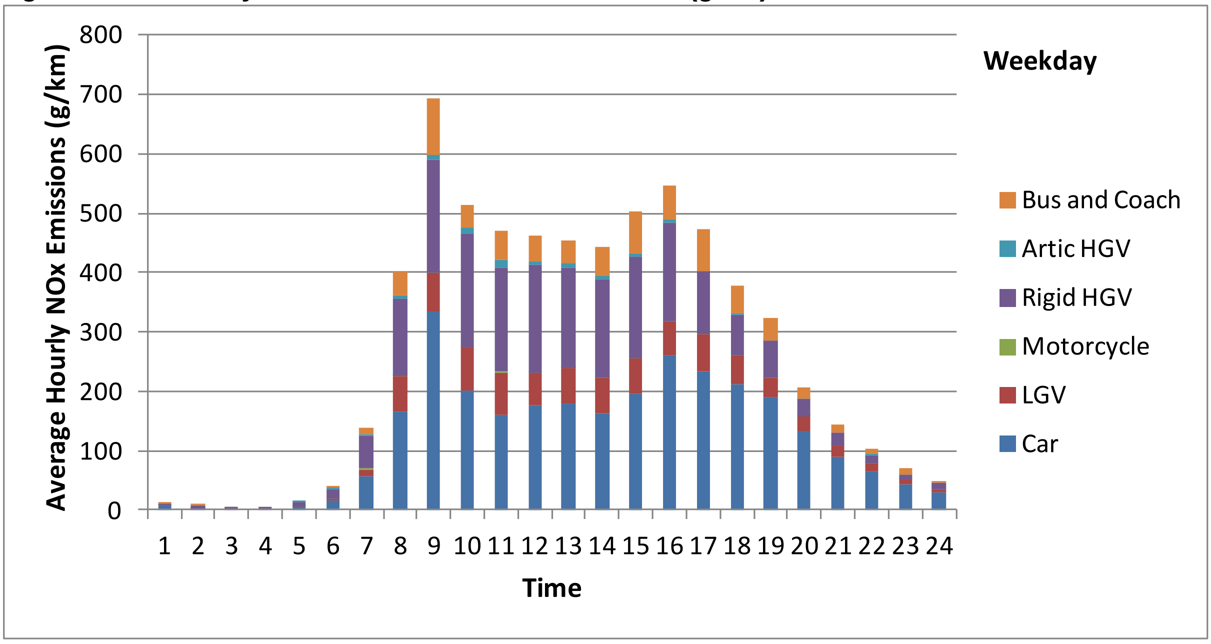


Figure 18: Weekend day Diurnal Profile of NOx Emissions (g/km) - High Street

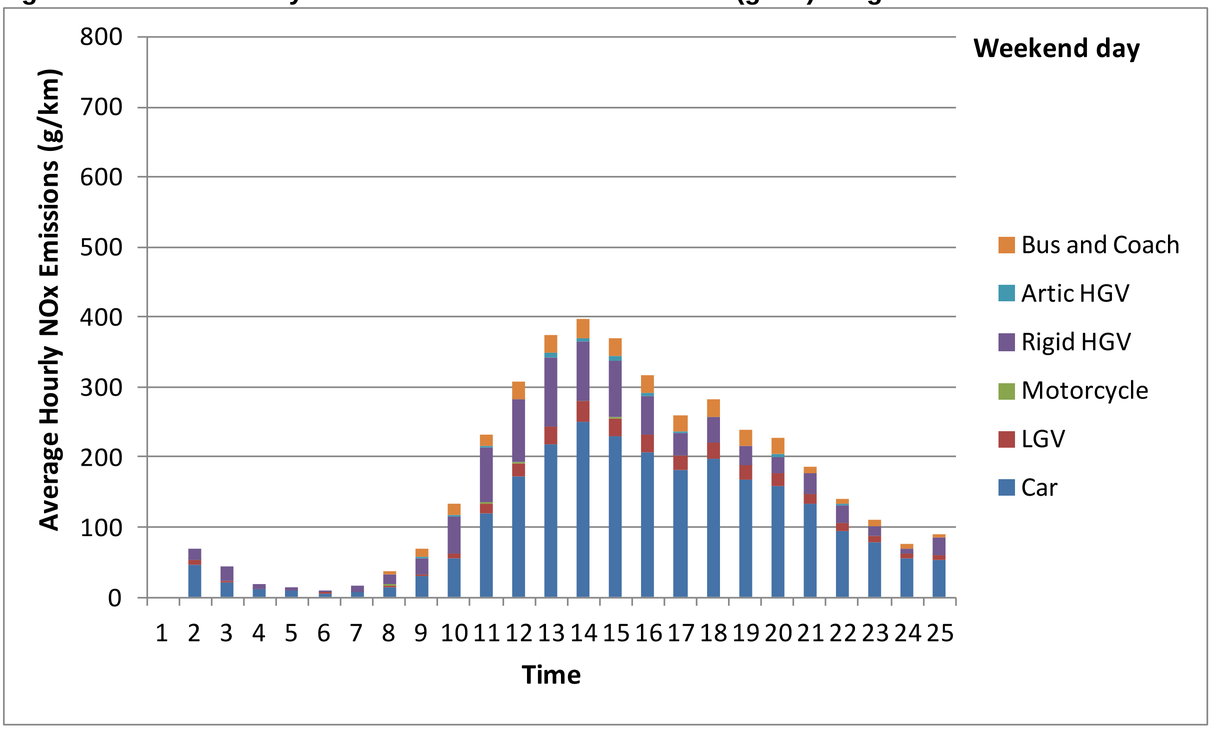
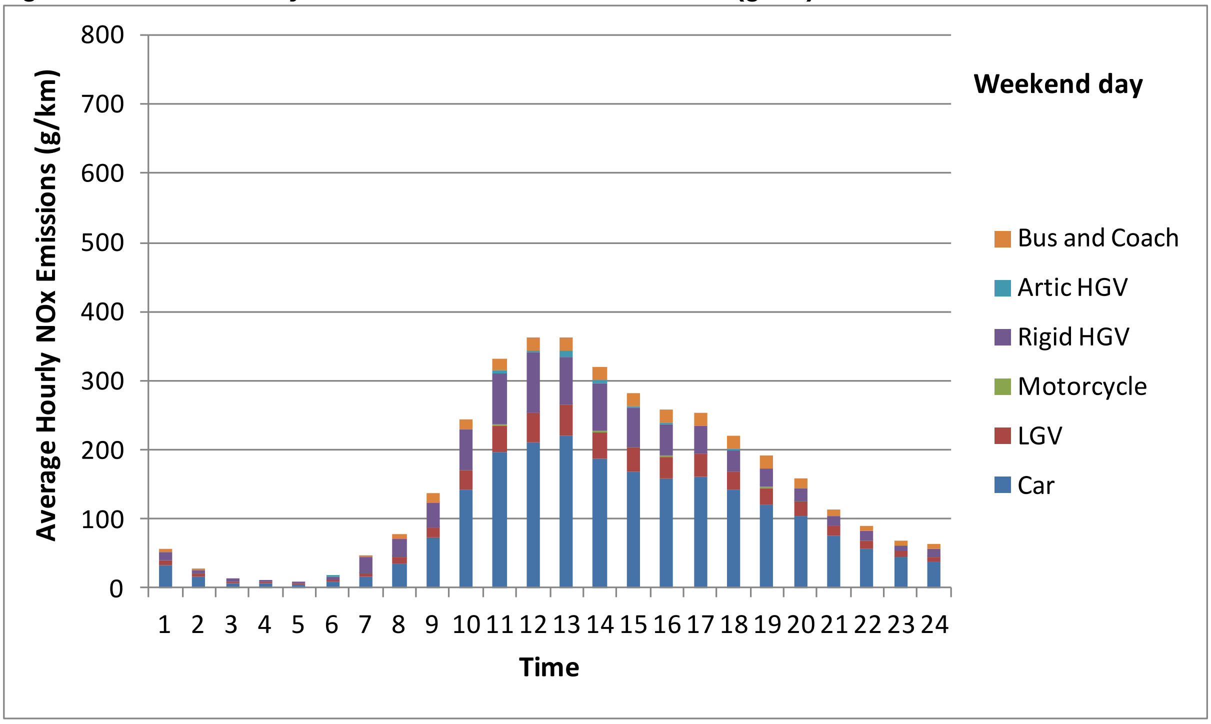


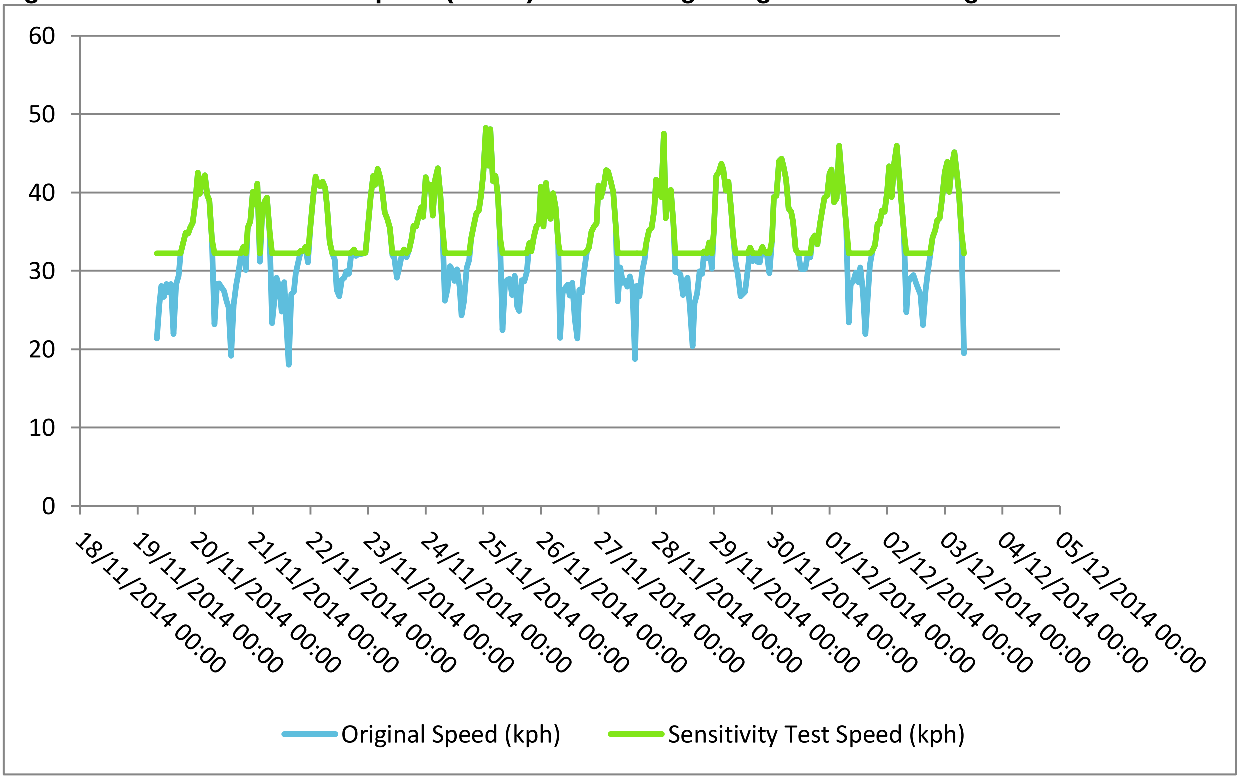
Figure 19: Weekend day Diurnal Profile of NOx Emissions (g/km) - Mill Street



4.4 Effect of Congestion on Emissions

Traffic speeds in the High Street are shown in Figure 12. Hourly traffic speed data on High Street are often lower than the speed limit which is 20 mph (32 kph). If congestion could be reduced so that traffic travels at a minimum speed of 32 kph, emissions during congested hours would decrease. The change in the speed profile that would result from this is shown in Figure 20.

Figure 20: Effect on Vehicle Speed (km/hr) of Reducing Congestion in the High St



The effect of this on NO_x emissions has been calculated using the Emission Factor Toolkit as a sensitivity test. The average weekday and weekend NO_x emissions using the measured speeds and with the increased speeds are reported in Table 7 and the change in NO_x emissions have been calculated. Reducing congestion would decrease NO_x emissions on weekdays by 9% and at weekends by 2.6%.

Table 7: Average Weekly NO_x Emissions (g/km) – High Street

Day	All Vehicle	All LDV	All HDV	Car	LGV	Motorcycle	Rigid HGV	Artic HGV	Bus and Coach
With Measured Speed									
Weekdays	7321	4032	3289	3195	833	5	2336	121	831
Weekend days	4020	2815	1205	2519	289	7	859	41	305
With Reduced congestion									
Weekdays	6665	3781	2884	2993	783	5	2062	101	721
Weekend days	3914	2756	1158	2465	283	7	827	38	292
Change in NOx Emissions (%)									
Weekdays	-9.0	-6.2	-12.3	-6.3	-5.9	-0.5	-11.7	-16.9	-13.3
Weekend days	-2.6	-2.1	-3.9	-2.1	-1.8	0.0	-3.7	-6.6	-4.2

4.5 Effect of Vehicle Restrictions on Emissions

HGVs (rigid and articulated) produce around 31% of NO_x emissions in the High Street. Buses and coaches contribute a further 11%. If all heavy duty vehicles (HDVs) were prohibited from driving in the AQMA, NO_x emissions would decrease by around 42%. The more polluting HGVs could be restricted through the implementation of a Low Emission Zone which sets minimum emission standards for HGVs entering the zone.

5 Improvement Options and Recommendations

5.1 Introduction

This report has presented the existing traffic and air quality conditions within Caerleon and identified three fundamental factors contributing to the poor air quality within the AQMA:

1) The number of polluting vehicles travelling through the AQMA: these are more readily targeted by 'soft' improvements;
2) The traffic congestion (slow speeds) within the AQMA: partly caused by the number of polluting vehicles, but also the physical road layout which could be improved to reduce congestion; and
3) The physical environment within the AQMA (i.e. the narrow uphill road, with tall buildings on either side): engine loads will be higher for vehicles travelling up the road, and the tall buildings restrict dispersion of the surrounding air.

5.2 Improvement Options

We present a number of improvement options below. These are categorised by 'non-transport infrastructure' and 'transport infrastructure' improvements. For each improvement option we have provided a brief description of the possible intervention, and a consideration of its impact based on our understanding of the existing air quality and traffic conditions.

Non-infrastructure interventions

- **HGV restrictions:** HGV emissions contribute ~31% towards the AQMA exceedance; a high proportion of these HGVs appear to be using Caerleon as a through route. An HGV restriction could be imposed either by weight, number of axles, or engine type/age, with exemptions provided for specific loading vehicles within the town (e.g. servicing shops, schools or residential properties etc). Automatic Number Plate Recognition (ANPR) enforcement could be used to identify and fine/prosecute vehicles contravening the restriction.

  To identify more accurately the effectiveness of an HGV ban (and the most appropriate way to implement it), a cordon number plate survey should be carried out around the town and at strategic locations out of the town. This, in conjunction with consultation with businesses both in the town and at key 'generators' outside of the town, will help inform the most effective HGV reduction strategy. Early engagement with the Freight Transport Association and Road Haulage Association is also recommended.

- **School travel planning:** During school peak times there is a high level of pick up/drop off activity contributing to congestion and emissions. By encouraging greater numbers of pupils/parents to use more sustainable transport modes, the numbers of vehicles travelling through the AQMA would reduce and congestion would be improved.

- **Cleaner bus fleet:** Bus emissions contribute ~11% towards the AQMA exceedance. By only allowing 'clean' buses into Caerleon then emissions would be reduced. This could be achieved through the development of a bus quality partnership with local bus operators.

Transport infrastructure improvements

Caerleon High Street suffers from congestion at specific times of the day, most notably at school opening and closing times. Video analysis has shown there are a number of pinch points through the corridor, and not one specific location that needs to be targeted. Transport infrastructure improvements to provide greater capacity could improve the flow of traffic through the High Street, and help reduce the level of emissions within the AQMA. However these improvements alone will not be sufficient to bring the air quality exceedances below the threshold. **Figure** 21 shows the locations of the transport infrastructure improvements, described in more detail overleaf.

A	**High Street / Mill Street junction improvements:** The video surveys indicate the High Street / Mill Street junction is operating over capacity, and queues form back down the high street from the northbound approach. The lack of space at the junction, and relatively few conflicting vehicles, makes it difficult to make any drastic changes to improve efficiency. However by providing better road markings on the approach to the junction, and improving visibility would make better use of the two lane approach. A more extreme junction capacity improvement would be to only allow westbound vehicles from Usk Road to turn left southbound down Mill Street (i.e. ban the right turn up Ponthir Road). This would significantly reduce the number of conflicting vehicles at the junction (98 vph and 57 vph in the AM and PM peak respectively) and thus reduce blocking back through High Street. This restriction could increase vehicle flows on Backhall Street and Church Street as vehicles re-routed to make the required movement.	
B	**High Street: Remove zebra crossing:** Removal of the zebra crossing at the top end of High Street would improve junction throughput. An alternative crossing could be provided further south away from the mouth of the junction.	
C	**High Street: Inset bus stop:** The current bus stop can make it difficult for vehicles to pass by, especially if there are parked vehicles on the adjacent side of the road. Insetting the bus stop into the green could improve efficiency.	
D	**High Street: Remove of parking:** Parked vehicles along this section of the high street, on both sides of the green, slow vehicles down and increase the number of conflicts and stop/start traffic. Parking could be removed on one side of the road, or inset into the green.	
E	**High Street: Remove/widen zebra crossing:** The zebra crossing requires vehicles to stop every time a pedestrian wishes to cross. Converting to a signal controlled crossing would improve traffic flow. However given its proximity to the school this is likely to be a controversial intervention, and pedestrians would be significantly penalised. Widening the zebra crossing could help improve traffic flow.	

F	**High Street: Remove parking:** Parking on both sides of the road makes the carriageway very narrow, and difficult for vehicles to pass each other if parking manoeuvres are being made. Removing the parking on one/both sides of the road will enable smoother flow of traffic and minimise queue formation back into the AQMA.	
G	**High Street: Remove zebra crossing:** The pedestrian crossing causes blocking back into the AQMA. The narrow carriageway provides good opportunity for informal crossings, without the need for a zebra crossing.	
H	**High Street: Remove zebra crossing:** The pedestrian crossing causes blocking back directly into the AQMA. The narrow carriageway provides good opportunity for informal crossings, without the need for a zebra crossing. Should pedestrian priority be retained then a puffin crossing could be provided.	
I	**Mill Street: Relocate bus stop and remove zebra crossing:** There is some evidence of queuing from Mill Street back to the roundabout with High Street. The bus stop could be causing some blocking back, as well as the zebra crossing. However no video footage was collected of this road and so the issues cannot be confirmed.	
J	**B4236: Gating signals:** Traffic could be 'gated' on the approach to Caerleon on the B4236. This would be through a signalised stopline, possibly using the existing pedestrian crossing just on the approach to High Street. This would restrain traffic flow into Caerleon to flow levels low enough to maintain suitable air quality. Although this would 'transfer' the queuing issues to another part of the network, the B4236 to the south appears to be less built up and dispersion would be higher. This approach could help deter vehicles from 'rat-running' through Caerleon, and using more appropriate strategic routes. This intervention could be quite low cost, making use of the existing traffic signals infrastructure to manage the network. A more sophisticated system could respond directly to real-time air quality monitoring instruments deployed in the AQMA.	
	Change in direction of one way system: A change in direction of the one way system (i.e. from clockwise to anticlockwise) was considered but is not thought will illeviate congestion through the AQMA. Re-directing the one way system would almost definitely require a signalised junction at the southern end of High Street with Castle Street which would cause continuous stop-start traffic through the AQMA whilst southbound vehicles were held and then released.	

5.3 Recommendations

This report has presented the existing infrastructure, traffic and air quality conditions at Caerleon. These existing conditions have been used to help identify the key issues leading to poor air quality, and informed the improvements most suitable and targeted to improve air quality for the residents, businesses, pupils, and visitors of the town.

Two key issues and targeted improvements have been identified. These are summarised below with recommended actions for how they should be progressed further:

<table>
<tr><th>Issue</th><th>Improvement</th><th>Recommended actions</th></tr>
<tr><td rowspan="2">High number of Heavy Duty Vehicles (HDVs)</td><td>Restricting HGVs travelling within the AQMA, particularly targeting ‘through movements’, i.e. HGVs which do not serve Caerleon itself.</td><td>• Undertake a more detailed survey of HGV movements to determine routing behaviour and fleet characteristics.
• Consult and engage with local businesses, fleet operators, and representative bodies to identify appropriate restrictive measures
• Develop HGV restriction and implementation strategy</td></tr>
<tr><td>Upgrading the bus fleet with lower emission and cleaner engines.</td><td>• Consult with local bus operators
• Develop Bus Quality Partnership to help initiate change</td></tr>
<tr><td rowspan="2">Stop/start traffic within the AQMA</td><td>Network capacity improvements, in particular at the High Street/Mill Street junction at the northern end of Caerleon.</td><td>• Develop a detailed microsimulation traffic model for Caerleon
• Use the traffic model to undertake design and assessment of junction and road improvements to reduce congestion and blocking back through the AQMA.
• The microsimulation model can also link to an instantaneous emissions model to accurately predict the emission reductions from the schemes.</td></tr>
<tr><td>School travel planning.</td><td>• Consult with the local primary and secondary school to identify travel planning initiatives to help reduce car use.</td></tr>
</table>

Capabilities on project:
Environment

Network alterations

A: High Street/Mill Street junction improvements
B: Remove zebra crossing
C: Inset bus stop
D: Remove parking
E: Remove zebra crossing
F: Remove parking
G: Remove zebra crossing
H: Remove zebra crossing
I: Relocate bus stop and remove zebra crossing
J: Gating signals

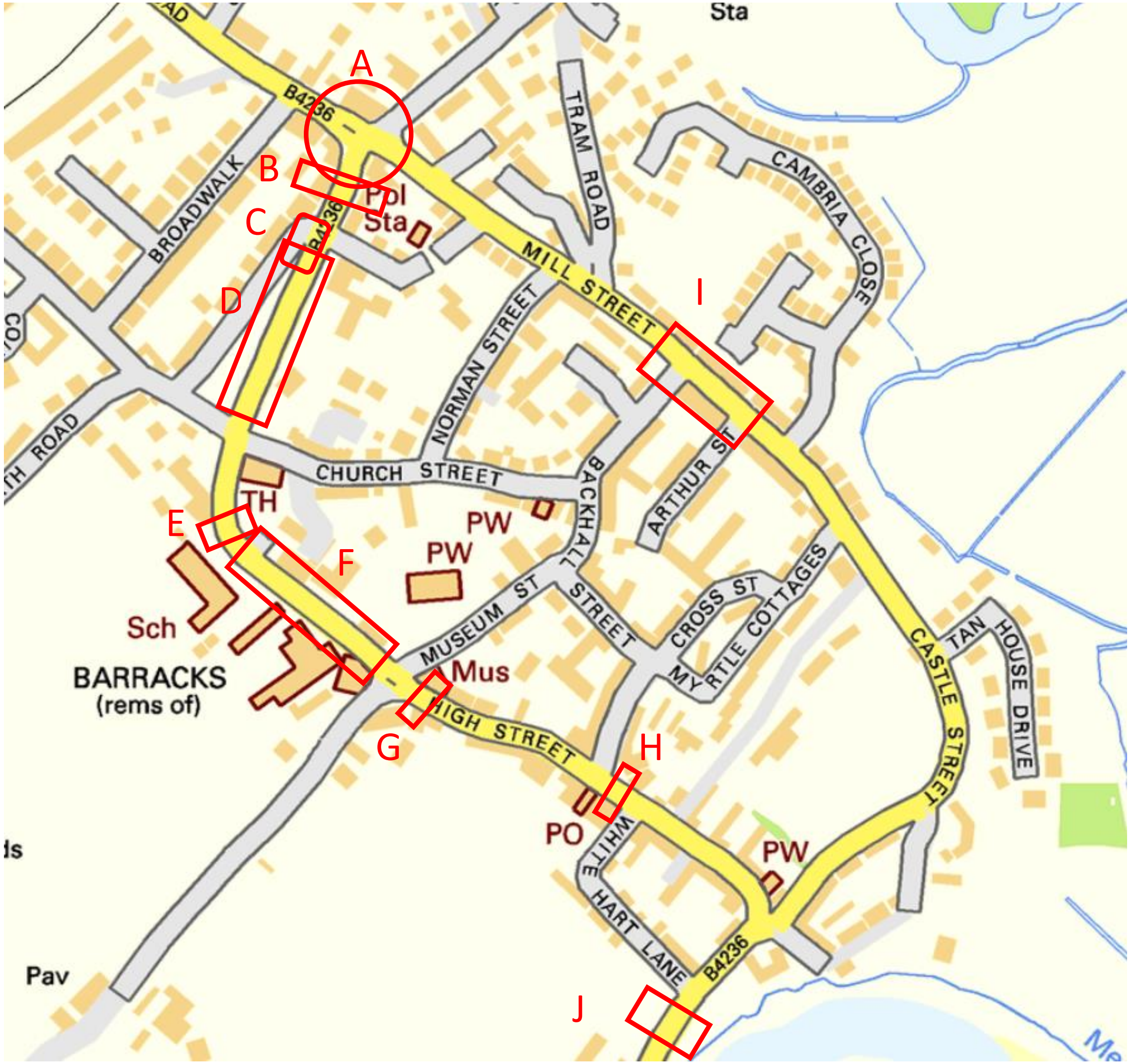


Figure 21: Highway Improvement Locations

Appendix 1: Air Quality Objectives and Limit Values

Table 8: Air Quality Objectives included in Regulations for the purpose of LAQM in Wales

Pollutant	National Air Quality Objectives	Measured as	Date to be Achieved by and Maintained thereafter
Benzene	5.0 µg/m^3	Annual Mean	31.12.2010
1,3-Butadiene	2.25 µg/m^3	Annual Mean	31.12.2003
Carbon Monoxide	10.0 mg/m^3	8-hour Mean	31.12.2003
Lead	0.25 µg/m^3	Annual Mean	31.12.2008
Nitrogen Dioxide	200 µg/m^3 not to be exceeded more than 18 times a year	1 Hour mean	31.12.2005
	40 µg/m^3	Annual Mean	
Particles (PM_{10})	50 µg/m^3 not to be exceeded more than 35 times a year	24 Hour Mean	31.12.2004
	40 µg/m^3	Annual Mean	
Sulphur Dioxide	266 µg/m^3 not to be exceeded more than 35 times a year	15 Minute Mean	31.12.2005
	350 µg/m^3 not to be exceeded more than 24 times a year	1 Hour Mean	31.12.2004
	125 µg/m^3 not to be exceeded more than 3 times a year	24 Hour Mean	31.12.2004

Table 9: EU Limit Values

Pollutant	EU Limit Value	Measured as	Date to be Achieved by and Maintained thereafter
Benzene	5 µg/m^3	Annual Mean	1 January 2010
Carbon Monoxide	10.0 mg/m^3	8-Hour Mean	1 January 2005
Lead	0.5 µg/m^3	Annual Mean	1 January 2005
Nitrogen Dioxide	200 µg/m^3 not to be exceeded more than 18 times per year	1 Hour Mean	1 January 2010
	40 µg/m^3	Annual Mean	
Ozone(Target)	120 µg/m^3 not to be exceeded more than 25 times per year	8-hour Mean	1 January 2010
Particles (PM_{10})	50 µg/m^3 not to be exceeded more than 35 times per year.	24 Hour Mean	1 January 2005
	40 µg/m^3	Annual Mean	
Particles ($PM_{2.5}$)	25 µg/m^3	Annual Mean	1 January 2015
Sulphur Dioxide	350 µg/m^3 not to be exceeded more than 24 times per year	1 Hour Mean	1 January 2005
	125 µg/m^3 not to be exceeded more than 3 times per year	24 Hour Mean	

Appendix 2: Site Visit Technical Note

Technical Note

AECOM

Project:	**Newport Air Quality**	Job No:	**60323009**
Subject:	**Site Visit Observations - Caerleon**		
Prepared by:	**Ellena Caudwell**	Date:	**22/10/2014**
Checked by:	**Hector Lee**	Date:	**06/11/2014**
Approved by:	**George Lunt**	Date:	**06/11/2014**

Site visit info: Caerleon
Date visited: Tuesday 21st October 2014
Weather: Cold, mostly clear/sunny with some light rain showers
Times visited: AM: 08:20-09:20
PM: 14:00-17:40

General observations:

- Air quality monitoring station at the High Street / Castle Street junction is no longer there
- Narrow roads, pavements sometimes disappear from one side of the road.
- Slow moving vehicles - 20mph zone, and cautious drivers often leaving large gaps in front of them, very slow movement from multiple zebra crossings

- Seemed to be a large number of HGVs using the roads

- Primary school (infants and juniors) and secondary school very close together
- Secondary school buses on Broadway
- Public car park/access to front of secondary school on Cold Bath Rd

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- Vocal local resident – felt traffic had doubled in the time she had been there (16yrs)
- Slow moving buses often had a trail of traffic behind – even when no traffic in front
- Side roads used little, other than school bus access (above)
- Many speed monitors displaying your current speed – traffic on Mill St/Castle St observed above 20mph frequently
- Post office and Chip shop bus stops – didn't block road, cars would drive around stopped bus
- Goldcroft Common and Museum Street bus stop – would block road, cars very slowly edged around bus at times. Parking on opposite side of road combined with stopped bus causes problems

AM:

- Busy with queues building dissipating repeatedly. No queue on High St when we arrived, queued all around corner within a few minutes.

- Queues usually slow moving
- Peds on zebra crossing would hold all traffic up for a time
- Traffic parking on both sides of High Street (northern section) – when parking occurred, all traffic was held up for some time.


- High St/Lodge Rd junction busy – all directions
- Cold Bath Rd busy – causes some hold up on Lodge Rd, busy both directions
- High St/Station Rd junction – busy southbound on Station Rd. Cautious driving observed. Many vehicles heading to Mill St.

- Observed a vehicle heading southbound on Mill St to give way to a left-turning driver on Usk Rd
- High St busy, but times when vehicles weren't ready at the stop line due to conflict on High St – parked cars/peds/bus
- Mill St southbound busy, slow moving due to parked cars/20mph zone

PM:

- Busy during school run (approx 15:10-15:40)
- Parking outside primary school increased steadily

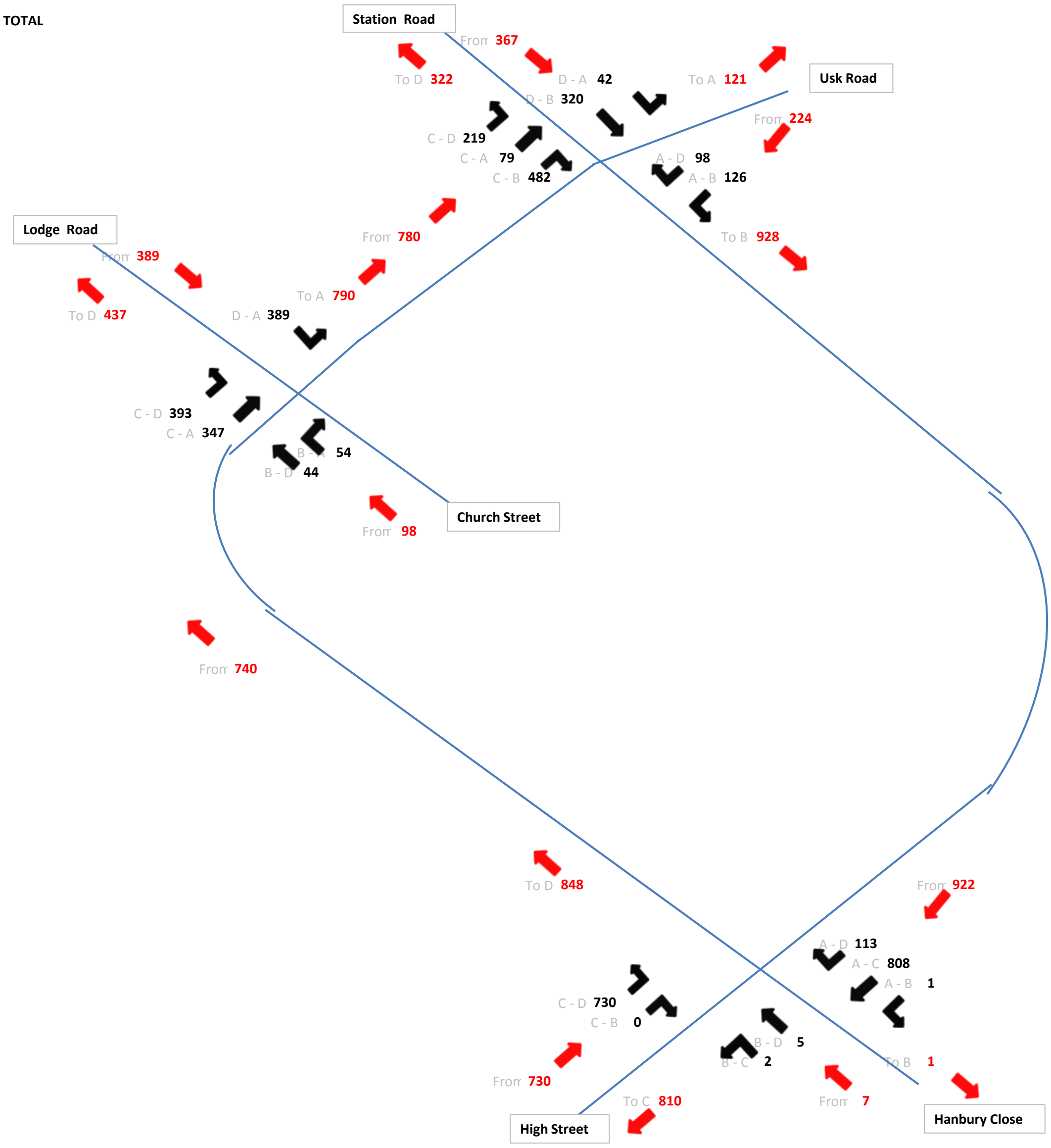
- Ped crossing at northern end of primary school in frequent use, at times for a couple of minutes. Difficult for traffic to keep flowing
- Parking both sides of High St (northern part) causing issues, same as AM. Bus stop by Goldcroft Common noticeably causing delays

- Large number of HGVs observed – buses, trucks etc
- No observed southbound queue on Station Rd – High St still queued
- Largest amount of traffic from Broadway at this time

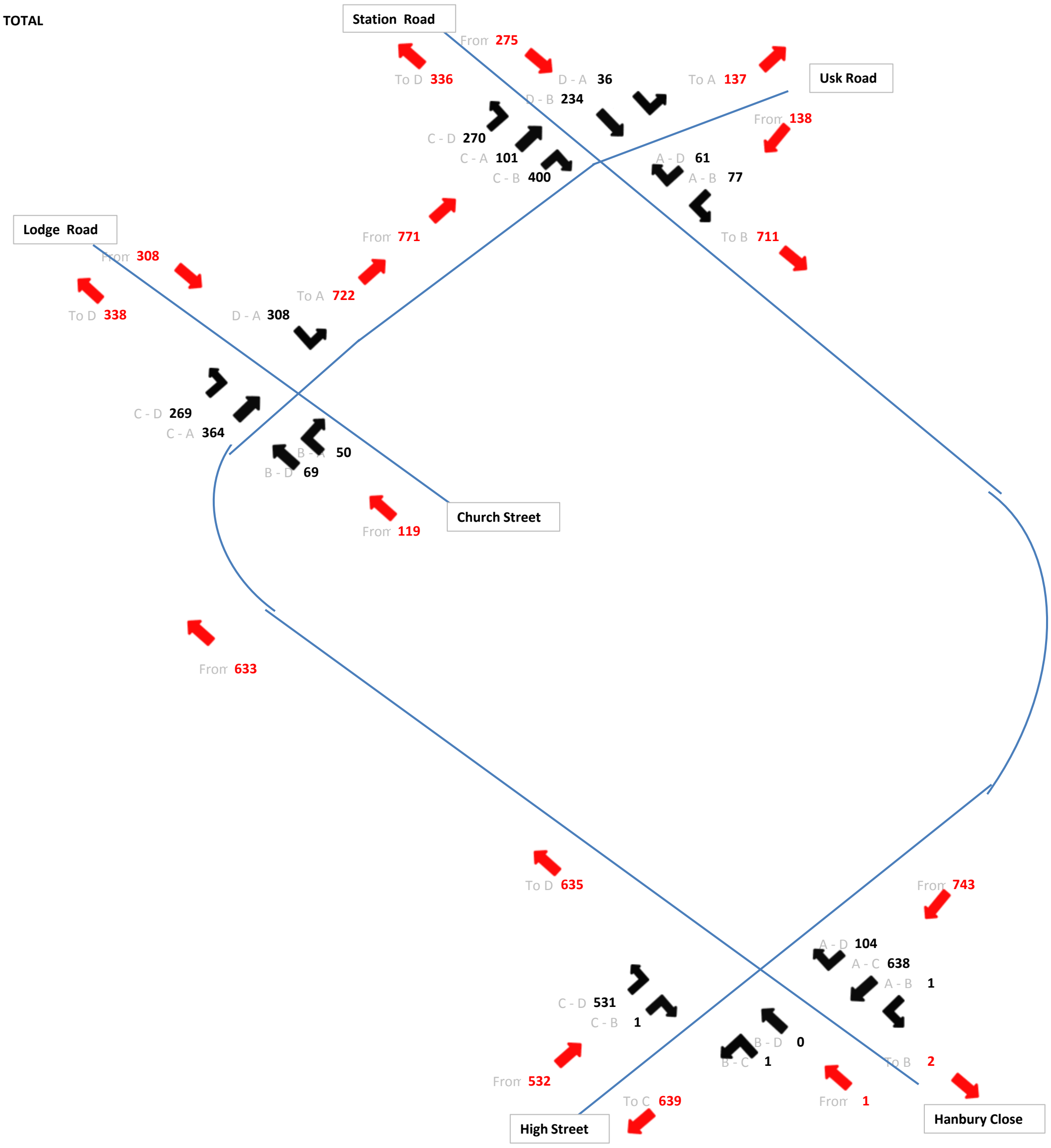
- Southbound queue on Lodge Rd cleared by 15:30
- No peak observed later on – still constant traffic though

Appendix 3: Junction Turning Counts

Hr fr 08:00 TOTAL



Hr fr 15:00 TOTAL



Hr fr 17:00 **TOTAL**