Appendix 4.8 Calculations of NO2 Concentration inside the Semi-Enclosure in front of St. Antonius Girls' College

- Normal speed

Tunnel Parameter

Tunnel length (m), L	=	70
Tunnel height (m), H	=	7.7
Tunnel width (m), W	=	20
Tunnel size (m2), At	=	H * W
		154
Equivalent diameter (m), dt	=	(4*At/p)^0.5
		14.00282
Effective length of the tunnel (m), Le	=	L + 2*3*dt
		154.0169

Emission Data

		Traffic Breakdown (%)					
	Traffic flow (veh/hr)	M/C	Car/Taxi	Minibus	LGV	HGV	Bus
Tunnel traffic	3080	3	67	6	11	5	8
Q (veh/hr)		92.4	2063.6	184.8	338.8	154	246.4
		M/C	Car/Taxi	Minibus	LGV	HGV	Bus
Emission Factor (g/km) - EURO3		0.46	0.8	1.67	1.35	4.67	8.44

Weighted NOX E.F. (g/km/veh) = 1.7072

NO2 emission factor per unit length (g/m/s), w = 12.5% * Weight NOX E.F. * Traffic flow
= 0.000182576

Vehicle Data

Nominal dimensions of vehicles are given in Transport Planning and Design Manual, Vol. 2 as:

	W	H	L
Cars and Taxi	1.7	1.5	4.6
Light Bus	2	3	6.5
LGV	2.1	1.6	5.2
HGV	2.5	4.6	16
Bus	2.5	4.6	12

Nominal cross-sectional area (m2) = (0.03+0.67)*1.7*1.5+0.06*2*3+0.11*2.1*1.6+(0.05+0.08)*2.5*4.6
= 4.0096

Number of lanes per direction, nl = 3

Equivalent cross-sectional area for each direction (m2), Av = 12.0288

Equivalent diameter of vehicle (m), dv = (4*Av/p)^0.5
= 3.91351

Traffic density (traffic flow /s), N = 0.855556

Average vehicle speed (m/s), v = 50 km/hr
= 13.88889

Head to head distance on a lane (m), l = 2*nl*v/N
= 97.4026

Diffusion Parameters

Reynolds number, Re = (v*dv)/s where s = 15.6*10^-6
= 3484250

According to Figure 16 (Ohashi and Koso)

Since l / dt = 6.955926

D / (N * dt^2 * Re^0.13) = 0.4

Longitudinal diffusion coefficient (m2/s) , D = 0.4 * (N * dt^2 * Re^0.13)
= 475.5691

Maximum Concentration of NO2

Cmax (µg/m3) = w * Le^2 / (8 * D * At)

(without background) = 7.391886

Appendix 4.8 Calculations of NO2 Concentration inside the Semi-Enclosure in front of St. Antonius Girls' College

- **Worse case**

Tunnel Parameter

Tunnel length (m), L	=	70
Tunnel height (m), H	=	7.7
Tunnel width (m), W	=	20
Tunnel size (m2), At	=	H * W
		154
Equivalent diameter (m), dt	=	(4*At/p)^0.5
		14.00282
Effective length of the tunnel (m), Le	=	L + 2*3*dt
		154.0169

Emission Data

		Traffic Breakdown (%)					
	Traffic flow (veh/hr)	M/C	Car/Taxi	Minibus	LGV	HGV	Bus
Tunnel traffic	3080	3	67	6	11	5	8
Q (veh/hr)		92.4	2063.6	184.8	338.8	154	246.4
		M/C	Car/Taxi	Minibus	LGV	HGV	Bus
Emission Factor (g/km) - EURO3		0.46	0.8	1.67	1.35	4.67	8.44

Weighted NOX E.F. (g/km/veh) = 1.7072

NO2 emission factor per unit length (g/m/s), w = 12.5% * Weight NOX E.F. * Traffic flow
= 0.000182576

Vehicle Data

Nominal dimensions of vehicles are given in Transport Planning and Design Manual, Vol. 2 as:

	W	H	L
Cars and Taxi	1.7	1.5	4.6
Light Bus	2	3	6.5
LGV	2.1	1.6	5.2
HGV	2.5	4.6	16
Bus	2.5	4.6	12

Nominal cross-sectional area (m2) = (0.03+0.67)*1.7*1.5+0.06*2*3+0.11*2.1*1.6+(0.05+0.08)*2.5*4.6
= 4.0096

Number of lanes per direction, nl = 3

Equivalent cross-sectional area for each direction (m2), Av = 12.0288

Equivalent diameter of vehicle (m), dv = (4*Av/p)^0.5
= 3.91351

Equivalent length of each vehicle (m) = (0.03+0.67)*4.6+0.06*6.5+0.11*5.2+0.05*16+0.08*12
= 5.942

Distance between vehicle (m) = 1 (worst case)

Head to head distance on a lane (m), l = 6.942

Traffic density (traffic flow /s), N = 0.855556

Average vehicle speed (m/s), v = l*N/(2*nl)
= 0.969878

Diffusion Parameters

Reynolds number, Re = (v*dv)/s where s = 15.6*10^-6
= 248326.7

According to Figure 16 (Ohashi and Koso)

Since l / dt = 0.495757

D / (N * dt^2 * Re^0.13) = 0.13

Longitudinal diffusion coefficient (m2/s) , D = 0.13 * (N * dt^2 * Re^0.13)
= 109.6417

Maximum Concentration of NO2

Cmax (µg/m3) = w * Le^2 / (8 * D * At)

(without background) = 32.06218

Appendix 4.8 Calculations of NO2 Concentration Inside the Semi-Enclosure in front of St. Antonius Girls' College

- Overall Concentrations

Four assessment points (ASRs P9-P12) at the boundary of the full enclosure are chosen (see Figure A3). Using CALINE4 model, the NO2 concentrations at the 4 assessment points at different levels are calculated (see Appendix 4.7). The highest concentration among the four assessment points is assumed to be the background NO2 concentration inside the full enclosure section.

Without Route 9 Slip Road Full Enclosure:

Elevation	NO2 Concentrations (ug/m3) at Various Levels			
(mAG)	P9	P10	P11	P12
0	157	149	197	182
3.85	159	151	243	215
7.7	161	151	283	243

Therefore, the background concentration inside the full enclosure section is 283 ug/m3.

Overall Maximum NO2 concentration inside the full enclosure section (Normal Speed) = 7.4 + 283
= 291 ug/m3

Overall Maximum NO2 concentration inside the full enclosure section (Worse Case) = 32.1 + 283
= 315 ug/m3