

Proposed Heavy Commercial Vehicle Restriction over Norton Level Crossing - Predicted Impacts on Pollutant Emissions

1.0 Purpose

The purpose of this report is to present an assessment of the potential impact on road traffic air pollutant emissions resulting from the prohibition of certain Heavy Commercial Vehicles (HCV's) from using Norton level crossing.

2.0 Background

North Yorkshire County Council (NYCC) is considering prohibiting certain HCV's from using Norton level crossing in order to assist in the improvement of air quality in the Malton Air Quality Management Area (AQMA). The AQMA was declared in 2009 because concentrations of nitrogen dioxide (NO₂) were found to exceed the annual mean air quality objective (AQO) at several locations where there is relevant exposure. The restriction or prohibition of HCV movements would accord with the Malton Air Quality Action Plan which identified this as an Action Plan Measure intended to support the reduction of nitrogen dioxide concentrations in the AQMA.

3.0 Assessment Methodology - The Emissions Factors Toolkit (EFT)

- 3.1 The Emissions Factors Toolkit (EFT) is published by Defra and the Devolved Administrations to assist local authorities in carrying out the Review and Assessment of local air quality as part of their duties under the Environmental Act 1995.
- 3.2 The EFT allows users to calculate road vehicle pollutant emission rates for NO_x, PM₁₀, and PM_{2.5} for specified years, road types, vehicle speeds and vehicle fleet compositions.
- 3.3 The EFT is updated regularly and the latest version (version 6.0.2), released in November 2014 was used for this assessment. Further details of the methodology, datasets and assumptions used in the development of the EFT are provided in the *EFT User Guide*, available to view and download at: <<http://laqm.defra.gov.uk/documents/EFT-user-guide-v1.2.pdf>>.
- 3.4 The traffic flow and fleet composition information used as input data for this EFT assessment was provided by the County Council. NYCC commissioned Jacobs, Highways & Transportation Consultants, to carry out a 12 hour (0700h to 1900h) video survey of traffic using the level crossing on 7 October 2015 . The survey allowed all vehicle classes and turning movements over the crossing to be counted. Other data inputs include:

- Road type - (Urban (Not London)), which was selected from a list of seven options). The urban categorisation relates to the Department for Transport definition of an urban area with a population of 10,000 or more; and
 - Speed.
- 3.5 Currently there is a 48 kph (30 mph) speed limit at the level crossing and on all three road links. In practice traffic speeds on the road links will vary widely up to this limit during the day. There are significant periods of time, particularly on Castlegate and Church Street, when congestion results in slow moving, standing or stop/start traffic. These conditions are associated with increased pollutant concentrations in exhaust emissions.
- 3.6 For the purposes of this assessment the EFT was run to generate outputs of traffic pollutant emissions (NO_x, PM₁₀ & PM_{2.5}) in the present year, 2016, for four different values of traffic speed (16, 24, 32 & 48kph). This was a necessary practical simplification of the real life conditions on these roads.
- 3.7 The EFT was then run to generate outputs of emissions using flows and fleet composition input data that excluded OVG1 (2 & 3 axle rigid commercial vehicles) and OVG2 (articulated commercial vehicles with 3 or more axles) classes, thus simulating an enforced/complied with HCV ban applicable to these vehicles. Buses and coaches were not excluded. This was done for the same four traffic speed values (16, 24, 32 & 48kph). The data inputs were also adjusted to account for the increased flow of cars that may arise because of the additional road capacity created by a HCV restriction. This assumed that for each OGV1/OGV2 class vehicle removed an additional 2.3 cars would use the crossing. The figure of 2.3 was provided by Jacobs and is derived from combining passenger car equivalent (PCE) figures of 1.9 for the OGV1 class and 2.9 for the OGV2 class.
- 3.8 Finally, the EFT was run to generate outputs of emissions using flows and fleet composition input data that excluded just OVG2 class HCV's. As above, this was done for the same four traffic speeds. Buses and coaches were again not excluded and the data inputs were adjusted to account for anticipated increased flows of cars based on the OGV2 PCE figure of 2.9.
- 3.9 The vehicle flows and fleet compositions used in the EFT are shown in Table 1. Tables 2 & 3 show the adjusted traffic data used when the EFT was run to calculate emissions for the two HCV restriction scenarios.

Road Link		All Vehicles	Car	LGV	OGV1	OGV2	Bus/Coach	Mtr/cycle
Castlegate (B1248)	Origin	6311	5190	826	133	96	35	31
	Destination	4051	3246	540	132	89	17	27
	TOTAL	10362	8436	1366	265	185	52	58
Church Street (B1248)	Origin	7520	6203	932	169	99	61	56
	Destination	7319	6026	930	152	97	63	51
	TOTAL	14839	12229	1862	321	196	124	107
Norton Road	Origin	1102	915	115	21	1	28	22
	Destination	3563	3036	403	39	10	44	31
	TOTAL	4665	3951	518	60	11	72	53

Table 1: Summary of Norton Level Crossing Traffic Data - 12 hour Count , 7 October 2016

Road Link		All Vehicles	Car	LGV	OGV1	OGV2	Bus/Coach	Mtr/cycle
Castlegate (B1248)	Origin	6772	5880	826	0	0	35	31
	Destination	4175	3591	540	0	0	17	27
	TOTAL	10947	9471	1366	0	0	52	58
Church Street (B1248)	Origin	7846	6797	932	0	0	61	56
	Destination	7665	6621	930	0	0	63	51
	TOTAL	15511	13418	1862	0	0	124	107
Norton Road	Origin	1120	955	115	0	0	28	22
	Destination	3637	3159	403	0	0	44	31
	TOTAL	4757	4114	518	0	0	72	53

Table 2: Adjusted Traffic Data used to Simulate Emissions Impact of OGV1 & OGV2 Prohibition

Road Link		All Vehicles	Car	LGV	OGV1	OGV2	Bus/Coach	Mtr/cycle
Castlegate (B1248)	Origin	6494	5469	826	133	0	35	31
	Destination	4220	3504	540	132	0	17	27
	TOTAL	10714	8973	1366	265	0	52	58
Church Street (B1248)	Origin	7708	6490	932	169	0	61	56
	Destination	7503	6307	930	152	0	63	51
	TOTAL	15211	12797	1862	321	0	124	107
Norton Road	Origin	1104	918	115	21	0	28	22
	Destination	3583	3066	403	39	0	44	31
	TOTAL	4687	3984	518	60	0	72	53

Table 3: Adjusted Traffic Data used to Simulate Emissions Impact of OGV2 Prohibition

4.0 Results

- 4.1 Emissions of NO_x, PM₁₀ and PM_{2.5} from road vehicles computed using the EFT for a range of average vehicle speeds are summarised below in a series of tables, Tables 4 to 7.
- 4.2 Each table shows predicted aggregated pollutant emissions (i.e. emissions from all motor vehicle types) over a 12 hour period (0700h to 1900h) at a particular speed for each of the three road links leading to the level crossing. Emissions are expressed in grams per kilometre (g/km).
- 4.3 The tables show three predicted values for each pollutant on each road link: firstly, the predicted emission based on the traffic flows and composition found by the CCTV traffic survey; secondly the predicted emissions based on adjusted flows and composition that simulate the prohibition of OGV1's & OGV2's (but not coaches and buses) from using the level crossing; and thirdly predicted emissions based on adjusted flows and composition that simulate the prohibition of OGV2's (but not coaches and buses) from using the crossing. The aggregated pollutant emissions predicted to result from the HCV restrictions are also expressed in terms of the percentage reduction relative to the 'no HCV restriction scenario'.

Road Link	Pollutant	Aggregate Emissions 2016 (g/km) (% age Reduction is shown in brackets)		
		No OGV Restriction	OGV1 & OGV2 Prohibition	OGV2 Prohibition
A - Castlegate (B1248)	NOx	8067	6112.2 (24.2)	7230.8 (10.4)
A - Castlegate (B1248)	PM25	271.3	242.4 (10.7)	260.2 (4.1)
A - Castlegate (B1248)	PM10	440.8	398.7 (9.5)	425.1 (3.6)
B - Church Street (B1248)	NOx	11227.6	8994.4 (19.9)	10344.4 (7.9)
B - Church Street (B1248)	PM25	381.5	348.5 (8.7)	369.8 (3.1)
B - Church Street (B1248)	PM10	619.9	571.8 (7.7)	603.2 (2.7)
C - Norton Road	NOx	3275.5	2978.9 (9.1)	3227.1 (1.5)
C - Norton Road	PM25	114.6	110.2 (3.8)	114 (0.5)
C - Norton Road	PM10	186.2	179.8 (3.4)	185.3 (0.5)

Table 4: Comparison of Aggregate Vehicle Emissions in 2016 with and without OGV1/OGV2 and OGV2 Prohibition (Traffic Speed 16 kph)

Road Link	Pollutant	Aggregate Emissions 2016 (g/km) (% age Reduction is shown in brackets)		
		No OGV Restriction	OGV1 & OGV2 Prohibition	OGV2 Prohibition
A - Castlegate (B1248)	NOx	6557.6	5266.8 (19.7)	6046.1 (7.8)
A - Castlegate (B1248)	PM25	257.6	233.9 (9.2)	248.6 (3.5)
A - Castlegate (B1248)	PM10	426.3	389.8 (8.6)	412.9 (3.2)
B - Church Street (B1248)	NOx	9168.4	7688.7 (16.1)	8628 (5.9)
B - Church Street (B1248)	PM25	362.5	335.6 (7.4)	353.1 (2.6)
B - Church Street (B1248)	PM10	599.8	558.2 (6.9)	585.6 (2.4)
C - Norton Road	NOx	2707.6	2506.6 (7.4)	2678.2 (1.1)
C - Norton Road	PM25	109.1	105.6 (3.2)	108.6 (0.5)
C - Norton Road	PM10	180.5	175 (3)	179.7 (0.4)

Table 5: Comparison of Aggregate Vehicle Emissions in 2016 with and without OGV1/OGV2 and OGV2 Prohibition (Traffic Speed 24kph)

Road Link	Pollutant	Aggregate Emissions 2016 (g/km) (% age Reduction is shown in brackets)		
		No OGV Restriction	OGV1 & OGV2 Prohibition	OGV2 Prohibition
A - Castlegate (B1248)	NOx	5549.8	4609.1 (17)	5202.1 (6.3)
A - Castlegate (B1248)	PM25	248.4	227.4 (8.5)	240.5 (3.2)
A - Castlegate (B1248)	PM10	416.7	382.9 (8.1)	404.3 (3)
B - Church Street (B1248)	NOx	7780.2	6698.7 (13.9)	7412.8 (4.7)
B - Church Street (B1248)	PM25	349.8	325.8 (6.9)	341.4 (2.4)
B - Church Street (B1248)	PM10	586.4	547.9 (6.6)	573.3 (2.2)
C - Norton Road	NOx	2314.1	2164.4 (6.5)	2294.3 (0.9)
C - Norton Road	PM25	105.4	102.3 (3)	105 (0.4)
C - Norton Road	PM10	176.5	171.5 (2.8)	175.8 (0.4)

Table 6: Comparison of Aggregate Vehicle Emissions in 2016 with and without OGV1/OGV2 and OGV2 Prohibition (Traffic Speed 32kph)

Road Link	Pollutant	Aggregate Emissions 2016 (g/km) (% age Reduction is shown in brackets)		
		No OGV Restriction	OGV1 & OGV2 Prohibition	OGV2 Prohibition
A - Castlegate (B1248)	NOx	4312	3726.7 (13.6)	4124.2 (4.4)
A - Castlegate (B1248)	PM25	237.8	219.2 (7.8)	230.8 (2.9)
A - Castlegate (B1248)	PM10	405.6	374.3 (7.7)	394.1 (2.8)
B - Church Street (B1248)	NOx	6066.6	5390 (11.2)	5868 (3.3)
B - Church Street (B1248)	PM25	334.9	313.8 (6.3)	327.5 (2.2)
B - Church Street (B1248)	PM10	570.8	535.2 (6.2)	558.7 (2.1)
C - Norton Road	NOx	1821.3	1724.5 (5.3)	1810.8 (0.6)
C - Norton Road	PM25	101	98.3 (2.7)	100.6 (0.4)
C - Norton Road	PM10	171.9	167.3 (2.7)	171.3 (0.4)

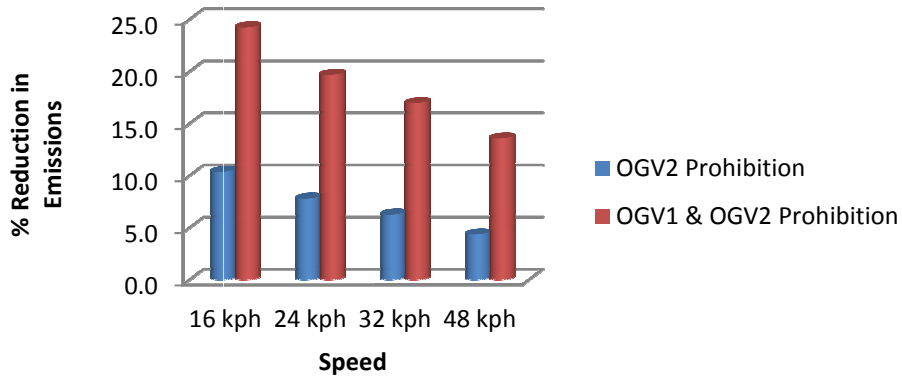
Table 7: Comparison of Aggregate Vehicle Emissions in 2016 with and without OGV1/OGV2 and OGV2 Prohibition (Traffic Speed 48 kph)

5.0 Observations

- 5.1 The results in Tables 4 to 7 show that pollutant emissions increase as traffic speed decreases (irrespective of whether HCV restrictions are in place).
- 5.2 The results clearly indicate that the HCV restrictions would result in net decreases in emissions of NO_x and the other vehicle pollutants (PM_{2.5} & PM₁₀) on all three road links to the level crossing. This is true across the full range of traffic speeds considered. The results also take into account increases in the number of cars that it has been assumed would take advantage of the extra capacity created by a HCV restriction.
- 5.3 The magnitudes of predicted emissions reductions that would arise from the HCV restriction vary in relation to traffic speed, so that as speeds go down increasing quantities of pollutants would be removed on each of the road links by the restriction.
- 5.4 This clearly indicates that restricting HCV's would reduce emissions of NO_x, and the other vehicle pollutants, at all times. Furthermore, these results suggest that during peak periods, which are associated with slow speeds and stop start driving, the reduction in emissions would be greatest.
- 5.5 Whilst this does show that the HCV restrictions would have the biggest beneficial impact in relation to low traffic speeds and the stop start driving associated with congestion, it is important to recognise that congestion and slow moving traffic still results in increasing emissions from the remaining parts of the vehicle fleet.
- 5.6 The relationship between traffic speed and emissions also suggests that whilst increasing congestion may in some circumstances deter drivers from using particular roads at certain times, thereby reducing vehicle numbers (traffic flow), it may at the same time increase pollutant emissions from the remaining vehicles. This means that the impact on traffic emissions of increasing congestion, by design, in pollution hotspots in order to persuade more drivers to use alternative routes could have an adverse impact on air quality. The likely impacts of such proposals do therefore need to be carefully assessed.
- 5.7 The results provide a strong indication that prohibiting both OGV1 and OGV2 classes would give rise to significantly greater reductions in pollutant emissions than a prohibition limited to the OGV2 class. The difference in predicted reductions vary for each pollutant and according to traffic speed. In respect of NO_x, the predicted reduction with prohibition of OGV1 and OGV2 classes is more than double that for an OGV2 class prohibition. This applies at all the values of traffic speed considered in this assessment.
- 5.8 The relationship between pollution reduction and traffic speed, and a comparison of the impact of an OGV1 and OGV2 class prohibition against a prohibition solely of the OGV2 class, is illustrated by the chart in Figure 1.

The chart shows predicted percentage reductions in total NO_x emissions on the Castlegate road link for the two HCV restriction options for each of the four traffic speeds considered in the assessment.

Figure 1: Impact Comparison of HCV Restriction Options -NO_x Emissions Castlegate



5.9 The disproportionately high contribution to NO_x emissions made by HCV's in relation to the rest of the vehicle fleet (based on the EFT results in this assessment) is shown by the charts in Figures 2 to 5. For this purpose the fleet has been divided into just two components: Light Duty Vehicles (LDV's) (comprising all cars, light goods vehicles and motor cycles) and Heavy Duty Vehicles (HDV's) (comprising rigid HCV's, articulated HCV's, buses and coaches). This series of charts also illustrates the increasing proportion of total traffic NO_x emissions attributable to HDV's as traffic speed decreases.

Figure 2: Comparison of LDV and HDV NO_x Emissions by Fleet Composition at 16kph

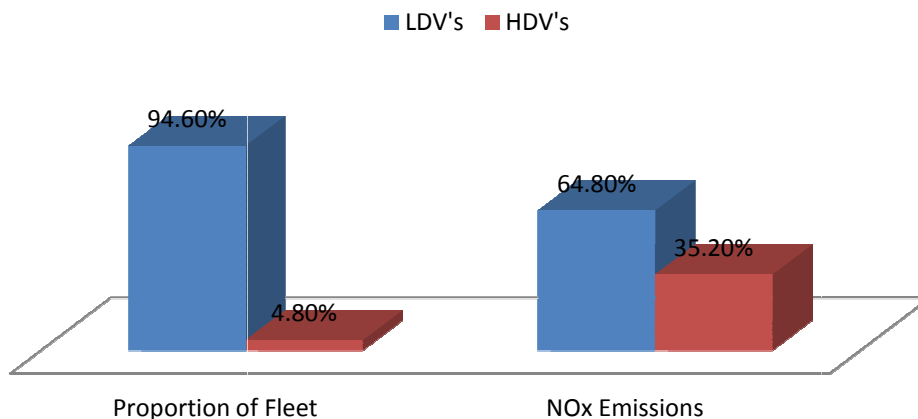


Figure 3: Comparison of LDV and HDV NOx Emissions by Fleet Composition at 24 kph

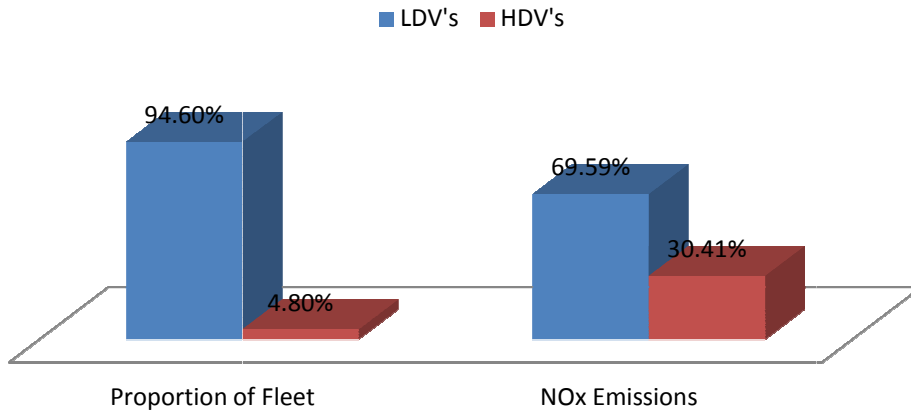


Figure 4: Comparison of LDV and HDV NOx Emissions by Fleet Composition at 32 kph

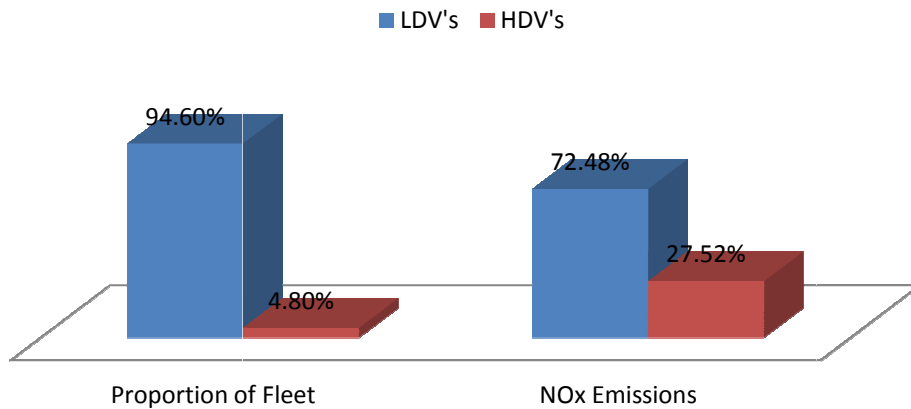
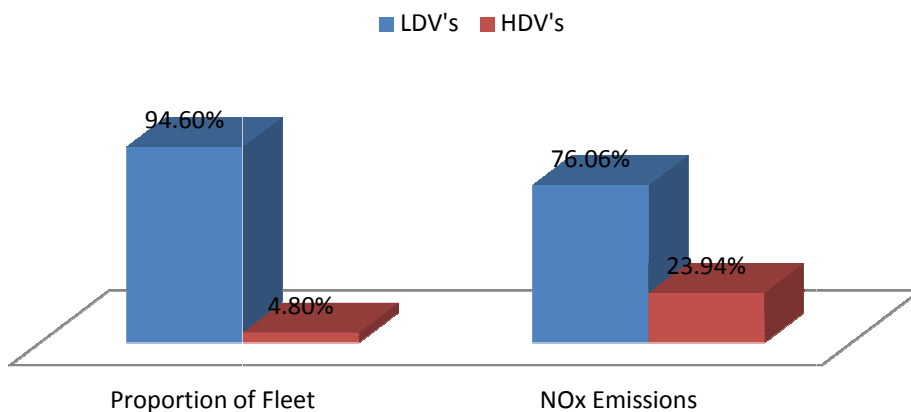


Figure 5: Comparison of LDV and HDV NOx Emissions by Fleet Composition at 48 kph



- 5.10 To further illustrate these results the ratios of HDV:LDV NO_x emissions at the four speeds applied to the EFT in this assessment have been calculated from the emissions outputs for the Castlegate road link and are shown below in Table 8.

Vehicle Speed (kph)	HDV:LDV NO _x Emissions Ratio
16	10.7:1
24	8.6:1
32	7.5:1
48	6.2:1

Table 8: Relationship between HDV:LDV NO_x Emissions and Vehicle Speed

- 5.11 The Table shows relative NO_x emissions from HD and LD vehicles averaged across the entire fleet. Emissions from vehicles (both from LDV's and HDV's) will of course cover a wide range according to the vehicle model and engine size & type (diesel or petrol) and age (Euro type approval class). The EFT incorporates assumptions on the Euro Class distribution of vehicles within the fleet.

6.0 Conclusions

- 6.1 The results of this assessment suggest that prohibiting the OGV1 and OGV2 classes of HCV's from using the Norton level crossing would result in significant reductions in emissions of NO_x and other road traffic pollutants along the three road links to the crossing. These roads include Castlegate (B1248), which runs north from the crossing to Butcher Corner in the centre of Malton, through part of the Malton AQMA. This applies even when allowance is made for increases in movements of cars that it has been assumed would take up the increased highway capacity created by a HCV restriction.
- 6.2 The assessment indicates that whilst a prohibition applying to just the OGV2 class would also result in reductions in emissions of NO_x and the other road traffic pollutants, the reductions in emissions would be considerably lower, probably less than half as much.
- 6.3 It follows from this that the restrictions on the movement of HCV's considered by this assessment would contribute to the improvement of air quality in the Malton AQMA, including the reduction of NO₂ concentrations. This would contribute to the achievement of compliance with the NO₂ annual mean national air quality objective, which is currently breached at certain relevant exposure locations in the AQMA.
- 6.4 This assessment supports the implementation of Malton Air Quality Action Plan Measure AP2a - HCV restriction, through the prohibition of OGV1 and OGV2 class vehicles from using the Norton Level crossing.