Carnforth Air Quality Action Plan Scenario Testing

Addendum to Carnforth Further Assessment 2008

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1. Introduction

This report follows the work presented in Lancashire City Council's Further Assessment of Air Quality in Carnforth, completed in 2008. That study carried out an assessment of monitoring data in Carnforth and presented modelling results for the local area. Estimations were also presented for the apportionment of pollution to various categories of vehicle for each road link, along with a calculation of the likely reductions in emissions that would be required along each link in order for the annual mean air quality objective for nitrogen dioxide to be achieved at all monitoring locations.

This report presents an additional assessment of the likely reductions in pollution concentrations that might be achieved under a range of scenarios aimed at reducing traffic levels on certain road links in the area. This assessment is based specifically on the same modelling work presented in the 2008 Further Assessment, and therefore it should be read in conjunction with that document.

1.1. Scenario 1: "Relocate TDG"

This option would relocate the heavy duty vehicle depots from existing sites west of Carnforth (accessed via Market Street) to new sites east of Carnforth, the latter being accessed via the A601(M) southern spur and Kellet Road. The need for HDVs serving these businesses to travel into and through the Carnforth air quality management area would be prevented. The primary existing HDV depot to the west of Carnforth is operated by a company named TDG.

Lancashire County Council (Highways) has estimated that the effect of this option might be to reduce HDV traffic flows on Market Street (West) and the A6 Scotland Road (north of the junction with Market Street) to a more typical value for through roads in the area that do not serve HDV depots, i.e. 5%. The brief from Lancaster City Council for air quality modelling of this option to identify impacts on the Carnforth AQMA is that the modelling base year and all other modelling variables in the Further Assessment (December 2008) are unchanged.

Implementation of Scenario 1

Following discussion with Nick Howard at Lancaster City Council it was decided to lower the HDV flows on Market Street West to 5% of the current total flow, and then remove this number of HDVs from the A6 Scotland Road north of the junction.

Further investigation of traffic flows however suggested that it was unlikely that all HGV traffic leaving TDG would be going north as this would remove too many vehicles from the A6 northern link. This was clarified with Neil Stevens at Lancashire County Council (Highways) who agreed, suggesting that some traffic would potentially head south to Heysham Docks and other locations. The scenario was therefore reassessed. Turning counts were examined and it was found that of HDV traffic turning onto the A6 from Market Street, 68% went north and 32% went south. The removed outgoing/eastbound traffic from Market Street (West) was then removed from the A6 links in these proportions. Similarly, although northbound traffic on the A6 can get to TDG via Haws Hill, turning counts suggest that HDVs entering Market Street (West) are divided between 13% entering from the A6 south of the junction and 87% from the A6 north of the junction. The number of vehicles removed from the A6 flows was split according to this proportion.

The difference in the number of vehicles removed from the east and westbound flows on Market Street (West) were then removed from Haws Hill. The HDV flows for Wharton Road in both the base case and the scenarios were adjusted so that they matched Market Street (West) plus Haws Hill.

1.2. Scenario 2: "Implement M6 Heysham Link Road"

This option would deliver the presently proposed M6 Heysham link road, directly connecting the M6 Junction 34 with the A683 bypass road. This would prevent the need for existing Carnforth 'through traffic' heading to and from Morecambe, Heysham, their industrial areas and the port. Presently the A6 route through Carnforth attracts substantial 'through traffic' of this type in preference to the route via M6 Junction 34 and Lancaster.

Lancashire County Council (Highways) has estimated that the effect of this option might be to reduce both LDV and HDV traffic flows on the A6 in Carnforth by 25%. The brief from Lancaster City Council for air quality modelling of this option to identify impacts on the Carnforth AQMA is that the modelling base year and all other modelling variables in the Further Assessment (December 2008) are unchanged.

Implementation of Scenario 2

Scenario 2 was implemented by reducing the flows of both HDVs and LDVs on all stretches of the A6 by 25%. No consideration was given to the impact that this might have on vehicles turning off the A6 into Market Street or Haws Hill.

1.3. Scenario 3: Scenarios 1 and 2 Combined

In this combined scenario, the two previous options were combined. The 25% reduction in flow along the A6 was calculated from the base case, and then the reduction in HGV traffic due to the relocation of TDG was then subtracted from this.

1.4. Notes on all Scenarios:

Other than the changes described above, no other flows were changed.

No changes were made to the distribution of vehicle flows during the diurnal cycle.

No changes were made to vehicle speeds.

The same model adjustment factor of 2.64 was used to adjust the initial modelled NOx contribution, in line with the verification and adjustment work presented in the Further Assessment.

2. Changes in Traffic Flows

Table 1 and Table 2 show the comparative traffic flows for each road link under each of the scenarios modelled.

ADMS-Roads uses Annual Average Hourly Flows rather than Daily Flows, and will only accept integer figures. Therefore where the calculations of reductions to flows have been made on the basis of percentage reductions, the new flow has been calculated by reducing the flow to 5% of the Baseline AAHF and rounding to the nearest integer. In the case of Market Street, this has resulted in the resultant HDV flows being slightly more than 5% of the final flows.

Total AADF & %HDV	Base		Scenario 1		Scenario 2		Scenario 3	
Road	AADF	%HDV	AADF	%HDV	AADF	%HDV	AADF	%HDV
A6(North)	11664	7.2%	11136	2.8%	8736	7.1%	8208	1.2%
A6(South)	14064	4.4%	13896	3.3%	10536	4.3%	10368	2.8%
Haws Hill	2808	5.1%	2688	0.9%	2112	5.7%	2016	1.2%
Kelling Road	6840	4.2%	6840	4.2%	6840	4.2%	6840	4.2%
Market Street	7032	15.0%	6336	5.7%	7032	15.0%	6336	5.7%
North Road	2496	3.8%	2496	3.8%	2496	3.8%	2496	3.8%
Wharton Road	6960	17.2%	6144	6.3%	6960	17.2%	6144	6.3%

Table 1: Traffic flows used in each scenario (total on each road link)

Total AADF & %HDV		Base		Scenario 1		Scenario 2		Scenario 3	
Road	Direction	AADF	%HDV	AADF	%HDV	AADF	%HDV	AADF	%HDV
A6(North)	Northbound	6624	7.2%	6336	3.0%	4968	7.2%	4680	1.5%
	Southbound	5040	7.1%	4800	2.5%	3768	7.0%	3528	0.7%
A6(South)	Northbound	7536	4.8%	7488	4.2%	5640	4.7%	5592	3.9%
	Southbound	6528	4.0%	6408	2.2%	4896	3.9%	4776	1.5%
Haws Hill	Northbound	2808	5.1%	2688	0.9%	2112	5.7%	2016	1.2%
Kelling Road	Eastbound	4296	3.9%	4296	3.9%	4296	3.9%	4296	3.9%
	Westbound	2544	4.7%	2544	4.7%	2544	4.7%	2544	4.7%
Market Street	Eastbound	4608	14.1%	4200	5.7%	4608	14.1%	4200	5.7%
	Westbound	2424	16.8%	2136	5.6%	2424	16.8%	2136	5.6%
North Road	Southbound	2496	3.8%	2496	3.8%	2496	3.8%	2496	3.8%
Wharton Road	Eastbound	3048	21.3%	2640	9.1%	3048	21.3%	2640	9.1%
	Westbound	3912	14.1%	3504	4.1%	3912	14.1%	3504	4.1%

Table 2: Traffic flows used in each scenario (total on each road link)

3. Modelling Results

Modelling was carried out to predict the total NO_2 concentrations under each traffic scenario at each diffusion tube location in the study area. The locations of the diffusion tubes/receptor points (along with an indication of the maximum annual mean concentration in 2006 and 2007) are shown in Figure 1.

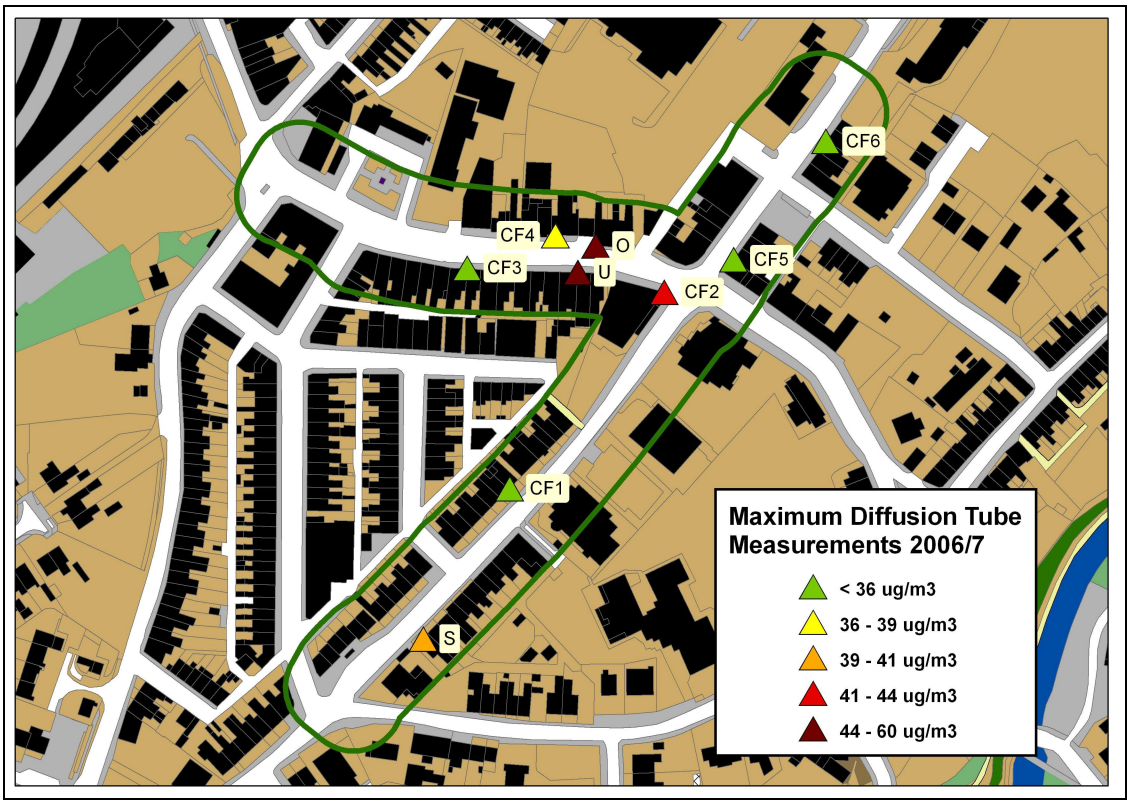

Figure 1: Map showing diffusion tube/model receptor locations used in modelling

The following section presents the model output for NO_2 at all diffusion tube locations in the Carnforth study area. The tables indicate the concentrations from the initial 2007 base scenario, along with concentrations under action scenarios 1-3 and a calculation of the percentage reduction in pollution predicted at each receptor point for each scenario.

3.1. Reductions in Nitrogen Oxide Emissions

This section looks at the modelled concentrations of NOx (nitrogen oxides i.e. NO + NO_2) from road traffic, without consideration of background concentrations. As all other factors affecting dispersion have remained the same (except in-built dispersion parameters in the model based on numbers of vehicle movements rather than speed), the reductions in NOx concentrations from the modelled roads can be taken to approximately represent the reductions in emissions.

Table 3 shows the predicted concentrations of NOx from local road transport at the model receptor points. On Market Street, the reduction in HGV traffic in Scenario 1 from 15% to around 5% is shown to reduce concentrations of NOx by over 50% at all four receptors. The reduction of HGV flow also impacts on flows on the A6 with concentrations of NOx along this road falling by between 18 and 43%.

Combined road NOx concentrations from all vehicle groups at receptors (µg/m^3 and % reduction)									
Receptor		Base		Scenario 1		Scenario 2		Scenario 3	
		Road Contribution	% Reduction	Road Contribution	% Reduction	Road Contribution	% Reduction	Road Contribution	% Reduction
Market St	O	111.9	-	54.3	51.5%	109.1	2.5%	51.6	53.9%
	U	105.9	-	43.4	59.0%	102.9	2.8%	40.5	61.8%
	CF3	48.6	-	22.1	54.6%	47.0	3.4%	20.4	58.0%
	CF4	104.8	-	50.3	52.0%	102.7	2.0%	48.2	54.0%
Junction	CF2	75.5	-	47.7	36.7%	67.2	11.0%	39.4	47.7%
A6(N)	S	61.1	-	47.3	22.6%	45.8	25.0%	32.0	47.6%
	CF1	45.1	-	36.6	18.8%	34.2	24.2%	25.7	42.9%
A6(S)	CF5	52.7	-	32.3	38.7%	42.8	18.8%	22.4	57.5%
	CF6	65.0	-	36.9	43.2%	49.2	24.3%	21.1	67.6%

Table 3: Combined road NOx concentrations from vehicle groups at receptors (µg/m^3 and % reduction)

3.2. Reductions in Total Nitrogen Dioxide Concentrations

This section presents the total modelled NO_2 concentrations at each receptor point, including both background concentrations and the modelled road component. The conversion of NOx to NO_2 has been carried out using the new LAQM conversion spreadsheet tool, as opposed to the method used in the Further Assessment.

Total NO_2 concentrations at receptors (µg/m^3 and % reduction)									
Receptor		Base		Scenario 1		Scenario 2		Scenario 3	
		Total NO_2	% Reduction	Total NO_2	% Reduction	Total NO_2	% Reduction	Total NO_2	% Reduction
Market St	O	49.5	-	34.1	31.2%	48.9	1.3%	33.2	33.0%
	U	48.1	-	30.4	36.9%	47.4	1.4%	29.3	39.1%
	CF3	32.2	-	22.2	31.1%	31.6	1.8%	21.5	33.3%
	CF4	47.9	-	32.8	31.6%	47.4	1.0%	32.0	33.1%
Junction	CF2	40.4	-	31.9	21.2%	38.1	5.9%	28.9	28.4%
A6(N)	S	36.2	-	31.7	12.4%	31.2	13.8%	26.2	27.7%
	CF1	31.0	-	27.9	9.9%	27.0	12.8%	23.7	23.5%
A6(S)	CF5	33.5	-	26.3	21.7%	30.2	10.1%	22.3	33.5%
	CF6	37.4	-	28.0	25.1%	32.4	13.4%	21.8	41.8%

Table 4: Total NO_2 concentrations at receptors (µg/m^3 and % reduction)

Table 4 shows the predicted total NO_2 concentrations at each of the seven receptor points for the three scenarios. The shaded rows indicate those

monitoring locations where the 40 µg/m^3 annual mean NO_2 objective concentration is was breached in 2007.

Scenario 1 shows a reduction in total NO_2 by more than 30% at all four monitoring locations in Market Street. This brings concentrations at all monitoring locations well below the objective concentration, and also well within an uncertainty margin of 10% (i.e. 36 µg/m^3). This scenario also reduces concentrations by between 10% and 25% at receptors along the A6.

Scenario 2 brings concentrations at all receptors along the A6 down by over 10% (other than at receptor CF2 at the junction). However, its impact on concentrations in Market Street is minimal, as might be expected as it does not alter traffic flows there). Concentrations in Market Street decline by less that 2%. Concentrations in Market Street are still therefore expected to exceed the annual mean NO_2 objective.

Scenario 3 (combining the measures from Scenario 1 and 2) achieves very significant reductions in concentrations at all receptors, from around 23% to 41%. Concentrations at all receptors are well within the objective and the 10% safety margin.

3.3. Cautionary note

The modelling carried out is intended to be indicative of the relative effects of the scenarios being assessed. A number of simplifying assumptions have been made within the development of the scenarios, as outlined in Section 1. Within the modelling itself there is a large degree of uncertainty associated with the use of the adjustment factor applied to the initial modelled NOx component. This factor (2.64) was derived in the original Further Assessment and it can account for a wide range of factors that have been identified as likely to cause model under-predictions. The main factors include:

- Estimates of background concentrations;
- Meteorological data uncertainties;
- Uncertainties in source activity data such as traffic flows, fleet composition and emission factors;
- Model input parameters such as roughness length, minimum Monin-Obukhov; and overall model limitations such as the poor representation of building effects;
- Uncertainties associated with monitoring data, including locations.

Whilst the modelling undertaken here has kept to an assumption of ‘all other things being equal’, it may be the case that the previous model error on which the

adjustment factor was based was overly influenced by error or uncertainties relating to Heavy Goods Vehicle emissions relating to TDG traffic (for example the potential underestimation of the impact of cold-starts on vehicles). Without special knowledge about the nature of these uncertainties and how they might influence these predictions, all modelling parameters have been kept constant other than the numbers of vehicles.

It is important to note that uncertainty may relate to both over- and under-prediction by the model. In this situation, from the known factors, there maybe a tendency for the predicted reductions in pollution to be *under-estimated* (i.e. the measures may reduce pollution even more than suggested by the modelling) due to the potential for the reductions in flow to lead to reductions in congestion and smoother and faster flow along the links.

4. Conclusions

On the basis of the modelling, Scenario 2 alone may bring concentrations of NO_2 safely within the objective concentration for properties along the A6, even at the junction with Market Street. However, the reduction in traffic solely along the A6 will not make a significant contribution to reducing concentrations in Market Street.

Conversely, the relocation of TDG, and the consequent reduction in Heavy Goods Vehicle movements in Market Street is likely both to reduce concentrations of NO_2 in Market Street below the annual mean objective, and bring concentrations along the A6 well within this objective.

The combined impact of both measures will lead to an even greater reduction in concentrations.

Appendix 1: Tables of Additional Model Results

Total NOx concentrations at receptors (µg/m^3 and % reduction)									
Receptor		Base		Scenario 1		Scenario 2		Scenario 3	
		Road Contribution	% Reduction	Road Contribution	% Reduction	Road Contribution	% Reduction	Road Contribution	% Reduction
Market St	O	126.2	-	68.6	45.6%	123.4	2.2%	65.9	47.8%
	U	120.2	-	57.7	52.0%	117.2	2.5%	54.8	54.4%
	CF3	62.9	-	36.4	42.2%	61.3	2.7%	34.7	44.8%
	CF4	119.1	-	64.6	45.8%	117.0	1.8%	62.5	47.5%
Junction	CF2	89.8	-	62.0	30.9%	81.5	9.3%	53.7	40.1%
A6(N)	S	75.4	-	61.6	18.3%	60.1	20.3%	46.3	38.5%
	CF1	59.4	-	50.9	14.3%	48.5	18.3%	40.0	32.6%
A6(S)	CF5	67.0	-	46.6	30.4%	57.1	14.8%	36.7	45.2%
	CF6	79.3	-	51.2	35.4%	63.5	19.9%	35.4	55.4%

Table 5: Total NO_x concentrations at receptors (µg/m^3 and % reduction)

Combined road NO_2 concentrations from all vehicle groups at receptors (µg/m^3 and % reduction)									
Receptor		Base		Scenario 1		Scenario 2		Scenario 3	
		Road NO_2	% Reduction	Road NO_2	% Reduction	Road NO_2	% Reduction	Road NO_2	% Reduction
Market St	O	37.3	-	21.9	41.4%	36.7	1.7%	21.0	43.8%
	U	35.9	-	18.2	49.5%	35.2	1.9%	17.1	52.4%
	CF3	20.0	-	10.0	50.1%	19.4	2.9%	9.3	53.6%
	CF4	35.7	-	20.6	42.4%	35.2	1.4%	19.8	44.4%
Junction	CF2	28.2	-	19.7	30.3%	25.9	8.4%	16.7	40.7%
A6(N)	S	24.0	-	19.5	18.7%	19.0	20.8%	14.0	41.8%
	CF1	18.8	-	15.7	16.3%	14.8	21.2%	11.5	38.9%
A6(S)	CF5	21.3	-	14.1	34.1%	18.0	15.8%	10.1	52.7%
	CF6	25.2	-	15.8	37.3%	20.2	19.9%	9.6	62.1%

Table 6: Combined road NO_2 concentrations from all vehicle groups at receptors (µg/m^3 and % reduction)