# Air Quality Modelling for Proposed Legacy Way Toll Road Control Centre, RL 43.15 m

Prepared for

**Brisbane City Council**
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**FINAL**

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## Glossary

| Term | Definition |
|---|---|
| BCC | Brisbane City Council |
| °C | degrees Celsius |
| CO | Carbon monoxide |
| DERM | Department of Environment and Resource Management |
| m | metre |
| m/s | metres per second |
| $m^2$ | square metres |
| mg | milligram |
| $NO_2$ | Nitrogen dioxide |
| $NO_x$ | Oxides of nitrogen |
| PM | Particulate matter (fine dust) |
| $PM_{2.5}$ and $PM_{10}$ | Particulate matter less than 2.5 or 10 microns, respectively |
| $\mu g/m^3$ | micrograms per cubic metre |
| µm | microns |

## Executive Summary

*Katestone Environmental was commissioned by the Brisbane City Council (BCC) to quantify concentrations of air pollutants associated with the ventilation system of the Clem Jones Tunnel at the proposed Toll Road Control Centre for the Legacy Way Tunnel Project (The Legacy Way TCC), at Bowen Hills. A building with a height of 43.15m (RL) has been considered.*

*An air quality impact assessment study has been conducted to determine the likelihood of impact of the exhaust from the Clem7 northern ventilation outlet on the facade of the Legacy Way TCC and the affect of the Legacy Way TCC on plume dispersion of the Clem7 northern ventilation outlet.*

*The assessment has found that:*

- *The Legacy Way TCC was not found to adversely affect dispersion of the plume from the Clem7 Tunnel ventilation outlets, with concentrations predicted at existing receptors unlikely to change.*
- *Predicted ground-level concentrations of $NO_2$, CO and $PM_{10}$ comply with the Coordinator General's air quality goals across the modelling domain for the 2011 and 2021 model simulations*
- *The predicted annual average ground-level concentrations of $PM_{2.5}$ exceed the Coordinator General's air quality goal for all modelled scenarios; however this is due to the elevated background concentration of 8.4 $\mu g/m^3$, not due to the Legacy Way TCC, which is predicted to contribute less than 0.4% to the total predicted annual average concentrations*
- *Predicted concentrations of $NO_2$, CO and $PM_{10}$, and the predicted 24-hour average concentration of $PM_{2.5}$ comply with the Coordinator General's air quality goals at all heights on the proposed TCC building facade*

# 1. Introduction

In August 2005, the Coordinator General approved the construction and operation of the Clem7 Tunnel to link Kangaroo Point and Woolloongabba to Bowen Hills while bypassing Fortitude Valley and the CBD. Katestone Environmental was commissioned by the Brisbane City Council (BCC) to quantify concentrations of air pollutants associated with the ventilation system of the Clem7 Tunnel at the proposed Toll Road Control Centre for the Legacy Way Tunnel Project (The Legacy Way TCC), at Bowen Hills. The significance of air pollutant concentrations is to be assessed against the Coordinator General's air quality goals for the Clem7 Tunnel.

The proposed development site is on land on the northern side of O'Connell Terrace, between Sneyd Street and the Inner City Bypass; which adjoins the Clem7 northern ventilation outlet and TCC (Figure 1). The current concept design for the TCC is seven storeys high, with a maximum height of approximately 43.15 m AHD. However, this height is subject to change as the concept design is still being developed. This report considers a building with a maximum height of 43.15 m AHD.

This assessment has considered the likelihood of impact of the exhaust from the ventilation outlet on the facade of the Legacy Way TCC and the affect of the Legacy Way TCC on plume dispersion.

The ventilation design and emission rates of air pollutants from the ventilation outlets of the Clem7 Tunnel are unchanged from those presented in the supporting information provided by River City Motorways to the Coordinator General (Katestone Environmental, 2008). The dispersion model and meteorological model are unchanged from those presented in Katestone Environmental' Report to Brisbane City Council, "Clem Jones Tunnel Ventilation Outlet Air Quality Modelling Methodology, 2010".

## 2. Ambient air quality goals

The Coordinator General's Condition of Development, Schedule 3, Condition 17(f) specifies that:

"...

*(e) The ventilation system must be designed so that the system is capable of meeting...the appropriate NEPM goals for ambient air quality set out in Table 5."*

Table 5 of Schedule 3 of the Coordinator General's Condition of Development is reproduced in the Table 1 below and are the air quality goals used in this assessment.

**Table 1 Air quality goals specified by the Coordinator General for the Clem Jones Tunnel ventilation outlets**

| Pollutant | Goal | Unit | Measuring Period |
|---|---|---|---|
| Carbon monoxide (CO) | 8<br>or 10 | ppm<br>mg/m³ | 8-hour maximum* |
| Nitrogen dioxide ($NO_2$) | 0.12<br>or 245 | ppm<br>µg/m³ | 1-hour maximum |
| Particulate matter less than 10 µm ($PM_{10}$) | 50<br>50 | µg/m³<br>µg/m³ | 24-hour maximum**<br>Annual mean |
| Particulate matter less than 2.5 µm ($PM_{2.5}$) | 25<br>8 | µg/m³<br>µg/m³ | 24-hour maximum<br>Annual mean |
| Total suspended particulate matter (TSP) | 90 | µg/m³ | Annual mean |

Note *Allowable exceedances, one day per year
**Five days per year allowable exceedence, not including exceedence in ambient goals due to external events (e.g. dust storms, fires, major construction works)

# 3. Background air quality

The existing air quality at sensitive receptor locations, such as houses or schools, will depend on the proximity to major roads and industry. For receptors close to the major roads, vehicle emissions will be the primary source of air pollution. Air quality at locations more than 500 metres from major existing roads will be dominated by background urban pollution sources and any local industrial emissions.

In order to estimate background levels of relevant pollutants, data from the Department of Environment and Resource Management (DERM) monitoring sites at South Brisbane, Rocklea and Woolloongabba have been analysed for 2010. These results are summarised in Table 2.

**Table 2 Ambient air quality monitoring data for various traffic pollutants (µg/m³)**

| Pollutant | Averaging period | Monitoring station | | |
|---|---|---|---|---|
| | | South Brisbane | Rocklea[1] | Woolloongabba |
| Nitrogen oxides | 1-hour (95th percentile) | - | - | - |
| Nitrogen dioxide | 1-hour (95th percentile) | - | 57.5 | - |
| Carbon monoxide | 8-hour (95th percentile) | - | - | 1,625[1] |
| $PM_{10}$ | 24-hour (95th percentile) | - | 25.3 | - |
| | Annual | - | 19.3[3] | - |
| $PM_{2.5}$ | 24-hour (95th percentile) | - | 13.6 | - |
| | Annual | 6.9[2] | 8.2 | 8.4[2] |

Note: [1] Data sourced from "Queensland 2010 air monitoring report", DERM
[2] Data sourced from "Air Quality Bulletin South-East Queensland, December 2010", DERM
[3] Data sourced from Katestone Environmental 2010 based on 2008 data, as annual $PM_{10}$ is not reported in sources 1 and 2.

For this study, the maximum concentration of each pollutant from the three monitoring stations has been used as a background level for the impact assessment as indicated in Table 3. This is a conservative method as data from all of the monitoring sites will contain varying degrees of emissions from local anthropogenic sources and, consequently, this method will provide an overestimate of background levels.

**Table 3 Background levels of ambient air quality for various traffic pollutants**

| Pollutant | Averaging period | Background level (µg/m³) |
|---|---|---|
| Nitrogen dioxide | 1-hour (95th percentile) | 57.5 |
| Carbon monoxide | 8-hour (95th percentile) | 1625 |
| $PM_{10}$ | 24-hour (95th percentile) | 25.3 |
| | Annual | 19.3 |
| $PM_{2.5}$ | 24-hour (95th percentile) | 13.6 |
| | Annual | 8.4 |

# 4. Modelling methodology

A multi-stage approach was used to generate the meteorological data fields. The prognostic model TAPM (developed by CSIRO, version 4) was used to generate wind information for 2008. The results from TAPM were used in conjunction with site specific meteorological data to develop a three-dimension wind field representing wind flows in the region using the diagnostic meteorological model CALMET (developed by EarthTec, version 6.326). Data for 2008 from DERM monitoring sites at Rocklea and South Brisbane were used for data assimilation in both the TAPM and CALMET models.

The dispersion model CALPUFF (developed by EarthTec, version 6.263) was used in the assessment to estimate concentrations of air pollutants emitted by the ventilation system of the Clem7 Tunnel. The two ventilation outlets were modelled as point sources. Details of model configuration are presented in Katestone Environmental, 2010.

The modelling exercise has limitations as the distance between the Legacy Way TCC and the Clem7 northern ventilation outlet is less than the 100m resolution of the Calpuff model used. To provide better optimisation of impacts, wind tunnel modelling would be required.

## 4.1 Ventilation outlet configuration

The ventilation outlet configurations for the Clem7 Tunnel are summarised in Table 4 and are the same as those presented in supporting information submitted by River City Motorways to the Coordinator General (Katestone Environmental, 2008). Discharge velocities from these outlets vary over time and the values used in this study are summarised in Table 5 and Table 6.

**Table 4 Ventilation outlet configurations for the Clem Jones Tunnel**

| Parameter | North Vent | South Vent |
|---|---|---|
| Stack locations | 503.046 6963.871 | 503.570 6959.298 |
| Outlet height | 46.0 m AHD | 51.7 m AHD |
| Discharge velocity | 5.4 m/s – 8.2 m/s | 5.4 m/s – 8.2 m/s |
| Discharge area | 46.3 $m^2$ | 46.3 $m^2$ |
| *Ground level is 11.16 m AHD at the north vent, and 9.87 m AHD at the south vent, so these heights correspond to 34.8 m and 41.8 m above ground, respectively. | | |

## 4.2 Emissions

Two scenarios were assessed to give an overview of the potential effect of the project:

- 2011 - the intended year for tunnel opening
- 2021 - ten years after intended year for tunnel opening

The emission rates of air pollutants from the ventilation outlets have been calculated for conditions that are representative of normal operations determined by Maunsell Parsons Brinckerhoff Design Joint Venture as detailed in Katestone Environmental (2008). These emission rates were based on PIARC emission tables (PIARC, 1995), which reflect the improvement in efficiency and reduction in pollutants emitted from vehicles over time as the Australian Design Rules are implemented.

Traffic flow, ventilation outlet discharge velocity and air pollutant emission rates used in this study are summarised in Table 5 and Table 6.

**Table 5 Traffic flow, ventilation outlet discharge velocity and air pollutant emission rates for 2011 for the Clem Jones Tunnel ventilation system**

| Hour of Day | North Ventilation Outlet | | | | | South Ventilation Outlet | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VPH | Velocity (m/s) | CO (g/s) | $NO_x$ (g/s) | $PM_{10}$ (g/s) | VPH | Velocity (m/s) | CO (g/s) | $NO_x$ (g/s) | $PM_{10}$ (g/s) |
| 1 | 321 | 5.40 | 2.0 | 0.32 | 0.011 | 273 | 5.4 | 1.6 | 0.28 | 0.010 |
| 2 | 201 | 5.40 | 1.2 | 0.20 | 0.007 | 171 | 5.4 | 1.0 | 0.17 | 0.006 |
| 3 | 165 | 5.40 | 1.0 | 0.17 | 0.006 | 140 | 5.4 | 0.8 | 0.14 | 0.005 |
| 4 | 180 | 5.40 | 1.1 | 0.18 | 0.006 | 153 | 5.4 | 0.9 | 0.16 | 0.006 |
| 5 | 337 | 5.40 | 2.1 | 0.34 | 0.012 | 327 | 5.4 | 2.0 | 0.33 | 0.012 |
| 6 | 1133 | 5.40 | 6.9 | 1.14 | 0.039 | 962 | 5.4 | 5.8 | 0.98 | 0.036 |
| 7 | 3340 | 6.77 | 20.0 | 3.40 | 0.119 | 2837 | 6.5 | 16.5 | 2.89 | 0.110 |
| 8 | 3840 | 7.46 | 23.0 | 3.91 | 0.137 | 3262 | 7.2 | 19.0 | 3.32 | 0.126 |
| 9 | 3840 | 7.46 | 23.0 | 3.91 | 0.137 | 3262 | 7.2 | 19.0 | 3.32 | 0.126 |
| 10 | 3144 | 6.50 | 18.8 | 3.20 | 0.112 | 2671 | 6.3 | 15.5 | 2.72 | 0.103 |
| 11 | 2613 | 5.88 | 15.9 | 2.62 | 0.089 | 2220 | 5.7 | 13.3 | 2.25 | 0.084 |
| 12 | 2530 | 5.77 | 15.4 | 2.54 | 0.086 | 2149 | 5.6 | 12.9 | 2.18 | 0.081 |
| 13 | 2507 | 5.73 | 15.3 | 2.52 | 0.086 | 2261 | 5.7 | 13.5 | 2.30 | 0.085 |
| 14 | 2533 | 5.77 | 15.4 | 2.54 | 0.086 | 2286 | 5.8 | 13.7 | 2.32 | 0.086 |
| 15 | 2825 | 6.19 | 17.2 | 2.84 | 0.096 | 2548 | 6.2 | 15.3 | 2.59 | 0.096 |
| 16 | 3492 | 6.98 | 20.9 | 3.55 | 0.125 | 3150 | 7.0 | 18.3 | 3.21 | 0.122 |
| 17 | 3726 | 7.31 | 22.3 | 3.79 | 0.133 | 3361 | 7.3 | 19.5 | 3.43 | 0.130 |
| 18 | 3726 | 7.31 | 22.3 | 3.79 | 0.133 | 3361 | 7.3 | 19.5 | 3.43 | 0.130 |
| 19 | 3378 | 6.83 | 20.2 | 3.44 | 0.121 | 3047 | 6.8 | 17.7 | 3.11 | 0.118 |
| 20 | 1819 | 5.40 | 11.1 | 1.83 | 0.062 | 1640 | 5.4 | 9.8 | 1.67 | 0.062 |
| 21 | 1377 | 5.40 | 8.4 | 1.38 | 0.047 | 1242 | 5.4 | 7.4 | 1.26 | 0.047 |
| 22 | 1286 | 5.40 | 7.8 | 1.29 | 0.044 | 1160 | 5.4 | 6.9 | 1.18 | 0.044 |
| 23 | 1033 | 5.40 | 6.3 | 1.04 | 0.035 | 932 | 5.4 | 5.6 | 0.95 | 0.035 |
| 24 | 683 | 5.40 | 4.2 | 0.69 | 0.023 | 616 | 5.4 | 3.7 | 0.63 | 0.023 |
| Total | 50,029 | - | 1086[1] | 182.2[1] | 6.32[1] | 44,031 | - | 933.8[1] | 161.3[1] | 6.06[1] |
| Note | [1]Total peak daily emission rate in kg. | | | | | | | | | |

**Table 6 Traffic flow, ventilation outlet discharge velocity and air pollutant emission rates for 2021 for the Clem Jones Tunnel ventilation system**

| Hour of Day | North Ventilation Outlet | | | | | South Ventilation Outlet | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | VPH | Velocity (m/s) | CO (g/s) | $NO_x$ (g/s) | $PM_{10}$ (g/s) | VPH | Velocity (m/s) | CO (g/s) | $NO_x$ (g/s) | $PM_{10}$ (g/s) |
| 1 | 423 | 5.4 | 1.1 | 0.17 | 0.010 | 367 | 5.4 | 0.9 | 0.15 | 0.009 |
| 2 | 265 | 5.4 | 0.7 | 0.11 | 0.006 | 230 | 5.4 | 0.6 | 0.09 | 0.006 |
| 3 | 217 | 5.4 | 0.5 | 0.09 | 0.005 | 188 | 5.4 | 0.5 | 0.08 | 0.005 |
| 4 | 237 | 5.4 | 0.6 | 0.10 | 0.005 | 205 | 5.4 | 0.5 | 0.08 | 0.005 |
| 5 | 444 | 5.4 | 1.1 | 0.18 | 0.010 | 385 | 5.4 | 0.9 | 0.16 | 0.010 |
| 6 | 1822 | 5.4 | 4.6 | 0.73 | 0.042 | 1581 | 5.4 | 3.9 | 0.64 | 0.040 |
| 7 | 4167 | 7.9 | 10.2 | 1.70 | 0.100 | 3618 | 7.7 | 8.6 | 1.47 | 0.093 |
| 8 | 4401 | 8.2 | 10.8 | 1.79 | 0.105 | 3821 | 8.0 | 9.1 | 1.55 | 0.147 |
| 9 | 4401 | 8.2 | 10.8 | 1.79 | 0.105 | 3821 | 8.0 | 9.1 | 1.55 | 0.147 |
| 10 | 3961 | 7.6 | 9.7 | 1.61 | 0.095 | 3439 | 7.4 | 8.2 | 1.39 | 0.132 |
| 11 | 3532 | 7.2 | 8.8 | 1.42 | 0.081 | 3066 | 7.0 | 7.5 | 1.24 | 0.115 |
| 12 | 3371 | 7.0 | 8.4 | 1.35 | 0.077 | 2927 | 6.8 | 7.2 | 1.18 | 0.110 |
| 13 | 3406 | 7.0 | 8.5 | 1.37 | 0.078 | 3038 | 7.0 | 7.4 | 1.23 | 0.114 |
| 14 | 3464 | 7.1 | 8.7 | 1.39 | 0.079 | 3090 | 7.0 | 7.5 | 1.25 | 0.116 |
| 15 | 3878 | 7.7 | 9.7 | 1.56 | 0.089 | 3441 | 7.6 | 8.5 | 1.40 | 0.130 |
| 16 | 4342 | 8.2 | 10.6 | 1.77 | 0.104 | 3873 | 8.1 | 9.2 | 1.57 | 0.149 |
| 17 | 4342 | 8.2 | 10.6 | 1.77 | 0.104 | 3873 | 8.1 | 9.2 | 1.57 | 0.149 |
| 18 | 4342 | 8.2 | 10.6 | 1.77 | 0.104 | 3873 | 8.1 | 9.2 | 1.57 | 0.149 |
| 19 | 4233 | 8.0 | 10.4 | 1.72 | 0.101 | 3776 | 7.9 | 9.0 | 1.53 | 0.145 |
| 20 | 2693 | 6.0 | 6.7 | 1.08 | 0.062 | 2402 | 5.9 | 5.9 | 0.97 | 0.090 |
| 21 | 1962 | 5.4 | 4.9 | 0.79 | 0.045 | 1750 | 5.4 | 4.3 | 0.71 | 0.066 |
| 22 | 1732 | 5.4 | 4.3 | 0.70 | 0.040 | 1545 | 5.4 | 3.8 | 0.62 | 0.058 |
| 23 | 1384 | 5.4 | 3.5 | 0.56 | 0.032 | 1235 | 5.4 | 3.0 | 0.50 | 0.046 |
| 24 | 915 | 5.4 | 2.3 | 0.37 | 0.021 | 817 | 5.4 | 2.0 | 0.33 | 0.031 |
| Total | 63,934 | - | 569.5[1] | 93.1[1] | 5.40[1] | 56,360 | - | 488.1[1] | 82.2[1] | 7.41[1] |
| Note | [1]Total peak daily emission rate in kg. | | | | | | | | | |

For this assessment, concentrations of $PM_{2.5}$ have been calculated from $PM_{10}$ assuming that 70% of $PM_{10}$ is in the form of $PM_{2.5}$. This is consistent with the air quality assessment of the EIS air quality study (Holmes Air Sciences, 2004) and is based on monitoring of road tunnel emissions in Melbourne. Monitoring data from the M5 tunnel in Sydney shows a much lower ratio of $PM_{2.5}$ to $PM_{10}$ of 35% and data from the Rocklea monitoring station in 2008 shows a ratio of approximately 33%, and so the use of a 70% ratio is conservative.

$NO_2$ is the component of the oxides of nitrogen ($NO_x$) that is considered due to its health impacts. Concentrations of $NO_2$ measured close to busy metropolitan roads such as Ipswich Road at Woolloongabba and the Ipswich Motorway at Goodna show that the percentage of $NO_2$ to $NO_x$ in the air is inversely proportional to the distance from the emission source. Lower ratios are observed closer to the emission source and higher ratios are observed at greater distances. At locations close to roads, it is likely that the ratio is approximately 20% (Holmes Air Sciences, 2004). Therefore this percentage of $NO_2$ to $NO_x$ has been used in this study to determine concentrations of $NO_2$.

## 4.3 Development details

The Legacy Way TCC is proposed to be built on land located on the northern side of O'Connell Terrace, between Sneyd Street and the Inner City Bypass. The building has two tiers; the first is proposed to be seven storeys in height while the second tier (the plant room) is a single story, located at the roof level of the main (7 storey) building. Details of the proposed building have been taken from the preliminary plans supplied by Brisbane City Council (Figure 2). Air pollutant concentrations have been predicted at various heights on the building facade nearest the Clem7 northern ventilation outlet, and directly above the building, as described in Section 4.4.

## 4.4 Discrete receptor locations

Locations at various positions on the facade of the proposed building facing the Clem7 northern ventilation outlet have been incorporated into the model as discrete receptors, as detailed in Figure 3. Each location was modelled at heights of 13.5 m, 23.5 m, 33.5 m and 43.5 m AHD to determine the potential impact of the Clem7 Tunnel ventilation system on the building facade.

## 4.5 Building downwash

Building downwash effects are important for stacks that are short or relatively close to buildings. The aerodynamic wake caused as air passes over the building can entrain the stack plume. Building downwash effects were included in the modelling and were derived using the BPIP (Building Profile Input Program) building downwash program for the stack sources. Modelling of the ventilation outlet emissions using the buoyant point sources algorithm incorporates wake effects for these sources. The locations of sources incorporated into the modelling are described in Table 4 and buildings included in the modelling are presented in Table 7. The Legacy Way TCC was separated into two tiers to account for the differences in the floor area of the plant room and the seven floors of the building.

**Table 7 Building information included in the building wakes modelling**

| Building name | Building or tier height (m AHD) | Maximum building length (metres) | Maximum building width (metres) |
|---|---|---|---|
| North Ventilation Outlet Building | 42.1 | 20 | 34.9 |
| Legacy Way TCC Tier 1 | 40.15 | 59 | 16 |
| Legacy Way TCC Tier 2 | 43.15 | 30 | 16 |

# 5. Assessment of air quality impacts

The results presented below are based on the maximum concentration of each pollutant that is predicted at the receptors over the one-year period. The results therefore represent the worst-case scenario. It is important to note that the contour plots are constructed such that the maximum value is obtained and stored at each point in the modelling domain. As these maximum values may occur at different times for receptors at different locations, these figures do not represent a single snapshot of conditions at any given time. The results presented also include a background level of each pollutant expected for the region.

## 5.1 Effects on building downwash

To establish the possible effect of the proposed building on the dispersion of the plume from the northern ventilation stack, predicted concentrations of pollutants from dispersion modelling with and without the proposed building are compared. Impacts have been considered for residential developments, The Mews and Tufton Street as well as the Royal Brisbane Hospital, which are located in close proximity to the Clem7 northern ventilation outlet.

Although the predicted concentrations at The Mews change slightly due to the proposed building, concentrations of CO, $NO_2$ and particulate matter as $PM_{10}$ at the three receptors are still well below the Coordinator General's air quality goals. Particulate matter as $PM_{2.5}$ exceeds the Coordinator General's air quality goal; however, this is due to the background air quality. The proposed building has a minimal (less than 0.4%) effect on the concentration of $PM_{2.5}$.

Table 8 shows the maximum concentrations of air pollutants predicted to occur at Tufton Street with and without the Legacy Way TCC.

**Table 8 Effect of the Legacy Way TCC on the predicted maximum concentrations of air pollutants due to the northern ventilation stack at Tufton Street for 2011. Concentrations include a background concentration**

| Pollutant | Averaging period | Maximum concentrations (µg/m$^3$) at elevated locations (m AHD) | | | | | Goal (µg/m$^3$) |
|---|---|---|---|---|---|---|---|
| | | 14.6 | 24.6 | 34.6 | 44.6 | 54.6 | |
| **Without Legacy Way TCC** | | | | | | | |
| CO | 8-hour | 2001 | 2011 | 2134 | 2413 | 2781 | 10,000 |
| $NO_2$ | 1-hour | 109 | 111 | 116 | 143 | 223 | 245 |
| $PM_{10}$ | 24-hour | 26 | 26 | 27 | 28 | 28 | 50 |
| | Annual | 19 | 19 | 19 | 19 | 19 | 50 |
| $PM_{2.5}$ | 24-hour | 14 | 14 | 15 | 15 | 16 | 25 |
| | Annual | 8.4 | 8.4 | 8.5 | 8.5 | 8.5 | 8 |
| **With Legacy Way TCC** | | | | | | | |
| CO | 8-hour | 2001 | 2011 | 2134 | 2413 | 2781 | 10,000 |
| $NO_2$ | 1-hour | 109 | 111 | 116 | 143 | 223 | 245 |
| $PM_{10}$ | 24-hour | 26 | 26 | 27 | 28 | 28 | 50 |
| | Annual | 19 | 19 | 19 | 19 | 19 | 50 |
| $PM_{2.5}$ | 24-hour | 14 | 14 | 15 | 15 | 16 | 25 |
| | Annual | 8.4 | 8.4 | 8.5 | 8.5 | 8.5 | 8 |

Note: Ground level at Tufton Street corresponds to 14.6 m AHD, therefore these heights correspond to 0m, 10m, 20m, 30m and 40m above ground level.

Table 9 shows the maximum concentrations of air pollutants predicted to occur at The Mews with and without the proposed building.

**Table 9 Effect of the Legacy Way TCC on the predicted maximum concentrations of air pollutants due to the northern ventilation stack at the Mews for 2011. Concentrations include a background concentration**

| Pollutant | Averaging period | Maximum concentrations (µg/m$^3$) at elevated locations (m AHD) | | | | | Goal (µg/m$^3$) |
|---|---|---|---|---|---|---|---|
| | | 14.2 | 24.2 | 34.2 | 44.2 | 54.2 | |
| **Without Legacy Way TCC** | | | | | | | |
| CO | 8-hour | 1981 | 2047 | 2306 | 2848 | 3228 | 10,000 |
| $NO_2$ | 1-hour | 77 | 78 | 91 | 144 | 187 | 245 |
| $PM_{10}$ | 24-hour | 26 | 27 | 28 | 29 | 30 | 50 |
| | Annual | 19 | 19 | 20 | 20 | 20 | 50 |
| $PM_{2.5}$ | 24-hour | 14 | 15 | 15 | 16 | 17 | 25 |
| | Annual | 8.5 | 8.5 | 8.6 | 8.7 | 8.8 | 8 |
| **With Legacy Way TCC** | | | | | | | |
| CO | 8-hour | 1982 | 2048 | 2306 | 2844 | 3213 | 10,000 |
| $NO_2$ | 1-hour | 77 | 78 | 91 | 144 | 187 | 245 |
| $PM_{10}$ | 24-hour | 26 | 27 | 28 | 29 | 30 | 50 |
| | Annual | 19 | 19 | 20 | 20 | 20 | 50 |
| $PM_{2.5}$ | 24-hour | 14 | 15 | 15 | 16 | 17 | 25 |
| | Annual | 8.5 | 8.5 | 8.6 | 8.7 | 8.8 | 8 |

Note: Ground level at the Mews corresponds to 14.2 m AHD, therefore these heights correspond to 0m, 10m, 20m, 30m and 40m above ground level.

Table 12 shows the maximum concentrations of air pollutants predicted to occur at the Royal Brisbane Hospital with and without the proposed building.

**Table 10 Effect of the Legacy Way TCC on the predicted maximum concentrations of air pollutants due to the northern ventilation stack at the Royal Brisbane Hospital for 2011. Concentrations include a background concentration**

| Pollutant | Averaging period | Maximum concentrations (µg/m$^3$) at 107.3 m AHD | | Goal (µg/m$^3$) |
|---|---|---|---|---|
| | | Without building | With building | |
| CO | 8-hour | 1994 | 1994 | 10,000 |
| $NO_2$ | 1-hour | 72 | 72 | 245 |
| $PM_{10}$ | 24-hour | 26 | 26 | 50 |
| | Annual | 19 | 19 | 50 |
| $PM_{2.5}$ | 24-hour | 14 | 14 | 25 |
| | Annual | 8.5 | 8.5 | 8 |

Note: Ground level at the Royal Brisbane Hospital corresponds to 17.3 m AHD, therefore this height corresponds to 80m above ground level.

## 5.2 Regional impacts

Table 11 shows the maximum ground-level concentration of air pollutants predicted to occur across the modelling domain for the two planning scenarios in 2011 and 2021 and compared with the Coordinator General's air quality goals. The modelling domain is a 4km by 8km area, centred at Easting 503000 m, Northing 6962000 m, in UTM Zone 56 S. The results include the increment due to the Clem7 ventilation outlets and the background concentrations as listed in Section 3. The maximum predicted concentrations of pollutants in all modelled scenarios are well below the Coordinator General's air quality goals. Figure 4 and Figure 5 present the ground-level concentrations of $NO_2$ predicted to occur for 2011 and 2021, respectively.

**Table 11 Predicted maximum ground level concentrations of air pollutants due to the Clem7 Tunnel plus background**

| Pollutant | Averaging period | Maximum concentration at ground level | | Goal (µg/m$^3$) |
|---|---|---|---|---|
| | | 2011 | 2021 | |
| CO | 8-hour | 2154 | 1914 | 10,000 |
| $NO_2$ | 1-hour | 117 | 86 | 245 |
| $PM_{10}$ | 24-hour | 27 | 26 | 50 |
| | Annual | 20 | 19 | 50 |
| $PM_{2.5}$ | 24-hour | 15 | 14 | 25 |
| | Annual | 8.6 | 8.5 | 8 |

## 5.3 Site-specific impacts

Results of the dispersion modelling at various heights above ground level on the facade of the Legacy Way TCC are presented alongside the Coordinator General's air quality goals in Tables 12 and 13 for 2011 and 2021. These results include the predicted increment due to the Clem7 ventilation outlets and the background concentrations of air pollutants listed in Section 3.

**Table 12 Predicted maximum concentrations of air pollutants for the Legacy Way TCC for 2011 including background levels**

| Pollutant | Averaging period | Maximum concentrations (µg/m$^3$) at elevated locations (m, AHD) | | | | Goal (µg/m$^3$) |
|---|---|---|---|---|---|---|
| | | 13.5 | 23.5 | 33.5 | 43.5 | |
| CO | 8-hour | 1707 | 1715 | 1743 | 1791 | 10,000 |
| $NO_2$ | 1-hour | 69 | 70 | 73 | 78 | 245 |
| $PM_{10}$ | 24-hour | 25 | 25 | 26 | 26 | 50 |
| | Annual | 19.3 | 19.3 | 19.3 | 19.3 | 50 |
| $PM_{2.5}$ | 24-hour | 14 | 14 | 14 | 14 | 25 |
| | Annual | 8.4 | 8.4 | 8.4 | 8.4 | 8 |

Note: Ground level at the Legacy Way TCC site corresponds to 13.5 m AHD, therefore these heights correspond to 0m, 10m, 20m and 30m above ground level.

**Table 13 Predicted maximum concentrations of air pollutants for the Legacy Way TCC for 2021 including background levels**

| Pollutant | Averaging period | Maximum concentrations (µg/m$^3$) at elevated locations (m, AHD) | | | | Goal (µg/m$^3$) |
|---|---|---|---|---|---|---|
| | | 13.5 | 23.5 | 33.5 | 43.5 | |
| CO | 8-hour | 1657 | 1658 | 1666 | 1702 | 10,000 |
| $NO_2$ | 1-hour | 63 | 64 | 65 | 67 | 245 |
| $PM_{10}$ | 24-hour | 25 | 25 | 25 | 26 | 50 |
| | Annual | 19.3 | 19.3 | 19.3 | 19.3 | 50 |
| $PM_{2.5}$ | 24-hour | 14 | 14 | 14 | 14 | 25 |
| | Annual | 8.4 | 8.4 | 8.4 | 8.4 | 8 |

Note: Ground level at the Legacy Way TCC site corresponds to 13.5 m AHD, therefore these heights correspond to 0m, 10m, 20m and 30m above ground level.

The results show that concentrations of CO, $NO_2$ and $PM_{10}$ and 24-hour $PM_{2.5}$ are well below the Coordinator General's air quality goals for all modelled scenarios. Annual concentrations of $PM_{2.5}$ are above the Coordinator General's air quality goal; however, this is due to the elevated background concentration of 8.4 $\mu g/m^3$. The contribution from the Legacy Way TCC is minimal (less than 0.4%).

# 6. Conclusions

An air quality impact assessment study has been conducted to determine the likelihood of impact of the exhaust from the Clem7 northern ventilation outlet on the facade of the Legacy Way TCC and the affect of the Legacy Way TCC on plume dispersion of the Clem7 northern ventilation outlet.

The assessment has found that:

- The Legacy Way TCC was not found to adversely affect dispersion of the plume from the Clem7 Tunnel ventilation outlets, with concentrations predicted at existing receptors unlikely to change.
- Predicted ground-level concentrations of $NO_2$, CO and $PM_{10}$ comply with the Coordinator General's air quality goals across the modelling domain for the 2011 and 2021 model simulations
- The predicted annual average ground-level concentrations of $PM_{2.5}$ exceed the Coordinator General's air quality goal for all modelled scenarios; however this is due to the elevated background concentration of 8.4 $\mu g/m^3$, not due to the Legacy Way TCC, which is predicted to contribute less than 0.4% to the total predicted annual average concentrations
- Predicted concentrations of $NO_2$, CO and $PM_{10}$, and the predicted 24-hour average concentration of $PM_{2.5}$ comply with the Coordinator General's air quality goals at all heights on the proposed TCC building facade

# 7. References


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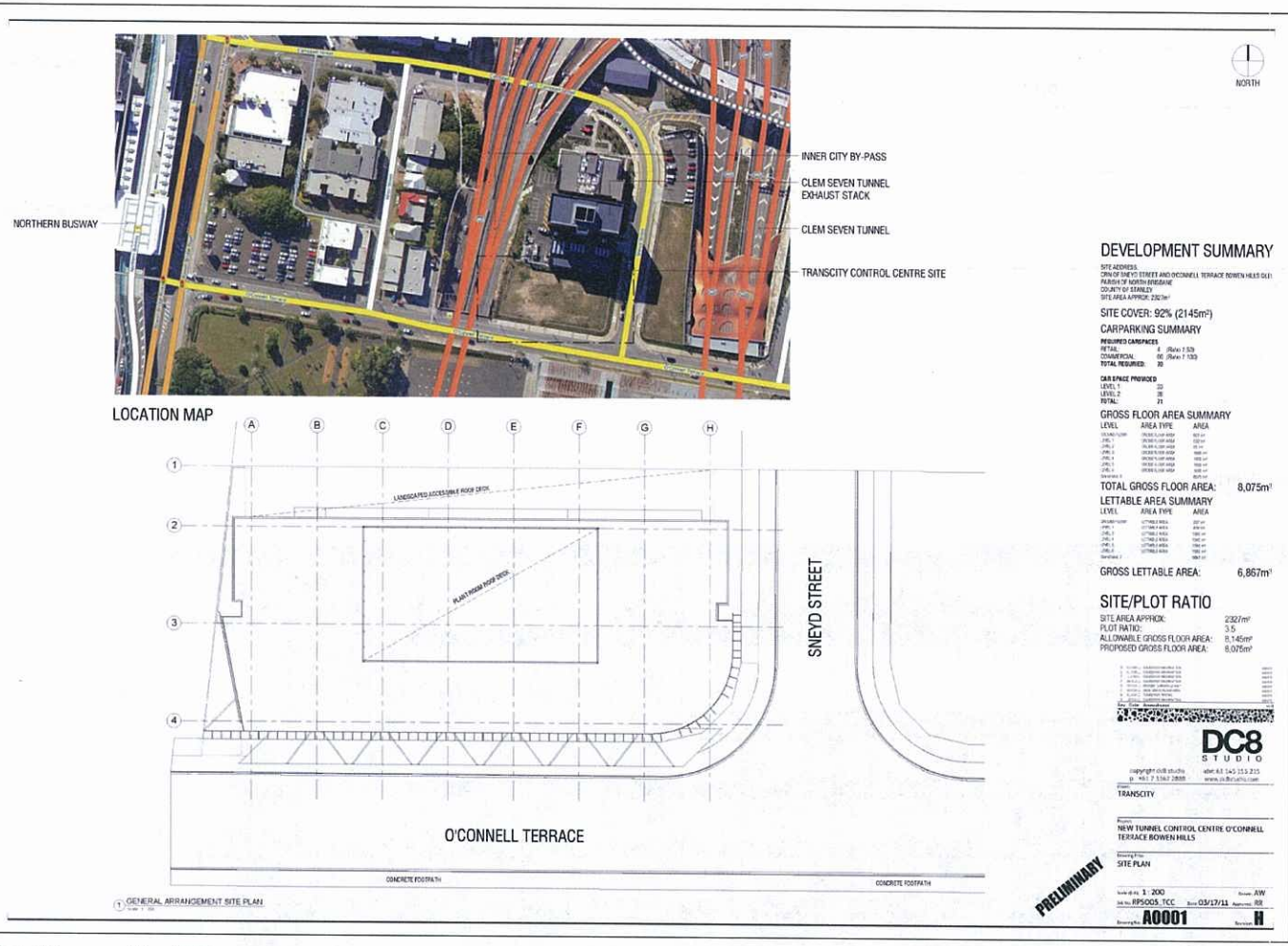


**Figure 1 Location of Legacy Way TCC**

| | | |
|---|---|---|
| **Location:** Bowen Hills, Qld | **Data source:** Brisbane City Council | |
| **Type:** Aerial image | **Prepared by:** Tania Haigh | **Date:** September 2011 |

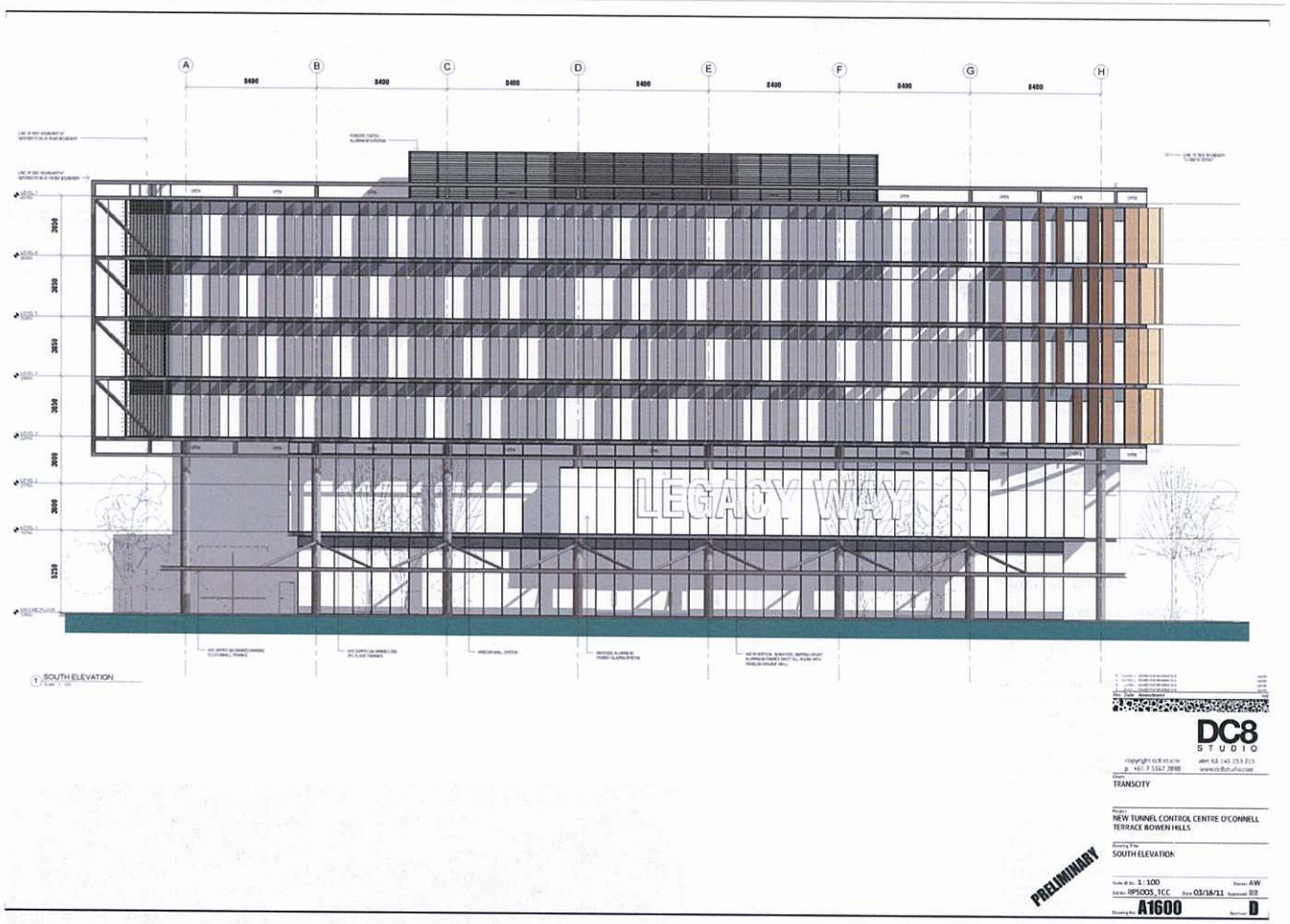


**Figure 2 Planning scenario 1 – Building dimensions**

| | | |
|---|---|---|
| **Location:** Bowen Hills, Qld | **Data source:** Brisbane City Council | |
| **Type:** South elevation diagram | **Prepared by:** Tania Haigh | **Date:** September 2011 |

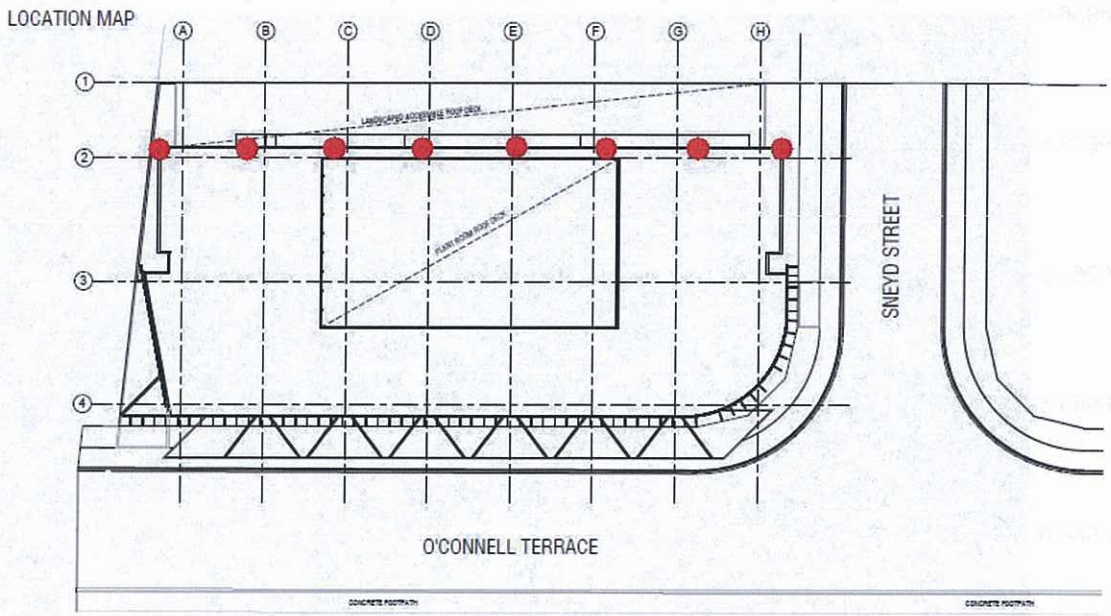


**Figure 3 Location of receptors along Legacy Way TCC Facade**

| | | |
|---|---|---|
| **Location:**<br>Bowen Hills, Qld | **Data source:**<br>Katestone Environmental | |
| **Type:**<br>Schematic | **Prepared by:**<br>Tania Haigh | **Date:**<br>September 2011 |

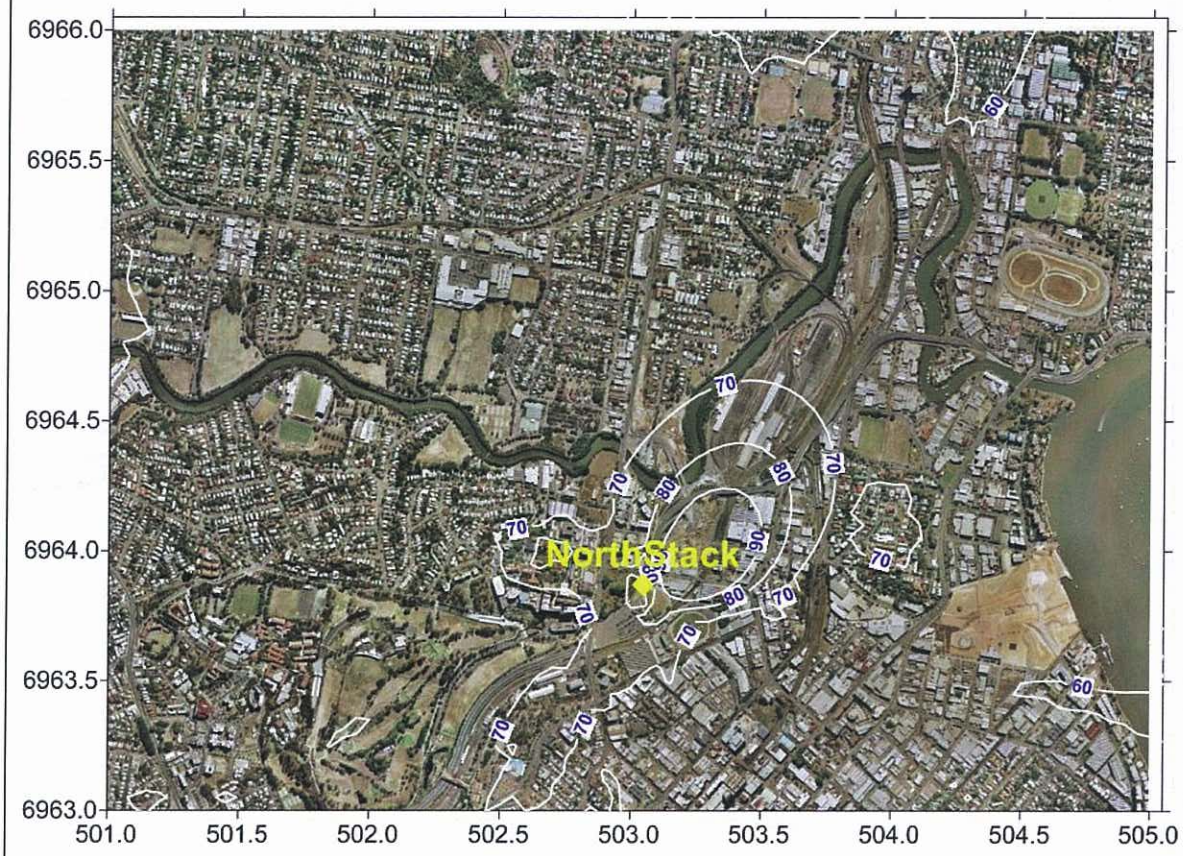


**Figure 4 Maximum predicted 1-hour average ground level $NO_2$ concentrations for 2011 including a background level of 59.5 µg/m³**

| **Location:** Brisbane, Qld | **Averaging period:** 1-hour | **Data source:** Calpuff | **Units:** µg/m³ |
|---|---|---|---|
| **Type:** Maximum contours | **Objective:** 245 µg/m³ | **Prepared by:** Tania Haigh | **Date:** September 2011 |

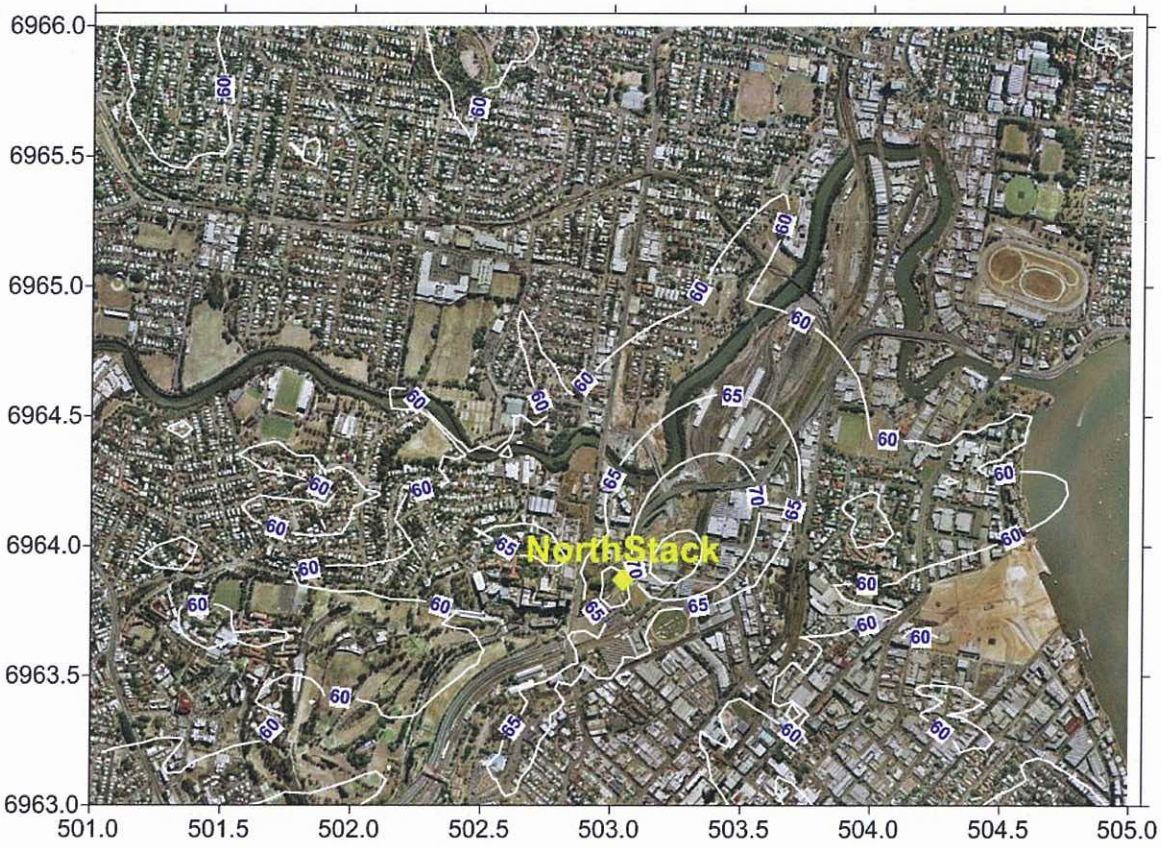


**Figure 5** **Maximum predicted 1-hour average ground level $NO_2$ concentrations for 2021 including a background level of 59.5 µg/m³**

| | | | |
|---|---|---|---|
| **Location:** Brisbane, Qld | **Averaging period:** 1-hour | **Data source:** Calpuff | **Units:** µg/m³ |
| **Type:** Maximum contours | **Objective:** 245 µg/m³ | **Prepared by:** Tania Haigh | **Date:** September 2011 |