



Gateway Upgrade Project



14. Air Quality

14

14. Air Quality

14.1 Introduction

A climate and air quality impact assessment has been undertaken by Katestone Environmental to provide information on the existing baseline environment and an assessment of the potential impacts on air quality associated with the development during construction and operation of the proposed GUP. Mitigation and management measures have been recommended where appropriate to minimise the identified potential impacts and the acceptability of residual impacts has been determined.

14.2 Methodology

The climatic conditions relevant to the GUP were determined using 30 minute average meteorological data from the EPA station at Eagle Farm and long term monitoring data from the Bureau of Meteorology Brisbane Airport station. The EPA Eagle Farm site is adjacent to the airport, and is representative of meteorological conditions for the project. Detailed wind fields for the region were generated using the Calmet model for use in dispersion modelling.

The air quality assessment for the GUP was conducted using a combination of dispersion models to evaluate impacts of NO₂, CO, PM₁₀, TSP, Benzene and 1,3-butadiene. Predictions of air quality impacts at residential locations close to the road were made using the CAL3QHCR model, which accounts for the distribution of winds as well as the additional local turbulence induced by vehicle movements. The Calpuff model was used to evaluate impacts at more than 1km from the road where the CAL3QHCR model cannot be used. The air quality impacts were evaluated for 2011 and 2021, both without the GUP (base case) and with the GUP.

The Greenhouse Gas assessment evaluated the likely generation of CO₂, N₂O and CH₄ due to emissions from motor vehicles. The total CO₂-equivalent emissions were estimated for all sections of the project.

14.3 Climatic Conditions

TOR Requirements:

- Describe the rainfall patterns (including magnitude and seasonal variability of rainfall), air temperatures, humidity, wind (direction and speed) and any other special factors (eg temperature inversions) that may affect air quality within the environs of the project.
- Discuss extremes of climate (droughts, floods, cyclones, etc) with particular reference to water management at the Project site.
- Address the vulnerability of the area to natural or induced hazards, such as floods and bushfires and the relative frequency, magnitude and risk of these events.
- Describe the potential for climate change and sea level rise over the life of the Project and obtain information about trends in changing climate patterns at a state and regional level from the Queensland Centre for Climate Change, Department of Natural Resources and Mining.

Surface Winds

Data collected between January 1997 and September 2003 has been analysed for this assessment. Figure 14.1 shows the wind rose for Eagle Farm for all hours, with wind roses by time of day and by season shown in Appendix J1.

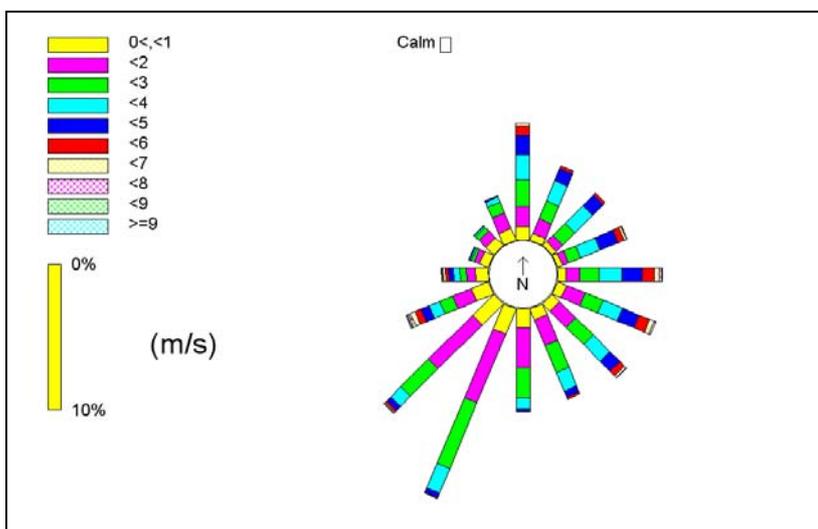


Figure 14.1 Wind Rose for all Hours for the Eagle Farm EPA Monitoring Site (January 1997 to September 2003)

The wind rose for all hours (Figure 14.1) shows the frequent occurrence of light winds from the south to south west, as well as from the north. Strong winds which aid dispersion of pollutants and cause dust erosion problems during construction, predominantly occur from the eastern sector. The distribution of wind speed and direction at Eagle Farm, is presented in Table 14.1. Winds less than 2m/s have been recorded 40% of the time, while strong winds above 5m/s occur 7.3% of the time.

Table 14.1 Percentage of 10m level winds recorded for each direction and wind speed range for Eagle Farm, January 1997 to September 2003, all hours

Wind Speed (m/s)	Wind Direction by Sector (Percentage)																Total
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
0-1	0.9	0.5	0.4	0.4	0.6	0.7	0.7	0.8	1.2	1.9	2.0	1.3	0.9	0.6	0.8	0.9	14.7
1-2	1.4	1.1	0.6	0.4	0.9	1.4	1.5	1.9	2.8	5.0	4.2	1.4	0.6	0.4	0.7	1.1	25.5
2-3	1.8	1.3	1.2	0.9	1.3	1.3	1.7	2.0	2.1	4.8	2.7	0.9	0.5	0.2	0.3	0.8	23.6
3-4	1.7	1.5	1.7	1.5	1.5	1.4	1.6	1.4	0.7	1.8	1.0	0.7	0.4	0.1	0.1	0.4	17.6
4-5	1.3	0.9	1.0	1.3	1.4	1.2	1.0	0.4	0.2	0.4	0.4	0.6	0.3	0.1	0.0	0.1	10.6
5-6	0.7	0.2	0.2	0.5	0.8	0.8	0.4	0.1	0.0	0.1	0.1	0.4	0.2	0.0	0.0	0.0	4.6
6-7	0.2	0.0	0.0	0.2	0.3	0.3	0.1	0.0	0.0	0.0	0.1	0.3	0.1	0.0	0.0	0.0	1.7
7-8	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.7
8-9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.2
9+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1
Total	8.0	5.5	5.0	5.2	7.1	7.2	7.1	6.6	7.0	14.0	10.5	6.1	3.1	1.4	1.9	3.3	
Calms	0.8																

Wind roses by hour of day, (refer Appendix J1), indicate the strong trend of night-time winds from the south to south-west, with occasional stronger winds from other sectors increasing in the morning. The afternoon wind distribution shows frequent strong winds from the north through to the south east reflecting the seabreeze, with less frequent components from the west to west south west. Night time winds show a weakening influence of the north easterly component, with frequent winds from the north and west through to the east.

The distribution of winds by season (refer Appendix J1) demonstrates how the spring and summer conditions are characterised by winds from the north through to the south east. Autumn and winter wind roses show a similar pattern of frequent winds from the west through to the south south west, with more frequent east to south easterly winds in autumn.

Temperature, Relative Humidity and Rainfall

Table 14.2 presents the average monthly values of temperature, relative humidity from the Eagle Farm site, and rainfall and number of raindays as recorded at the Bureau of Meteorology’s long term site at Brisbane Airport, with over 50 years of data.

Table 14.2 Monthly Averages for Various Meteorological Variables for Eagle Farm and Brisbane Airport

Month	Temperature (°C)	Relative Humidity (%)	Rainfall (mm)	Mean number of Rain days
January	25.1	70	157.7	13
February	25.1	74	171.7	14.2
March	24.3	73	138.5	14.1
April	21.4	74	90.4	11
May	18.7	72	98.8	10.5
June	16.1	71	71.2	7.5
July	15.4	70	62.6	7.2
August	16.4	67	42.7	6.6
September	19.5	67	34.9	6.9
October	21.5	68	94.4	10
November	22.3	70	96.5	10
December	24.7	70	126.2	11.5

The annual mean daily maximum temperature is 25.6°C. The average mean daily minimum temperature is 16.7°C. The hottest month of the year is January with a mean daily maximum of 29.3°C and a mean daily minimum of 21.3°C. The coolest month of the year on average is July with a mean daily maximum of 21.1°C and a mean daily minimum of 10.8°C.

The average annual rainfall, as recorded at Brisbane Airport, is 1,185.4mm. The highest mean monthly rainfall is 171.7mm in February with the lowest mean monthly rainfall of 34.9mm occurring in September. February has the highest mean number of raindays.

Atmospheric Stability

Atmospheric stability is a derived parameter that classifies the nature of the atmosphere and its ability to disperse pollutants. The more unstable the atmosphere the more likely a parcel of air will rise or fall and hence disperse, conversely for a stable atmosphere a parcel of air will remain compact and will not readily disperse.

The frequency of occurrence of stability classes from the Eagle Farm site is shown in Table 14.3 for data collected between 1997 and 1998. "A" class stability represents very unstable atmospheric conditions that may typically occur on a sunny day and "F" class stability represents very stable atmospheric conditions that typically occur during light wind conditions at night. The Eagle Farm site experiences a moderate proportion of stable conditions, as well as unstable conditions.

Table 14.3 Frequency of Stability Class at Eagle Farm

Pasquill-Gifford Stability Class	Frequency (%)	Description
A	16.0	Extremely unstable
B	20.5	Unstable
C	11.8	Slightly unstable
D	9.6	Neutral
E	15.2	Slightly stable
F	26.8	Stable

Mixing Heights

Mixing heights determine the vertical layer of the atmosphere through which pollutants can mix. A low mixing height (generally occurring overnight and in the early morning) results in higher ground level concentrations of pollutants, while a large mixing height means that emissions will be more diluted before they reach the ground.

Morning mixing heights have been determined from the daily radiosonde measurements at Brisbane Airport. These profiles provide representative morning temperature gradients for the Brisbane region, which are extended to all hours of the day. The mixing heights calculated for Eagle Farm are shown in Figure 14.2. Overnight mixing heights are typically around 100m, increasing to an average of 1,400m in the late afternoon. Higher mixing heights can occur at any time of the year.

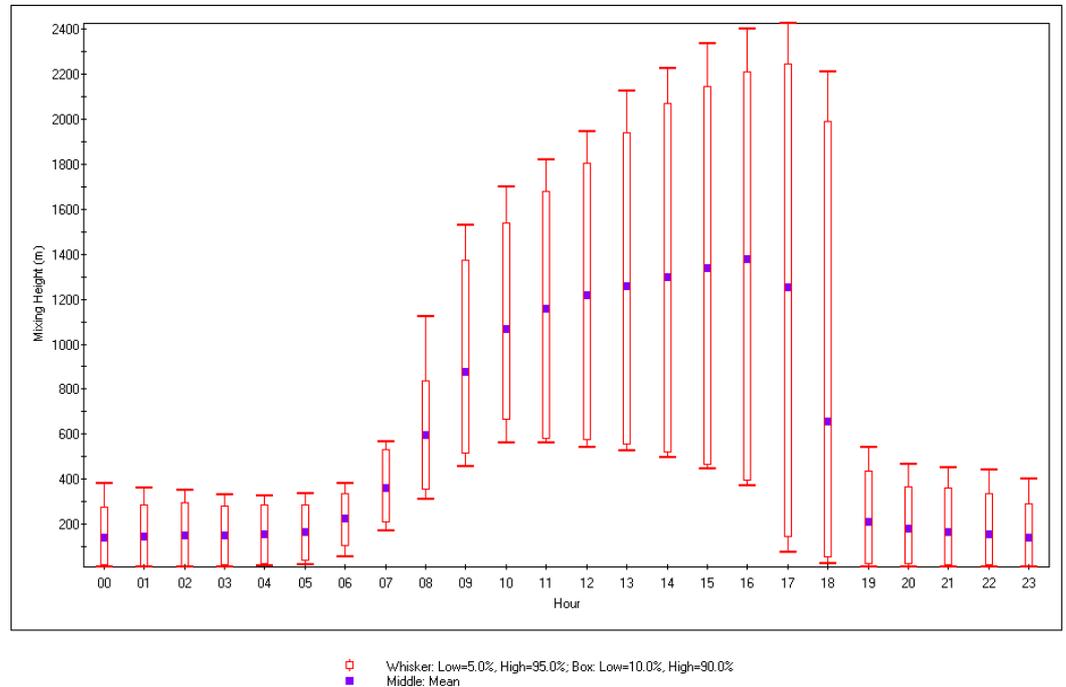


Figure 14.2 Mixing Height Profiles for Eagle Farm

14.4 Description of the Air Quality

TOR Requirements:

- Describe the existing air environment that may be affected by the proposed works in the context of environmental values as defined by the *Environmental Protection Act 1994* and Environmental Protection (Air) Policy;
- Provide a description of the existing air shed environment having regard for particulates, gaseous and odorous compounds, the background levels and sources of suspended particulates and any other major constituent of the air environment, including greenhouse gases, which may be affected by the proposed works, should be discussed;
- Gather sufficient data on local meteorology and ambient levels of pollutants to provide a baseline for later studies or for the modelling of air quality environmental harms within the airshed. Parameters should include air temperature, wind speed and direction, atmospheric stability, mixing depth and other parameters necessary for input to the models; and
- Provide discussion regarding relevant protocols, agreements and strategies for Greenhouse Gas. This may include reference to The National Greenhouse Strategy, National Greenhouse Gas Inventory, The Kyoto Protocol and The Framework Convention on Climate Change.

14.4.1 Air Quality Guidelines

The air quality guidelines used to evaluate the dispersion modelling results are shown in Table 14.4 and include:

- *Environmental Protection (Air) Policy 1997* (EPP (Air));
- National Environment Protection Measure (NEPM) for Ambient Air Quality (1998);
- National Health and Medical Research Council (NHMRC) Air Quality Goals; and
- United Kingdom Air Quality Strategy objectives (UK AQS).

The EPP (Air) is to be applied at residential locations for the protection of human health. Guidelines for the protection of biological integrity that are included in the EPP (Air) are also reported in Table 14.4 for nitrogen dioxide, however these are not used for evaluation of health impacts.

The NEPM air quality goals are intended to be applied as long term goals. They are not recommended for use at peak locations, such as near major roadways or industrial plants. Thus, in the evaluation of air quality impacts due to the GUP, the EPP (Air) guidelines for human health will be applied close to the roadway, and the NEPM goals will be applied at locations more than 1km from the road.

Table 14.4 Ambient Air Quality Guidelines used in Assessment

Pollutant	Averaging period	Maximum concentration ($\mu\text{g}/\text{m}^3$)	Allowable exceedances	Agency
Nitrogen dioxide	1 hour	320 ³	9 hours per year ¹	EPP (Air)
	1 hour	246	1 day per year	NEPM
	4 hour	95 ²	-	EPP (Air)
	1 year	30 ²	-	EPP (Air)
	1 year	62	-	NEPM
Carbon monoxide	8 hours	10,000 ³	-	EPP (Air)
Particles (as PM ₁₀)	24 hours	150 ³	-	EPP (Air)
	24 hours	50	5 days a year	NEPM
Particles (as TSP)	1 year	90 ³	-	EPP (Air)
Lead	90 day	1.5 ³	-	EPP (Air)
Benzene	Annual	0.39 (5 ppb)	-	UK AQS
1,3-butadiene	3-minute	73	-	Vic EPA

Table Notes:

1. No exceedance frequencies defined, values assumed
2. Part 2 – Indicators and goals relevant to biological integrity
3. Part 3 – Other indicators and goals

The Queensland guidelines for dust deposition from construction activities are equivalent to approximately 130mg/m²/day monthly average of insoluble dust at residences (Queensland EPA 1994). The NSW Environment Protection Authority provides goals for acceptable increments in average dust deposition depending on the existing dust levels. An appropriate goal for construction of this project would be a total dust deposition rate of 4g/m²/month measured on an annual basis (equivalent to 130mg/m²/day).

14.4.2 Mt Gravatt – Capalaba Road to Cleveland Branch Rail Line

The GUP between Mt Gravatt–Capalaba Road and Cleveland Branch Rail Line contains only a few industries. These include several food processing plants within 0.5km of the existing Gateway Motorway. Within 2km of the existing road are several former landfills. None of these industries are expected to significantly impact on air quality within the vicinity of the GUP corridor.

14.4.3 Cleveland Branch Rail Line to Pinkenba Rail Line

The GUP is located in an area that is cleared and developed land. Major industrial facilities in the area include the Port of Brisbane, Eagle Farm Industrial Area and the BP and Caltex Oil Refineries. Smaller industrial facilities within 1km of the GUP include metal processing and finishing plants, a concrete batching plant, an asphalt plant and a fertiliser plant. Air quality impacts due to these existing industries are expected to be represented by the EPA monitoring data at Eagle Farm.

14.4.4 Pinkenba Rail Line to Nudgee Road

The proposed deviation between Pinkenba Rail Line and Nudgee Road passes through land near the Brisbane Airport, the airport industrial area, the Army Stores and the Brisbane International Export Park. Part of the road traverses Brisbane Airport land and part is currently unoccupied land. The general industry and freight operations in these areas would result in minimal air quality impacts, and the Eagle Farm site would be expected to represent existing air quality.

14.4.5 Background Air Quality

Air quality at sensitive receptor locations, such as houses or schools, will be quite different dependant on the proximity to roads and light industry. For receptors close to the existing Motorway, vehicle emissions will be the primary source of air pollution. Air quality at locations more than 500m from the existing roads will be dominated by any local industrial emissions. The existing environment for air quality is assessed below using monitoring data available for SEQ.

The EPA has an air quality monitoring station located at Eagle Farm which monitors the following parameters: ozone, nitrogen dioxide (NO₂), oxides of nitrogen (NO_x), sulphur dioxide (SO₂) and airborne particles less than 10µm in diameter (PM₁₀). Lead was also monitored from 1996-1998. The distance from the project sections to the Eagle Farm monitoring site is summarised in Table 14.5.

Table 14.5 Distance from Project Section to Eagle Farm Monitoring Site

Project Section	Distance to Eagle Farm Monitoring Site
Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line	8.5 to 17km
Cleveland Branch Rail Line to Pinkenba Rail Line	6 to 7.5km
Pinkenba Rail Line to Nudgee Road	3.5 to 5.5km

The Eagle Farm data will be most representative of the industrial areas close to the Cleveland Branch Rail Line to Pinkenba Rail Line section of the GUP, and hence will over estimate the existing air quality for the other sections of the GUP. The results of monitoring are summarised in Annual EPA Ambient Air Quality Monitoring in Queensland Summary and Trend Reports and hourly data obtained for the Eagle Farm site. Measurements made adjacent to roads in SEQ have been summarised in a report by the EPA (2001). This presents carbon monoxide (CO), NO₂, PM₁₀ and lead monitoring results between 1994 and 1997.

The EPA report that included data on background levels of CO from 1994 to 1997 was updated by considering more recent CO monitoring at the EPA sites close to the Brisbane CBD. This included the monitoring site managed by the EPA and MR in South Brisbane, approximately 25m from the Pacific Motorway.

Combustion processes, such as from motor vehicle engines, produce pollutants including NO_x, volatile organic compounds (VOC), PM₁₀, carbon monoxide (CO) and lead. NO_x and VOC can react to form photochemical smog, of which ozone is the principal component. Lead is primarily produced from the burning of lead containing fuels in motor vehicles which has now been replaced by Lead replacement petrol. Motor vehicles are the main source of carbon monoxide in an urban environment, with measured levels approaching guideline levels near congested major roads.

Lead monitoring conducted between 1996 and 1998 at Eagle Farm showed that ambient concentrations were well below the ambient air quality guideline. Monitoring of lead at Ipswich Road in Woolloongabba (carrying high traffic volumes) has shown a steady decline in ambient concentrations between 1980 and 1997, due primarily to the reduction of lead in petrol. 90 day average lead concentrations are typically less than 0.25µg/m³ (1997 data) compared to the EPP (Air) guideline of 1.5µg/m³, thus lead concentrations close to the existing Motorway would be of a similar magnitude.

A review of the carbon monoxide monitoring program from the NSW Roads and Traffic Authority (Holmes 1997) recommended a background level of 1 to 2ppm (1,250 to 2,500µg/m³) of carbon monoxide that would represent mean hourly values for most situations. This is supported by ambient monitoring of carbon monoxide at the EPA sites in Brisbane CBD and Ipswich Motorway at Goodna which typically have a 95th percentile concentration below 2ppm. The air quality guideline specified in the EPP (Air) is 8ppm (10,000µg/m³) for an 8-hour average.

A summary of the monitored pollutant concentrations from Eagle Farm between January 1997 and September 2003 is presented in Table 14.6 below, together with the EPP (Air) and NEPM guidelines for ambient air quality. These data indicate that exceedances of the EPP (Air) guideline are not expected at this site. The 95th percentile concentration will be used as the background for dispersion modelling. The measured concentrations in Table 14.6 would also include contributions from existing roads near the monitoring sites.

Table 14.6 Summary of Air Quality Monitoring Data from the EPA's Eagle Farm Station

Parameter	Pollutant Concentration (µg/m ³)			
	NO ₂	NO _x	O ₃	PM ₁₀
Maximum 1-hour average	121.4	771.2	180.5	137.4 *
95 th Percentile 1-hour average	53.3	155.0	70.7	36.9 *
Air quality guideline (EPP (Air))	320	N/A	210	150 *
Air quality guideline (NEPM)	246	N/A	214	50 *

Table Notes:

* 24-hour average concentration

The PM₁₀ concentration has shown exceedances of the NEPM guideline at Eagle Farm due to an extensive dust storm and bushfires in 2002 which are atypical conditions. These resulted in a total of 11 exceedances for 2002, above the allowed limit of 5 exceedances per year. Monitoring of PM₁₀ close to roads with high traffic volumes has shown that concentrations below 35µg/m³ are typical for free flowing traffic. The annual average concentration of PM₁₀ measured at Eagle Farm is typically 20 – 25µg/m³, hence a background concentration of 25µg/m³ will be used for this assessment for annual average data. The annual average concentration of total suspended particulates (TSP) at Fortitude Valley in 2001 was 41µg/m³.

The EPA monitors concentrations of benzene at Brisbane CBD as reported in the EPA Air Quality Bulletins for South East Queensland. The annual average concentration measured varied from 0.9ppb to 1.3ppb (3µg/m³ to 4.5µg/m³) between 2001 and 2003. A background concentration for benzene of 4.5µg/m³ has been adopted for this project. Background concentrations of 1,3-butadiene are not routinely monitored in Brisbane.

In general, the existing air quality adjacent to the existing Motorway and surrounding area is considered acceptable.

14.5 Air Quality Assessment Methodology

14.5.1 Traffic Data and Emissions Estimation

Ground level concentrations at nearby receptors are strongly dependent on traffic flow, composition (eg percent of heavy vehicles), meteorological conditions, topography and local road conditions (eg slope). The traffic flows vary throughout the day, with the morning and afternoon peak hours causing the highest air emissions due to the number of cars on the road and resultant congestion.

Traffic data for the years modelled (2011 and 2021), both without and with the GUP, were included in the dispersion modelling. This contained the number of vehicles for peak hour traffic and the proportion of heavy vehicles for each scenario and each section of the existing Gateway Motorway and the proposed deviation. The route was broken into segments, and the grade of each road section was determined.

A recent report commissioned by Environment Australia (known as the *Fuel Quality Review*) included an estimation of vehicle emission factors for the Australian capital cities up to 2020 (Environment Australia 2000). The study included the adoption of the European Union's Euro vehicle emissions standards for petrol and diesel vehicles, and the reduction of petrol volatility. The proposed schedule is the introduction of petrol vehicle emissions standards of Euro 2 by 2004, Euro 3 by 2006 and Euro 4 by 2008. The proposed diesel vehicle emissions standards include the adoption of Euro 3 for medium and heavy diesel trucks by 2003, Euro 2 for light duty diesel vehicles and buses by 2003 and Euro 4 for all diesel vehicles by 2007. Adoption of these increasingly stringent standards means that the emissions of pollutants on a per-kilometre-travelled basis will be progressively decreased.

The emission data for carbon monoxide, particulate matter, nitrogen dioxide and hydrocarbons were obtained for Brisbane for 2010 and 2020 (Environment Australia 2000). These factors were adjusted to the projected vehicle speed, number of vehicles, grade of the road and to represent the projected vehicle fleet composition in 2011 and 2021 as explained below.

Emissions of benzene and 1,3-butadiene were estimated from studies on the Brisbane fleet (Katestone Scientific 1995), which included projections for 2010 and 2030. This study on vehicle emissions gives emissions of benzene as 4% of the total exhaust and evaporative emissions of hydrocarbons, and emissions of 1,3-butadiene as 0.5% of the total hydrocarbon emissions. The benzene content of fuel will be reduced in future years, however this reduction has not been accounted for in the benzene emission factors. These factors have been used in estimating emission rates for benzene and 1,3-butadiene.

Speed and Grade Correction Factors

Studies in the United States and Australia (Cicero-Fernandez et al. 1997; Williams et al. 1994) have shown that grades and vehicle speed have synergistic effects on the emission rates of carbon monoxide, nitrogen oxides, particulates and hydrocarbons from passenger vehicles. Fine particulate emissions from heavy vehicles can increase by a factor of between 1 and 24 (average of 8.5) when under high load compared to emissions when idling (Morawska et al. 1997). The standard fleet emission factors that are developed for essentially flat terrain have been corrected for local road conditions. The corrections for speed and grade are combined when estimating vehicle emissions up a hill.

The traffic emission rates have been based on recent emission factors determined for the Brisbane fleet (Environment Australia 2000), together with adaptations for terrain and speed influences based on a power-based emissions methodology developed by the CSIRO (Williams et al. 1994). This methodology has been suggested for use on steep grades by a draft report on the NSW Roads and Traffic Authority air quality monitoring program (Holmes 1997).

The emission estimation scheme for this study uses the power based methodology for different classes of vehicle but with various parameters chosen to ensure a close correspondence to the fleet emission factors of recent vehicle emission inventories when used for flat terrain and average speeds and idling times appropriate to the Australian Design Rule ADR27 drive cycle. The estimates of hydrocarbon emissions include exhaust and evaporative components (as detailed in Carnovale et al. 1995).

The emission factors for arterial free flow (average speed of 31km/hr and idle time of 15 percent) have been adjusted to the anticipated vehicle speed for the treatment of flat terrain, using relationships of pollutant emissions with vehicle speed derived from Australian (Stewart et al. 1982), North American (United States EPA 1991) and European studies (Corinair 1995).

Emission rates of carbon monoxide and volatile organic compounds are expected to decrease with vehicle speed while there is likely to be an increase in nitrogen oxide emission rates with an increase in vehicle speed. It is noted that there is considerable disparity between the available published information on speed dependencies for nitrogen oxide emissions, especially for vehicles equipped with a three way catalyst and being used for extended high-speed driving. It is assumed that this is due to differences in the experimental methods. The assumed speed (V) dependencies for light duty petrol vehicles, heavy duty petrol vehicles and heavy duty diesel vehicles have been taken as follows (Xu 1996):

Light Duty Petrol Vehicles:

$$\begin{aligned} \text{CO:} & \quad 26.33/V + 0.15 & \quad \text{for } V \leq 31 \text{ km/h;} \\ & \quad 31.0/V & \quad \text{for } V > 31 \text{ km/h.} \\ \text{HC:} & \quad (V/31)^{-0.73} \\ \text{NO}_x: & \quad \text{Exp} \left((0.4757 - 0.02104V + 0.0001837V^2)/0.7485 \right). \end{aligned}$$

Heavy Duty Petrol Vehicles:

CO: $\text{Exp}(1.48 - 0.061V + 0.000429V^2)$
HC: $\text{Exp}(1.567 - 0.0606V + 0.000324V^2)$
NO_x: $0.829 + 0.0055V$.

Heavy Duty Diesel Vehicles:

CO: $\text{Exp}(1.363 - 0.055V + 0.000355V^2)$
HC: $\text{Exp}(0.889 - 0.034V + 0.000172V^2)$
NO_x: $\text{Exp}(0.664 - 0.03V + 0.000277V^2)$.

Emission rates for steep terrain are also uncertain with earlier work (Kelly and Groblicki 1993) reporting increases by several orders of magnitude for emissions of carbon monoxide and volatile organic compounds during the brief enrichment events that occur during hard acceleration or hill climbing. This report has used the power based model (Williams et al. 1994) with a component to include the power necessary to climb a slope and overcome aerodynamic and frictional forces. This methodology also produces significant emission increases on even moderate grades and is therefore considered to be conservative.

Emission Rates for 2011 and 2021

Taking into account the likely changes of fleet composition and age and the predicted transport pattern for the region (Environment Australia 2000), the vehicle emission rates for 2011 and 2021 were determined (refer Appendix J2). Table J1 gives the estimated vehicle emission rates for each road section for the existing roads without the GUP for 2011, and Table J2 gives vehicle emission rates without the GUP for 2021. Table J3 gives the estimated vehicle emission rates for each road section for the existing roads and the proposed GUP for 2011, and Table J4 gives vehicle emission rates for the same road sections for 2021. The pollutants studied are Nitrogen dioxide (NO₂), Carbon monoxide (CO), Particulate matter less than 10µm (PM₁₀), Hydrocarbons (HC), Benzene (Benz) and 1,3-Butadiene (1,3-But).

The emission rates for the existing sections of the Gateway Motorway, both without and with the GUP show considerable improvements with the GUP. For 2011, the increase in lanes and resultant reduction in congestion to the south of the Gateway Bridge results in a decrease in emissions of up to 61% in 2011, and up to 55% in 2021. North of the Gateway Bridge, the addition of the deviation road results in a substantial decrease in emissions of up to 84% in 2011 and 2021. The emissions of CO, HC, Benz and 1,3-But are the most improved by the GUP, due to the reduction in congestion and increased mean vehicle speed. NO_x and PM₁₀ emissions are noted to increase with the GUP to the north of the northern bifurcation, as this road section is not widened but the traffic flows are increased with the GUP.

The emission rates for all pollutants are predicted to decrease over time, either with or without the GUP. The biggest reduction with year is noted for NO₂ and CO, where reductions in emissions of up to 69% in CO emissions are predicted. This is counteracted by the increase in vehicles that use the GUP which increases up to 23% between 2011 and 2021 at peak hour.

Emissions were estimated for the peak hour traffic flow, using the highest of either morning or afternoon peak periods. To represent the diurnal change in traffic volumes along the route, the daily variation in traffic (and corresponding emission rates of pollutants) was taken from Section 5 of the EIS for the Gateway Bridge as follows:

- Hour 0 to hour 3: 5% of peak hour flows;
- Hour 4: 10% of peak hour flows;
- Hour 5: 40% of peak hour flows;
- Hour 6: 80% of peak hour flows;
- Hour 7 to hour 8: 100% of peak hour flows;
- Hour 9 to hour 14: 65% of peak hour flows;
- Hour 15: 80% of peak hour flows;
- Hour 16 to hour 17: 100% of peak hour flows;
- Hour 18: 65% of peak hour flows;
- Hour 19 to hour 22: 20% of peak hour flows; and
- Hour 23: 10% of peak hour flows.

14.5.2 Construction Compounds

Three possible sites for construction compounds have been identified for the GUP. These are located on the north bank of the Brisbane River (CH17500 to 18000); near the toll plaza on the Airport deviation embankment works (CH19800 to 20000) and within the vicinity of the proposed second access to the airport interchange (CH22000 to 22500). The compounds will include offices and earthworks. A concrete batching plant will also be located at the construction compound on the north bank of the river. At the time of the assessment full details of the operations to be conducted in the construction compounds were not available.

The three construction compounds will be located well away from residential locations, with one on the land of the Royal Queensland Golf Club, one on currently unoccupied land (old airport site) and the remaining site also on unoccupied land south of Kedron Brook. The general industry areas in Hamilton Lands are as close as 100m to the proposed concrete batching plant and earthworks stockpiles, depending on the final site chosen. The proposed construction compounds are all more than 1.5km from residential areas, and minimal dust impacts would be expected at those distances.

The emissions from the construction compounds are difficult to estimate, due to the transient nature of the works. Particulate matter is the main potential impact from construction operations. Dust during construction will be managed by a range of strategies as detailed in Section 14.9 and the EMP (refer Section 23).

14.5.3 Distance to Residences

The distance to the closest residential receptors and other sensitive locations are summarised in Table 14.7 and have been used in analysing the “hotspots” for residential receptors. The kerb of the proposed pedestrian and cycle path over the new Gateway Bridge (if approved) will be 3m from the kerb of the roadway, with 5m between the centres of the bike and road lanes. Each of these locations was modelled at an elevation of 1m relative to the road. The proposed bikeway location was only included for the modelled scenarios with the GUP.

Table 14.7 Minimum Distances from Residences and Schools to Kerb

Nearest Street or Locality	Chainage Reference	Approximate AMG Coordinates Used	Minimum Distance between Kerb and Receptor (metres)
Mt Petrie Primary School, Mt Petrie Rd	5200 to 5300	512100, 6953100	Approx 500
Mansfield Primary and High Schools, Sandringham St	5160	510750, 6953250	Approx 650
Weedon St West	5600 to 5700	511420, 6953150	60
Weedon St East	5600 to 5700	511570, 6953500	50
Christian Outreach College, Wecker Rd	6200 to 6300	511350, 6954250	Approx 500
Silky Oak Cr	6300 to 7000	511920, 6954500	25
Coventry Ct	7200 to 7400	512050, 6955000	25
Hereford Cr	7500 to 7700	512020, 6955280	50
Kenilworth Pl	7700 to 8000	512000, 6955650	170
Ridgeview St	8300 to 8700	512200, 6956200	30
Mt Petrie Rd	9300 to 9800	512300, 6955680	50
Old Cleveland Rd Exit	10000 to 10500	512100, 6957750	75
Cross St	10000 to 10500	512320, 6957850	90
Palm Lakes Tourist Park	10500 to 10900	512300, 6958350	15
Belmont Rd	10700 to 11000	512410, 6958480	35
Ambara St	11100 to 11500	512165, 6959000	25
Ambara St	11600 to 11700	512065, 6959200	30
Glenavon St	11700 to 12000	512010, 6959520	60
Helemon St	12000 to 12100	512000, 6959600	120
Brandella PL	12200 to 12500	511700, 6960000	45
Stanton Rd	12900 to 13000	511620, 6960400	140
Stanton Rd	13000 to 13300	511580, 6960750	120
Wynnum Rd	13500	511340, 6960900	80
Bikeway on Gateway Bridge 1	16000 to 16100	510450, 6963000	3
Bikeway on Gateway Bridge 2	16100 to 16300	510330, 6963190	3
Bikeway on Gateway Bridge 3	16700 to 16900	509980, 6963910	3
Bikeway on Gateway Bridge 4	16900 to 17000	509940, 6964000	3
Bikeway on Gateway Bridge 5	17000 to 17200	509870, 6964125	3
Bikeway on Gateway Bridge 6	17200 to 17300	509800, 6964250	3
Bikeway on Gateway Bridge 7	17300 to 17500	509740, 6964410	3
Bikeway on Gateway Bridge 8	17500 to 17800	509560, 6964750	3
Viola Pl industry south	19300 to 19500	509200, 6966200	150

Nearest Street or Locality	Chainage Reference	Approximate AMG Coordinates Used	Minimum Distance between Kerb and Receptor (metres)
Viola PI industry central	19600 to 19800	509220, 6966320	350
Viola PI industry north	19800 to 20000	509250, 6966750	500
Lomandra Dr north	20600 to 20900	508750, 6967500	260
Lomandra Dr south	20300 to 20600	509000, 6967250	400
Cassia PI Electrical Maintenance	20700 to 20900	508500, 6967500	160
Brisbane TAFE campus (cnr Kingsford Smith Dr and Woonah Av)	-	507920, 6965500	50
Auction house	-	508000, 6965750	50

14.5.4 Dispersion Modelling Methodology

To fully capture the air flows in the vicinity of the GUP, the Calpuff modelling system was used. This entails a meteorological processor, Calmet (Earth Tech 2000a), which simulates the three dimensional wind fields in the model domain. Localised “hotspots”, for example for receptors less than 200m from the road and for the additional queuing around the toll plazas have been modelled using the model CAL3QHCR, which is specifically tailored to model impacts due to roads and traffic congestion. The Calpuff dispersion model (Earth Tech 2000b) allows simulation of regional air quality impacts due to roads, which are modelled as line sources.

The Calmet model was setup over a grid 20km wide by 26km long, to capture the wind flows over the extent of the Gateway motorway route and important meteorological considerations such as the coastline of Morton Bay. Terrain and land use information at a 500m resolution were used in the modelling to represent the changing conditions in the model domain. Prognostic modelling was performed in TAPM (Hurley 2002) using 4 nests from 30km down to a 1km resolution covering the model domain, and centred on Brisbane Airport. The extracted data from TAPM were used as the “initial guess” field in Calmet to provide the model with synoptic influences from outside the model domain. Surface observation data from four sites in Brisbane (Brisbane Airport, Eagle Farm, Rocklea and Wynnum) and upper air data extracted from TAPM at Brisbane Airport were used for the year 2001, which is considered to be a representative year for the Brisbane region. The Calmet wind fields generated were checked for consistency.

Predicted air quality at receptors located closer to the road is represented by results from the CAL3QHCR model at “hotspot” sites of interest, and impacts are evaluated using the EPP (Air) guidelines. Results using the Calpuff model are reported for distances greater than 1 km from the road, and are evaluated using the NEPM guidelines for locations away from major roadways or industrial plants.

CAL3QHCR is a steady state plume dispersion model that is designed to simulate air quality close to roads and is a recommended USEPA screening model for a case-by-case basis where refined modelling is required. This model uses mixing height algorithms from ISCST2. Diurnal emissions profiles were entered (using the same profile for weekday and weekend traffic flows). The model calculated 1 hour, 8 hour, 24 hour and annual average concentrations at each receptor as appropriate.

Meteorological data (wind speed, direction, temperature, mixing height, stability class) calculated from the Calmet modelling was used for a location central to the modelling area. The site was modelled using the urban mixing height calculation option. A surface roughness of 0.5m was used for the modelling. This roughness was adopted as the average height of buildings and trees near the road is expected to be below 5m.

The Calpuff dispersion model was set up using the Calmet wind fields with a smaller model domain (10km wide by 26km long) and a nested model to 250m resolution. Each road segment was modelled as a line source, with the line source width equal to the width of the roads (assuming all lanes are 3.5m wide as specified in Chapter 3 of the EIS). The release height for all road sections was specified to be 5 m, with an average buoyancy parameter of $50\text{m}^4/\text{s}^3$ (Radonjic et al 2003).

Predicted ground level concentrations of NO_x obtained from the model were converted to NO_2 concentrations by assuming an oxidation ratio of 10% for the bike lane (less than 10m from road), 15 % for distances from 10m to 100m (Holmes 1997) and 30 % for distances of more than 100m. For evaluation of short-term (24-hour average) dust impacts, all particulate matter emitted from vehicles was assumed to be PM_{10} .

A correction factor of 1.82 has been applied to the conversion of 1 hour averages to 3 minute averages using the equation $C_t = C_{60}[60/t]^{0.2}$, where the exponent of 0.2 is appropriate for surface sources.

14.5.5 Greenhouse Gas Assessment Methodology

Australia is a signatory to the United Nations Framework Convention on Climate Change with commitments to monitor and report greenhouse gas emissions. These commitments are implemented through the National Greenhouse Strategy (NGS).

Pollutants of importance to greenhouse warming and associated with transport activities are water vapour (H_2O), nitrous oxide (N_2O), carbon dioxide (CO_2), ozone (O_3), chlorofluorocarbons (CFCs) and methane (CH_4). Indirect greenhouse gases such as carbon monoxide (CO), nitrogen oxides other than N_2O and non methane volatile organic compounds (NMVOCs) do not have a strong radiative forcing effect in themselves, but influence atmospheric concentrations of the direct greenhouse gases. Water vapour from human sources is negligible compared to natural cycles. Carbon dioxide is the primary greenhouse gas from anthropogenic sources.

The efficiency of a greenhouse gas is measured in terms of its global warming potential (GWP). Nitrous oxide, carbon dioxide and methane are significant greenhouse gases associated with transport activities. Carbon dioxide tends to remain active for a lifetime of around 150 years and has a GWP of one. Nitrous oxide has a lifetime of 120 years and a GWP of 310. Methane, emitted by motor vehicles and potentially generated from decaying vegetation cleared for the road, has a lifetime of 14.5 years and a GWP of 21 (AGO 2004a). These GWP factors have been used in the estimation of total CO_2 -equivalent ($\text{CO}_2\text{-e}$) greenhouse gas emissions.

Emission rates for CO_2 , CH_4 and N_2O were estimated for petrol and diesel vehicles from AGO (2004b), based on data for passenger vehicles manufactured after 1997 (as vehicles over 14 years old are less than 20% of the fleet) and the average of medium and heavy duty diesel trucks. The emission rates are independent of the grade of the road, mean vehicle speed and congestion effects. The NGGI (2004) notes that the proportion of nitrous oxide emissions from vehicles doubled from 2.7% in 1990 to 5.6% in 2002 due to the increasing proportion of passenger vehicles equipped with three way catalytic converters which produce more N_2O per unit of fuel used while decreasing overall air emissions.

The emission rates (gram of pollutant per vehicle kilometre travelled) were scaled by the number of vehicles per day and length of each road segment to yield a total annual emission rate of each pollutant. Total annual CO₂-e emissions of greenhouse gases were then compared for each scenario modelled.

14.6 Climatic Considerations

Consideration of the climate can reduce potential environmental impacts during the construction of the road and bridge. In terms of the climate the ideal months for construction are June to October when rainfall is the lowest. One of the key environmental issues associated with road works is erosion and sediment transport and by avoiding periods where rainfall is higher such impacts can be managed with less risk and effort. These drier months may promote dust nuisance, however management of dust requires less requirements than erosion and sediment control. In addition, dust nuisance is generally managed better as it visually affects construction staff and it also has less risk to impact the environment than erosion and sediment transport.

Dust nuisance can be managed by a water spray truck. Should the construction take place during the winter months, erosion and sediment control measures may not be as onerous/detailed as what would be required for construction during the summer months where more rainfall (quantity and intensity) falls. Should the construction fall over summer and winter months, two erosion and sediment control plans may be utilised.

Rainfall and evaporation vary throughout the year. Based on the climatic data, there is no time throughout the year where evaporation is less than the rainfall over the month. As a result revegetation is likely to require initial watering and be targeted to ensure hardy flora are utilised. Revegetation throughout winter may limit the impact of higher temperatures of summer on the revegetation. Should construction take place over the winter months revegetation should be staged along with the works to ensure it is established successfully.

14.7 Potential Air Quality Construction Impacts

TOR Requirements:

- Climatic conditions contribute risk of impacts to other environmental elements discussed in the EIS (eg wind speeds influence dust generation and therefore air quality, while rainfall influences erosion risk);
- Discuss impacts and mitigation measures related to climate in the sections of most relevance.
- Define the potential impacts of the project on the air environment to:
 - Describe the objectives and practical measures for protecting or enhancing air quality;
 - Describe how nominated quantitative standards and indicators may be achieved; and
 - How the achievement of the objectives will be monitored, audited and managed.
- State the objectives for air emissions with respect to relevant standards (ambient and ground level concentrations), emission guidelines, legislation and the emissions modelled using a recognised atmospheric dispersion model;
- Compare the predicted levels of emissions with the current national, State and local authority guidelines. The predictions should be made for both normal and expected maximum emission conditions and the worst case meteorological conditions should be identified and modelled where necessary. Ground level predictions should be made at any residential, industrial and agricultural developments believed to be sensitive to the effects of predicted emissions. The techniques used to obtain the predictions should be referenced and key assumptions and data sets explained; and
- Identify the potential impacts of, and intended measures to minimise, greenhouse gas emissions.

Potential air quality impacts during construction include airborne dust and exhaust fumes from the construction plants. Airborne dust would be generated from a number of sources including:

- clearing of vegetation and topsoil;
- excavation and transport of materials;
- loading and unloading of trucks;
- re-entrainment of deposited dust by vehicle movements; and
- wind erosion from stockpiles and unsealed roads.

High wind conditions would increase the emission rates of airborne dust from stockpiles and exposed areas, while reducing the concentration of vehicle fumes. During high wind conditions, particular attention should be paid to dust suppression.

Impacts of the construction compounds on air quality at residential locations would be expected to be small due to separation of over 1.5km to residential locations.

Dust generated by erosion from stockpiles requires sufficient wind speed over the stockpile surface to raise dust from the surface. Parrett (1992) notes that threshold friction velocities (at the material surface) of 0.15 to 0.3m/s are typically found for bulk materials, equating to a wind speed of 1.5 to 3m/s as measured at the standard 10m height.

A summary of wind speeds greater than 1.5m/s and greater than 3m/s as measured at the Eagle Farm site is presented in Table 14.8. Winds passing over a stockpile would direct emissions towards a given receptor location up to 9.8% of the time for 1.5m/s winds, and up to 3.9% of the time for winds over 3m/s. The larger particles will redeposit within a short distance of the stockpile, and so will not be emitted offsite.

Table 14.8 Percentage of 10m Level Winds over 1.5 and 3m/s for Each Direction Range for Eagle Farm (January 1997 to September 2003)

Wind Speed (m/s)	Wind Direction by Sector (Percentage)																Total
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
Over 1.5m/s	6.1	4.4	4.2	4.5	5.6	6.0	5.2	4.7	3.8	9.8	5.5	3.9	1.7	0.5	0.7	1.7	68.4
Over 3.0m/s	3.6	2.4	2.7	3.3	3.9	3.9	2.9	1.7	0.8	1.9	1.3	2.4	1.1	0.2	0.1	0.4	32.6

14.8 Potential Operational Air Quality Impacts

Air quality impacts have been modelled using the methodology presented in Section 14.5, and are presented separately for each section of the GUP.

The predicted impacts are also presented for each scenario considered:

- 2011 base case (without GUP);
- 2011 with GUP;
- 2021 base case (without GUP); and
- 2021 with GUP.

Detailed analysis of impacts for receptors close to the road are presented using CAL3HQCR, while regional impacts for receptor locations more than 1km from the GUP are presented using Calpuff.

14.8.1 Mt Gravatt – Capalaba Road to Cleveland Branch Rail Line

Local Impacts

The maximum concentrations for each pollutant predicted within the Mt Gravatt – Capalaba Road to Cleveland Branch Rail Line section are presented in Table 14.9, with details provided in Appendix J3. Highest concentrations are predicted at the sites closest to the road. The modelling results show that at these sites the most significant differences are NO₂ levels. These are predicted to increase at the close receptor locations with the GUP, while the CO levels are predicted to decrease. An increase in NO₂ levels is expected due to the greater traffic volume and the slightly closer proximity to the receptors due to the road expansion. The decrease in CO levels is due to the lower emission factors calculated as the proportion of heavy vehicles decreased with the GUP. All predicted concentrations are well below the relevant guidelines.

Table 14.9 Predicted Maximum Concentrations (µg/m³) for Various Pollutants for each Scenario (Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line)

Maximum at a receptor including background	NO ₂ 1 hour average	CO 8 hour average	PM ₁₀ 24 hour average	TSP annual average	Benzene annual average	1,3-butadiene 3 minute average	HC 1 hour average
2011 without GUP	157.8	4,733.8	44.5	44.0	8.7	13.9	1,532.2
2021 without GUP	92.7	3,192.5	41.6	43.1	8.1	12.0	1,315.7
2011 with GUP	176.9	4,906.3	48.3	45.4	9.1	14.2	1,559.5
2021 with GUP	101.6	3,438.8	45.1	44.3	9.2	14.4	1,585.2
Background	53	2,500	35	41	4.5	N/A	N/A
Guideline	320	10,000	150	90	16	1000	-

Regional Impacts

The predicted dispersion modelling results are presented in Table 14.10 for NO₂ (99.9th percentile 1 hour average and annual average) and Table 14.11 for PM₁₀ (maximum 24 hour average). Comparison with the NEPM guidelines for receptors more than 1km from the road shows that impacts of NO₂ and PM₁₀ are well below the NEPM guidelines for all scenarios. The predicted concentrations of PM₁₀ are heavily dominated by the background concentration used in the assessment.

The modelling scenarios show a clear decrease in predicted NO₂ concentrations from 2011 to 2021 with a smaller decrease for PM₁₀, reflecting the improvements in vehicle emissions. The small increases in predicted concentrations of NO₂ with the GUP for either 2011 or 2021 reflect the higher vehicle flows for these years, with lower vehicle speed in peak hour.

Table 14.10 Predicted Ground Level Concentrations of NO₂ for Mt Gravatt–Capalaba Road to Cleveland Branch Rail Line

Year Modelled	Base Case		With GUP	
	1 hr 99.9 th	Annual	1 hr 99.9 th	Annual
2011	96.7	3.4	107.8	4.0
2021	33.5	1.2	42.2	1.5
Background	53	23	53	23
2011 with Background	149.7	26.4	160.8	27.0
2021 with Background	86.5	24.2	95.2	24.5
NEPM Guideline	246	62	246	62

Table Note:

Concentrations of NO₂ (as 30% of NO_x emitted, µg/m³) including background at more than 1km from the road for each scenario modelled

Table 14.11 Predicted Ground Level Concentrations of PM₁₀ (µg/m³) for Mt Gravatt–Capalaba Road to Cleveland Branch Rail Line

Year Modelled	Base Case 24 hour maximum	With GUP 24 hour maximum
2011	3.4	4.4
2021	2.5	3.4
Background	35	35
2011 with Background	38.4	39.4
2021 with Background	37.5	38.4
NEPM Guideline	50	50

Table Note:

Concentrations of PM₁₀ include background at more than 1km from the road for each scenario modelled

14.8.2 Cleveland Branch Rail Line to Pinkenba Rail Line

Local Impacts

The maximum predicted concentrations at the receptors in the Cleveland Branch Rail Line to the Pinkenba Rail Line section are shown in Table 14.12, with detailed results presented in Appendix J3 (refer Table J9 for 2011 and Table J10 for 2021). The pedestrian and cycle path will only exist with the upgrade and has therefore only been included in the upgrade sections. The TAFE location is the only other receptor included in this road section. The concentrations predicted at this location are lower with the GUP. This is simply due to a lower volume of traffic on the existing Gateway Motorway. Predicted concentrations along the bikeway are highest due to the close proximity to the road as well as the steep grade over the Gateway Bridge which results in higher vehicle emissions. Concentrations are predicted to comply with the guidelines.

Table 14.12 Predicted Maximum Concentrations ($\mu\text{g}/\text{m}^3$) for Various Pollutants for each Scenario, Cleveland Branch Rail Line to Pinkenba Rail Line

Maximum at a receptor including background	NO ₂ 1 hour average	CO 8 hour average	PM ₁₀ 24 hour average	TSP annual average	Benzene annual average	1,3-butadiene 3 minute average	HC 1 hour average
2011 without GUP	152.0	4,538.8	38.6	42.0	6.4	10.0	1103.8
2021 without GUP	88.2	3,310.0	37.8	41.8	6.4	10.3	1,129.0
2011 with GUP	181.4	4,725	53.2	47.6	9.4	13.7	1,742.0
2021 with GUP	107.2	3,618.8	50.6	46.6	10.7	19.5	2,139.3
Background	53	2,500	35	41	4.5	N/A	N/A
Guideline	320	10,000	150	90	16	1000	-

Regional Impacts

The dispersion modelling results are presented in Table 14.13 for NO₂ (99.9th percentile 1 hour average and annual average) and Table 14.14 for PM₁₀ (maximum 24 hour average). Comparison with the NEPM guidelines for receptors more than 1km from the road shows that impacts of NO₂ and PM₁₀ are well below the NEPM guidelines for all scenarios. The predicted concentrations of PM₁₀ are heavily dominated by the background concentration used in the assessment.

As for the Mt Gravatt-Capalaba Road to Cleveland Branch Rail Line section, the modelling scenarios show the decreasing concentration of pollutants from 2011 to 2021. The scenarios with the GUP show slight increases over the base case without the GUP due to the increased vehicle flows. The NO₂ results show the most noticeable changes with the year modelled, and the scenario with or without the GUP.

Table 14.13 Predicted Ground Level Concentrations of NO₂ for Cleveland Branch Rail Line to Pinkenba Rail Line

Year Modelled	Base Case		With GUP	
	1 hr 99.9 th	Annual	1 hr 99.9 th	Annual
2011	88.7	3.6	97.4	3.9
2021	33.1	1.3	40.6	1.6
Background	53	23	53	23
2011 with Background	141.7	26.6	150.4	26.9
2021 with Background	86.1	24.3	93.6	24.6
NEPM Guideline	246	62	246	62

Table Note:

Concentrations of NO₂ (as 30% of NO_x emitted, $\mu\text{g}/\text{m}^3$) including background at more than 1km from the road for each scenario modelled

Table 14.14 Predicted Ground Level Concentrations of PM₁₀ (µg/m³) for Cleveland Branch Rail Line to Pinkenba Rail Line

Year Modelled	Base Case 24 hour maximum	With GUP 24 hour maximum
2011	2.6	3.4
2021	1.7	2.7
Background	35	35
2011 with Background	37.6	38.4
2021 with Background	36.7	37.7
NEPM Guideline	50	50

Table Note:

Concentrations of PM₁₀ include background at more than 1km from the road for each scenario modelled

14.8.3 Pinkenba Rail Line to Nudgee Road

Local Impacts

The predicted maximum concentrations at the receptors in the Pinkenba Rail Line to Nudgee Road section are presented in Table 14.15, with detailed results presented in Appendix J3. Concentrations at the Auction House are predicted to decrease due to the lower number of vehicles. Only NO₂ and some of the hydrocarbon concentrations are predicted to increase at the other receptors as the deviation is closer to these sites. All predicted concentrations are below the relevant guidelines.

Table 14.15 Predicted Maximum Concentrations (µg/m³) for Various Pollutants for each Scenario, Pinkenba Rail Line to Nudgee Road

Maximum at a receptor including background	NO ₂ 1 hour average	CO 8 hour average	PM ₁₀ 24 hour average	TSP annual average	Benzene annual average	1,3- butadiene 3 minute average	HC 1 hour average
2011 without GUP	118.6	4,456.3	39.9	43.1	8.3	10.5	1,155.2
2021 without GUP	74.1	3,265.0	38.8	42.6	8.3	10.5	1,157.0
2011 with GUP	130.5	3,495.0	39.1	42.8	6.6	5.9	653.5
2021 with GUP	85.7	2,986.3	38.4	42.5	7.1	7.3	796.8
Background	53	2,500	35	41	4.5	N/A	N/A
Guideline	320	10,000	150	90	16	1000	-

Regional Impacts

The predicted dispersion modelling results are presented in Table 14.16 for NO₂ (99.9th percentile 1 hour average and annual average) and Table 14.17 for PM₁₀ (maximum 24 hour average). The predicted impacts of NO₂ and PM₁₀ are well below the NEPM guidelines for all scenarios. The predicted concentrations of PM₁₀ are heavily dominated by the background concentration used in the assessment.

The northern section of the road, encompassing the deviation, shows a net improvement in predicted ground level concentrations of NO₂ and PM₁₀ with the GUP. The vehicle emissions are distributed between two separate roadways, resulting in improved impacts. The air impacts are predicted to improve with time due to reduced vehicle emissions.

Table 14.16 Predicted Ground Level Concentrations of NO₂ for Pinkenba Rail Line to Nudgee Road

Year Modelled	Base Case		With GUP	
	1 hr 99.9 th	Annual	1 hr 99.9 th	Annual
2011	71.3	2.5	60.3	2.7
2021	25.1	0.9	24.8	1.1
Background	53	23	53	23
2011 with Background	124.3	25.5	113.3	25.7
2021 with Background	78.1	23.9	77.8	24.1
NEPM Guideline	246	62	246	62

Table Note:

Concentrations of NO₂ as 30% of NO_x emitted, µg/m³) including background at more than 1km from the road for each scenario modelled

Table 14.17 Predicted Ground Level Concentrations of PM₁₀ (µg/m³) for Pinkenba Rail Line to Nudgee Road

Year Modelled	Base Case 24 hour maximum	With GUP 24 hour maximum
2011	1.9	2.1
2021	1.5	1.8
Background	35	35
2011 with Background	36.9	37.1
2021 with Background	36.5	36.8
NEPM Guideline	50	50

Table Note:

Concentrations of PM₁₀ include background at more than 1km from the road for each scenario modelled

14.8.4 Greenhouse Gas Impacts

Greenhouse gas impacts have been estimated for the GUP using the methodology presented in Section 14.5.5. Table 14.18 presents the total vehicles per day using the existing Gateway Motorway and proposed deviation for each scenario modelled. Comparisons of the estimated annual greenhouse gas emissions for the main greenhouse gases for each scenario are presented in Table 14.19 as CO₂-equivalent tonnes per year.

Table 14.18 Total Number of Vehicles and Vehicle Kilometres Travelled per Day for Each Scenario

Scenario	Total Vehicles per Day	Total Vehicle Kilometres Travelled per Day
2011 base case	854,179	2,162,428
2021 base case	986,628	2,487,367
2011 with GUP	840,268	2,165,017
2021 with GUP	1,038,061	2,654,253

Table 14.19 Estimated Emissions of Greenhouse Gases for Each Scenario

Scenario	Annual Emissions (t/yr CO ₂ -e)			Total Greenhouse Gas Emissions (t/yr CO ₂ -e)
	CO ₂	N ₂ O	CH ₄	
2011 base case	97,096	1,886	201	99,183
2021 base case	111,709	648	187	112,543
2011 with GUP	95,334	1,697	182	97,214
2021 with GUP	117,090	681	198	117,969

The greenhouse gas emissions due to vehicles are predicted to increase by 13% from 2011 to 2021 for the base case, and by 21% from 2011 to 2021 with the GUP. The AGO (2003) calculated greenhouse gas projections from the transport sector for the “business as usual” case, that resulted in an increase of 15% from 2010 to 2020. Thus, the predictions for the base case are comparable to national predictions from transport sources.

Compared to the base case (without the GUP), the greenhouse gas emissions for 2011 are predicted to be 2% lower with the GUP. For 2021, the greenhouse gas emissions with the GUP are predicted to be 5% higher, due to an increase of 5% in the total number of vehicles compared to the base case. The increase in vehicles using the Gateway Motorway as a result of the upgrade will result in a net reduction in vehicle use and greenhouse gas emissions for other parts of the Brisbane road network, however this benefit for the whole airshed has not been quantified.

Greenhouse gas impacts assessed are expected to be a conservative estimate. A voluntary target under the Environmental Strategy for the Motor Vehicle Industry is for an 18% reduction in fuel consumption for new passenger cars between 2001 and 2010 (AGO 2003), which is projected to reduce national greenhouse gas emissions by 1.0 Mt CO₂-e (1% of total emissions). By 2020, this reduction should amount to 2.9 Mt CO₂-e (2.8% of total national emissions). Additional measures undertaken by local and state governments (such as increasing natural gas or ethanol usage and encouraging alternative forms of transport) may reduce greenhouse emissions by a further 1.6% in 2010 and 2.5% in 2020. These reductions have not been incorporated into the emissions projections for this project.

14.9 Summary of Impacts

Local air quality impacts are predicted to improve for all short term air quality guidelines from 2011 to 2021, due to the reduced emissions from vehicles with tighter emissions standards in future years. The predicted annual average concentration of benzene is predicted to increase slightly over this time however the reduction in the benzene content of fuel for future years has not been included in the emissions. The introduction of the GUP is predicted to improve the air quality impacts for CO, however for the other pollutants studied the impacts close to the road at many locations will be higher with the GUP.

Regional impacts of NO₂ are predicted to decrease significantly from 2011 to 2021, particularly for short-term impacts. The inclusion of the GUP will result in increased NO₂ impacts for receptors between the bridge and the Pinkenba Rail Line, but north of the rail line the regional air quality is expected to improve with the GUP due to the separation of emissions along two distinct roads.

Regional impacts of PM₁₀ are expected to improve from 2011 to 2021 due to increasingly stringent vehicle emissions standards. The construction of the GUP will result in a slight increase in the predicted concentration of PM₁₀, particularly for receptors south of Cleveland Branch Rail Line.

The increases in predicted air quality impacts with the GUP are due largely to the increased number of vehicles that are expected to use the upgraded road. It is important to note that the overall regional benefits of the expected reduction in vehicle numbers and congestion on minor roads with the GUP have not been assessed in this modelling. This effect is more important for receptors that are some distance from the road.

This air quality assessment is therefore conservative in only considering the increase in traffic impacts due to the GUP, with no consideration of reduced impacts from other roads. Additionally, the background concentrations used in the air quality assessment already include the contribution of roads (including the existing Gateway Motorway) near each monitoring site, and thus would be over-estimated.

Greenhouse gas impacts are expected to increase over time from 2011 to 2021 for either the base case or with the GUP. This is due to the 13% increase in vehicles with for the base case or 21% increase with the GUP over the ten years. With the inclusion of the GUP, the greenhouse gas impacts will increase compared to the base case due to the additional vehicles using the upgraded road.

14.10 Mitigation Measures

To minimise the potential impact of the GUP on the local and regional airshed the following mitigation measures should be implemented:

Design

- Roadway, on ramps and off ramps to minimise steep slopes and maximise traffic speeds within safety and design criteria.

Construction

- Applying water by truck sprays on all exposed areas as required to minimise dust emissions;
- Restricting dust generating activities such as blasting or topsoil removal during high winds or during more stable conditions with winds blowing toward nearby residences;
- Avoiding spillages and prompt cleanup;
- Covering haul vehicles moving outside the construction site;
- Restricting speed of construction vehicles;
- Visually checking particulate emissions from diesel vehicles and regular maintenance;

- Monitor emissions from onsite concrete batching plants;
- Prohibit burning or incineration onsite; and
- Monitor dust at nearby residences and schools using real time dust monitoring equipment.

14.11 Conclusion

The overall impact of the GUP will result in a slight increase in air quality impacts for receptors close to the Gateway Motorway. The results presented in this report incorporate conservative assumptions on the background air quality at residential locations, and use conservative methodologies including the combined effects of slope and vehicle speed on vehicle emissions.

The overall improvements in the road network traffic flows (and resultant reduction in congestion) when the GUP is operational have not been quantified in this study, but would have most benefit for receptors that are some distance away from the Gateway Motorway.