Attachment 1

AIR QUALITY IMPACT ASSESSMENT

PROPOSED DEVELOPMENT OF MIXED RESIDENTIAL/COMMERCIAL BUILDING AT 171-189 PARRAMATTA ROAD AND 58 & 60 VICTORIA STREET, GRANVILLE

NEXUS Environmental Planning

Job No: **3921**

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A PEL Company

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1 INTRODUCTION

This report has been prepared by PAEHolmes for NEXUS Environmental Planning to review general air quality and assess the effects of traffic emissions on air quality at a proposed mixed residential commercial building at 171-189 Parramatta Road and 58 & 60 Victoria Street, Granville. The NSW Department of Planning's (DoP) State Environmental Planning Policy (Infrastructure) (the 'Infrastructure SEPP') has been taken into consideration, as well as the relevant air quality criteria listed by the NSW Department of Environment, Climate Change and Water (DECCW).

The assessment of the impacts of motor vehicle emissions is based on the use of a computer model to determine the dispersion of emissions and to predict ground-level concentrations of the various exhaust components in the area close to the road. The primary pollutants of concern are carbon monoxide, oxides of nitrogen, particulate matter and to some extent sulphur dioxide.

2 LOCAL SETTING AND PROJECT DESCRIPTION

The proposal involves the demolition of existing buildings at 171-189 Parramatta Road, Granville and 58 & 60 Victoria Street, Granville. The location of the site and surrounding districts is shown in **Figure 2.1**. Following demolition it is proposed to construct a ten-level building comprising eight floors above ground level and a two-level basement for parking and delivery of goods. The frontage of the building will extend along Parramatta Road and along Duke Street (see **Figure 2.2**), at a set-back distance of approximately 10 m. In addition it is proposed to construct four separate buildings containing eight duplex units in total. These will have a frontage along Victoria Street. The ground floor of the proposed development would consist of two shops.

Residents' access to the basement parking would be from Duke Street. There is also provision for heavy vehicle access to the basement area at the eastern end of the building from Parramatta Road. The seven levels of residential units would be constructed above the retail level.

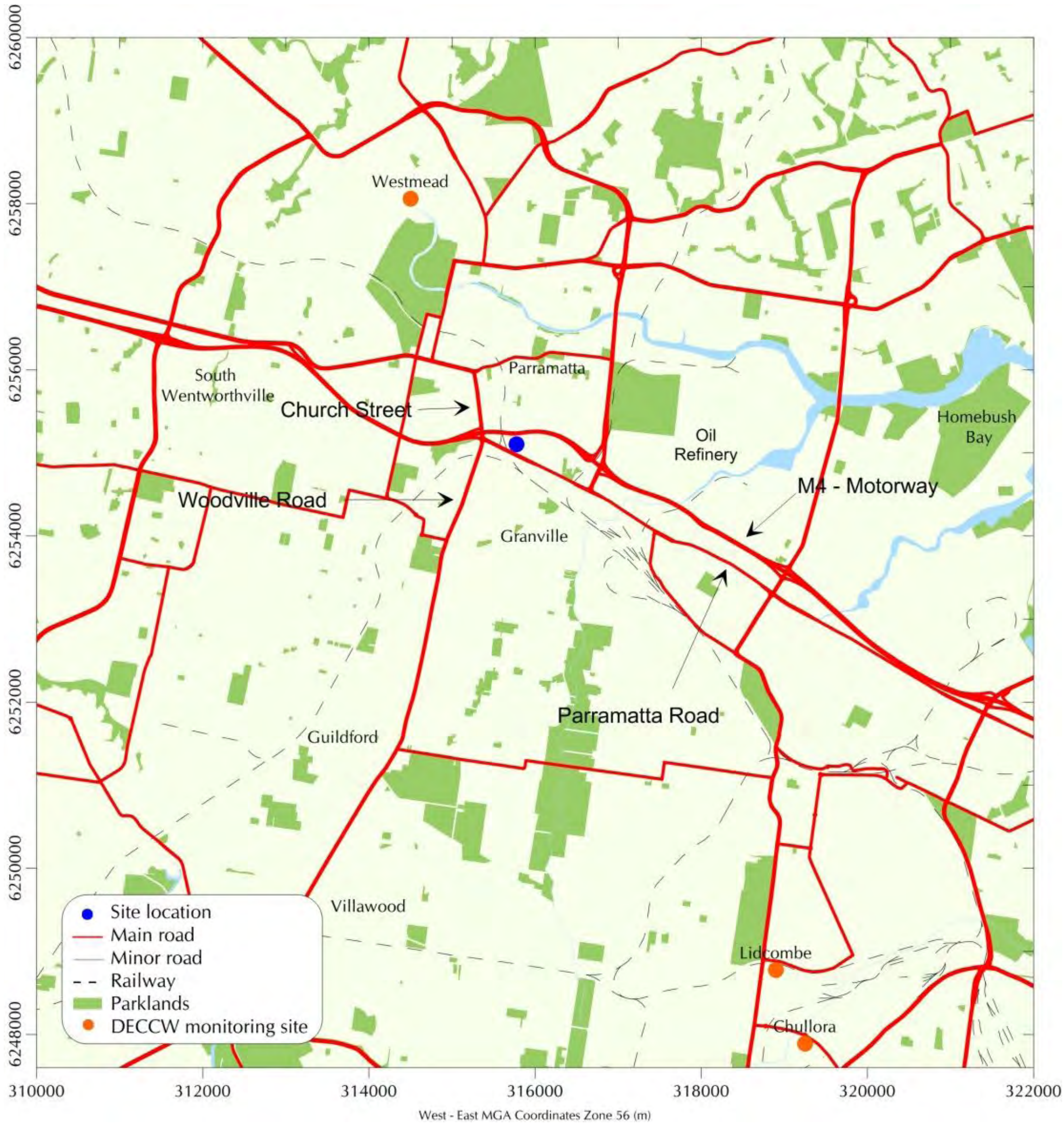

Figure 2.1: Location of the proposed development site and surrounding area

Figure 2.2: Location of the proposed development in relation to surrounding roadways

3 INFRASTRUCTURE SEPP AND DOP GUIDELINES

The Infrastructure SEPP refers to guidelines which must be taken into account where development is proposed in, or adjacent to, specific roads and railway corridors under clauses 85, 86, 87, 102 and 103 of the SEPP. These guidelines (referred to from here on as The Guideline) were developed by the NSW DoP (**DoP, 2008**).

Clause 102 may apply to this assessment of the proposed development. Clause 102, as referred to in The Guideline, states:

"development for any of the following purposes that is on land in or adjacent to a road corridor for a freeway, a tollway or a transit way or any other road with an annual average daily traffic volume more than 40,000 vehicles (based on traffic volume data on the website of the RTA) and that the consent authority considered is likely to be adversely affected by road noise or vibration:

- *building for residential use*
- *a place of worship*
- *a hospital*
- *an educational establishment or childcare centre"*

The annual average daily traffic (AADT) volumes for the sections of roadway adjacent or close to the proposed development, are greater than 40,000 (**RTA, 2010**). Clause 102 is therefore applicable and The Guideline must be taken into account. Although the clause is specifically referring to noise and vibration issues, in the context of the guideline it is prudent to also consider air quality.

The Guideline also recommends that air quality should be a design consideration for any development upon land within;

- 10 metres of a congested collector road (traffic speeds of less than 40 km/hr at peak hour) or a road grade > 4% or heavy vehicle percentage flows > 5%;
- 20 metres of a freeway or main road (with more than 2500 vehicles per hour, moderate congestion levels of less than 5% idle time and average speeds of greater than 40 km/hr);
- 60 metres of an area significantly impacted by existing sources of air pollution (road tunnel portals, major intersection / roundabouts, overpasses or adjacent major industrial sources); or
- As considered necessary by the approval authority based on consideration of site constraints and air quality issues.

This development is proposed for approximately 10 m from Parramatta Road, which is determined to carry more than 2500 vehicles per hour at peak times. As such, air quality has been investigated further to assure compliance with the DECCW criteria outlined in **Section 4**.

4 AIR QUALITY CRITERIA

The activities taking place within the residential units would comprise cooking, vacuuming and the normal domestic activities that take place in Australian households. There are studies that indicate that cooking and space heating in Australian homes may lead to air quality that would not be acceptable in the ambient air and would not comply with the DECCW ambient air quality goals. However these factors are generally at the control of the occupier of the residence and are beyond the control of the developer, the Council or any other regulatory agency.

This report therefore focuses on the likely quality of the ambient air in the vicinity of the building as influenced by the nearby major roads.

The quality of the ambient air will be determined by the combined effects of emissions in the Sydney air shed in general from all sources, and in particular from traffic using the M4 Motorway, Parramatta Road, Woodville Road and Church Street. In addition, there will be some contribution of air pollutants from minor suburban roads and, on occasions, emissions from industrial sources nearby.

The pollutants of interest for this assessment are:

- Sulphur dioxide (SO_2) (from industry and to a lesser extent traffic),
- Carbon monoxide (CO) (from traffic),
- Nitrogen dioxide (NO_2) (from traffic), and
- Particulate matter in the sub-10 micron size range (PM_{10}) (from a wide range of natural and anthropogenic sources).

There will also be secondary pollutants such as ozone (O_3) and other oxidants, which can be an issue[a] for the Sydney air shed generally, but which are widespread throughout the air shed and are not specific to the proposal.

In order to determine the likely air quality in the vicinity of the proposed development, emissions expected to occur from traffic using Parramatta Road, the M4 Motorway, Woodville Road and Church Street were used to calculate worst-case ambient concentrations of roadway pollutants. A review of meteorological conditions in the area has also been undertaken, focusing on the direction of the more common winds. These matters are discussed in the following sections.

The pollutants listed above have the capacity to adversely affect health if the concentration is too great over a particular exposure period.

The DECCW has historically noted air quality goals determined by the World Health Organisation (WHO), the United States Environmental Protection Agency (US EPA) and the National Health and Medical Research Council of Australia (NHMRC).

The National Environment Protection Council of Australia (NEPC) determined a set of air quality goals for adoption at a national level, which are part of the National Environment Protection Measures (NEPM). In its publication "Action for Air" (**EPA, 1998**), the NSW DECCW has adopted new air quality goals for nitrogen dioxide and particulate matter.

[a] The O_3 impact assessment criteria set by the DECCW are exceeded from time to time over much of the Sydney air shed. Management of ozone is an issue actively worked on by the DECCW.

The NSW DECCW specifies ground-level concentration criteria for criteria pollutants (**DEC, 2005**), as listed in **Table 4.1**. The basis of these air quality goals and, where relevant, the safety margins which they provide are outlined in the following sections.

Table 4.1: NSW DECCW Air Quality Assessment Criteria

Pollutant	Goal	Averaging period	Source
Carbon monoxide (CO)	30 mg/m^3 10 mg/m^3	1-hour 8-hour	WHO (2000) NEPC (1998)
Nitrogen dioxide (NO_2)	246 µg/m^3 62 µg/m^3	1-hour Annual	NEPC (1998) NEPC (1998)
Sulfur dioxide (SO_2)	712 µg/m^3 570 µg/m^3 228 µg/m^3 60 µg/m^3	10-minutes 1-hour 24-hour Annual	NHMRC (1996) NEPC (1998) NEPC (1998) NEPC (1998)
Particulate matter < 10 µm (PM_{10})	50 µg/m^3 30 µg/m^3	24-hour Annual	NEPC (1998) EPA (1998)

mg/m^3 – milligrams per cubic metre
µg/m^3 – micrograms per cubic metre

4.1 Carbon Monoxide

Carbon monoxide is produced from incomplete combustion of fuels, where carbon is only partially oxidised instead of being fully oxidised to form carbon dioxide.

Carbon monoxide can be harmful to humans because its affinity for haemoglobin is more than 200 times greater than that of oxygen. When it is inhaled it is taken up by the blood and therefore reduces the capacity of the blood to transport oxygen. This process is reversible and reducing the exposure will lead to the establishment of a new equilibrium. A period of three hours is the approximate time required to reach fifty percent of the equilibrium value.

Symptoms of carbon monoxide intoxication are lassitude and headaches, however these are generally not reported until the concentrations of carboxyhaemoglobin in the blood are in excess of ten percent of saturation. This is approximately the equilibrium value achieved with an ambient atmospheric concentration of 70 mg/m^3 for a person engaged in light activity. However, there is evidence that there is a risk for individuals with cardiovascular disease when the carboxyhaemoglobin concentration reaches four percent, and the WHO recommends that ambient concentrations be kept to values which would protect individuals from exceeding the four percent level.

The 15-minute, 1-hour and 8-hour goals noted by the DECCW provide a significant margin for safety to protect a wide range of people in the community including the very young and elderly. The 15-minute, 1-hour and 8-hour goals are 100 mg/m^3, 30 mg/m^3 and 10 mg/m^3 respectively.

4.2 Oxides of Nitrogen

Oxides of nitrogen are produced by motor vehicles when nitrogen from the air is oxidised at a high temperature and pressure in the combustion chamber.

Nitrogen oxides (NO_x) emitted by motor vehicles are comprised mainly of nitric oxide (NO, approximately 95 percent at the point of emission) and nitrogen dioxide (NO_2, approximately 5 percent at the point of emission). Nitric oxide is much less harmful to humans than nitrogen dioxide and is not generally considered a pollutant at the concentrations normally found in urban environments. Monitoring data collected in Sydney (**RTA, 1997**) indicate that close to the roadways, nitrogen dioxide would make up from 5 to 20 percent by weight of the total oxides of nitrogen.

Concern with nitric oxide is related to its transformation to nitrogen dioxide and its role in the formation of photochemical smog. Nitrogen dioxide has been reported to have an effect on respiratory function, although the evidence concerning effects has been mixed and conflicting.

The DECCW has not set any air quality goals for nitric oxide, however it has set 1-hour and annual average goals for nitrogen dioxide. It has adopted the NEPM standard of 0.12 ppm or 246 µg/m^3 and the WHO 1-hour goal of 0.11 ppm or 200 µg/m^3 as a long term reporting goal. The annual average goal is 0.03 ppm or 62 µg/m^3.

4.3 Sulfur Dioxide

Sulfur dioxide (SO_2) is an acid gas that can have harmful effects on the respiratory system as well as on vegetation and building materials. It is however a minor component of motor vehicle emissions, due to the low sulfur content of Australian petrol, and has not been assessed quantitatively in this study. For example, the Metropolitan Air Quality Study (MAQS) (**Carnovale et al, 1997**) estimates that for the 1992 Sydney fleet, average sulfur dioxide emissions under arterial travel conditions are 0.065 g/km compared to emissions of nitrogen oxides of 2.33 g/km for the same conditions. The 1-hour average air quality goal for SO_2 is 570 µg/m^3 compared with the 1-hour average goal for NO_2 which is 246 µg/m^3, given that the average SO_2 emissions are only 2% of the NO_2 emission rates, compliance with the NO_2 goal will ensure compliance with the SO_2 goal.

In addition transient emissions of above average levels of odorous sulfur compounds such as hydrogen sulfide and carbonyl sulfide (which may be smelt at concentrations as low as 5 ppb) have been noted from vehicles fitted with catalytic converters. While these compounds may produce a local short-term nuisance, they do not represent significant emissions under normal running conditions.

4.4 Particulate Matter

Particulate matter is emitted by motor vehicles due to incomplete combustion of fuels, additives in fuels and lubricants, worn material that accumulates in the engine lubricant, and brake and tyre wear.

The presence of particulate matter in the atmosphere can have an adverse effect on health and amenity. Larger particles, that is, those greater than 10 µm, generally adhere to the mucus in the nose, mouth, pharynx and larger bronchi and from there are removed by either swallowing or expectorating. Finer particles can enter bronchial and pulmonary regions of the respiratory tract, with increased deposition during mouth breathing, which increases during exercise. The health effects of particulate matter are further complicated by the chemical nature of the particles and by the possibility of synergistic effects with other air pollutants such as sulfur dioxide.

The DECCW has adopted the NEPM 24-hour standard of 50 µg/m^3, and references an annual average of 30 µg/m^3 as a long-term reporting goal.

4.5 Vehicle Emissions and Photochemical Smog

Motor vehicle emissions have the potential to contribute significantly to photochemical smog in an urban environment. Photochemical smog is formed by the reaction between nitrogen oxides and reactive hydrocarbons in the presence of sunlight. Models for the formation of photochemical smog envisage hydrocarbon emissions mostly from motor cars, facilities for the storage of hydrocarbons or spray painting operations and so on, mixing with nitrogen oxides from either industrial sources or from motor cars. The mixture of pollution from these sources then reacts photochemically to form photochemical smog comprising mainly ozone, but also including other oxidants. At concentrations of 0.1 ppm and above, the smog can affect the eyes and respiratory system and can adversely affect plants and building materials.

Ozone is not emitted directly from motor vehicles but results from photochemical reactions that take some time to occur. Concentrations close to roadways are low because fresh emissions of nitric oxide titrate out any ozone that may be present.

5 REVIEW OF DISPERSION CONDITIONS

This section provides a review of the dispersion conditions in the area with a view to identifying where the prevailing winds blow from (in relation to the major emission sources that are likely to affect the area) and to determine how well ventilated the area is likely to be. In addition information on atmospheric stability[b] is also presented as this assists in assessing the rate at which emissions would be expected to disperse.

5.1 Wind speed and direction

Annual and seasonal windroses, prepared from data collected in 2004 by Shell at the Clyde Refinery approximately 2.5 km to the east, are presented in **Figure 5.1**. Similar windroses collected by the DECCW in 1991 at their Lidcombe meteorological station approximately 6 km southeast of the development site are presented in **Figure 5.2**. The percentage of calms (winds less than 0.5 m/s) for the Shell Clyde Refinery and Lidcombe sites is 14.4 % and 16.3 % respectively.

Although the winds from the western quadrant at Lidcombe are rotated anticlockwise by between 22.5 and 45 degrees relative to those from the Shell Refinery, the two monitoring sites show similar patterns of wind and the similar seasonal variations. This suggests that this part of Sydney is subject to the similar conditions. Because the Shell site is closer and there is no significant intervening terrain this data set has been chosen to represent conditions at the development site.

The most common winds are from the northwest quadrant during most of the year. Winds from the southeast quadrant become the dominant winds during the summer months and to a lesser extent during winter and spring. Winds from the west-northwest and northwest are the most common winds in winter.

[b] In dispersion modelling stability class is used to categorise the rate at which a plume will disperse. In the Pasquill-Gifford-Turner stability class assignment scheme there are six stability classes A through to F. Class A relates to unstable conditions such as might be found on a sunny day with light winds. In such conditions plumes will spread rapidly. Class F relates to stable conditions, such as occur when the sky is clear, the winds are light and an inversion is present. Plume spreading is slow in these circumstances. The intermediate classes B, C, D and E relate to intermediate dispersion conditions.

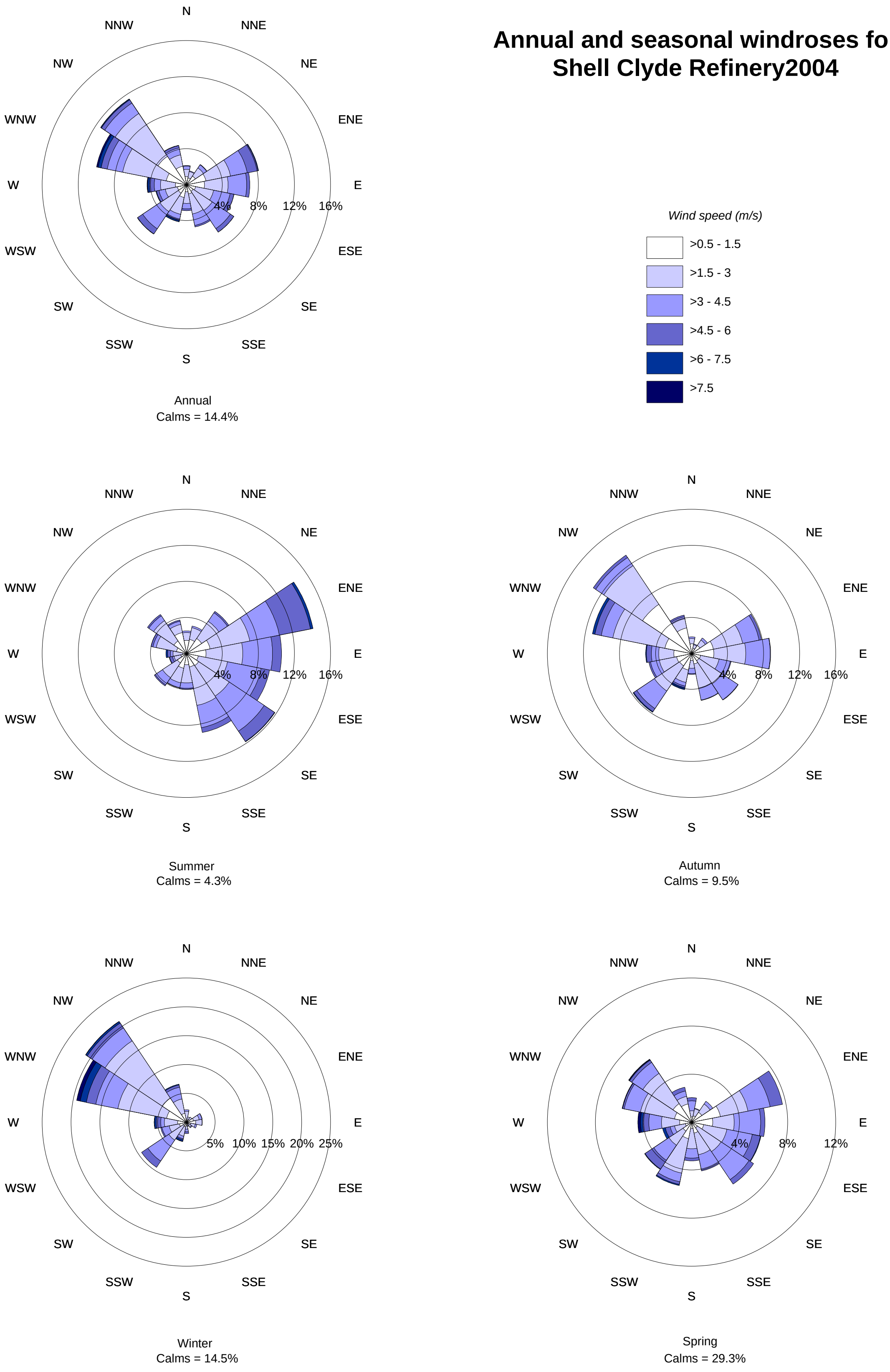

Figure 5.1: Annual and seasonal windroses for Shell Clyde Refinery – 2004

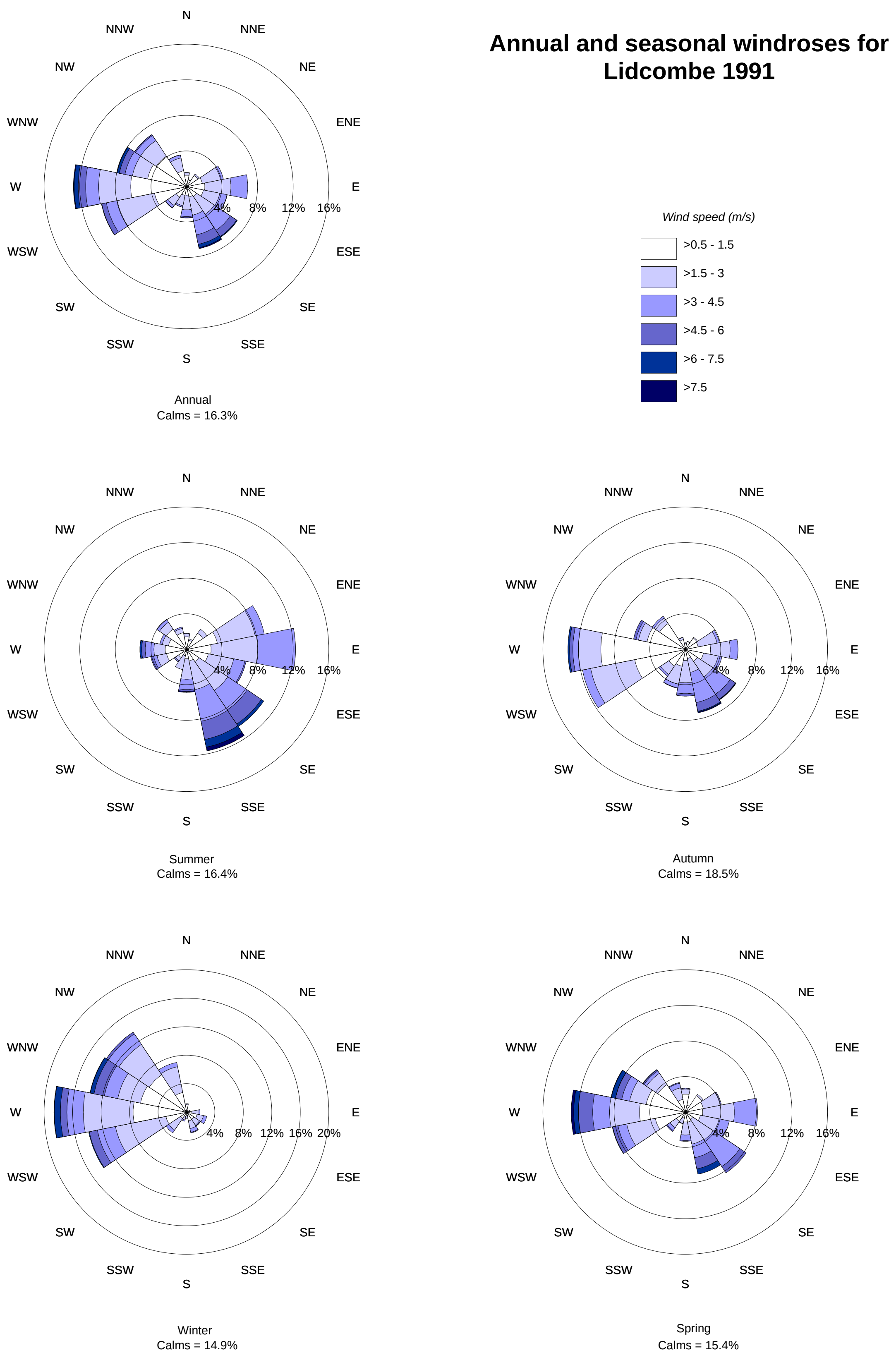

Figure 5.2: Annual and seasonal windroses for Lidcombe – 1991

5.2 Atmospheric stability

The rate at which pollutants disperse is controlled by atmospheric stability class and mixing height[c]. **Table 5.1** provides the frequency of occurrence of the six stability classes for the Shell Clyde Refinery using the method of **Turner (1994)**. It can be seen from **Table 5.1** that D-class stability occurred about one third of the time. Pollutant dispersion is moderate for these conditions with stability conditions considered neutral.

Table 5.1: Frequency of occurrence of stability class at the Shell Clyde Refinery (2004)

Pasquill-Guifford stability class	Frequency of occurrence (%)
A	10.9
B	10.3
C	12.9
D	33.9
E	13.2
F	18.8
Total	**100**

5.3 Temperature and rainfall

Temperature and rainfall data are available from the Bureau of Meteorology site located at Parramatta, north of the proposed site (see **Figure 2.1**). The data indicate that temperatures are typical for the Western suburbs of Sydney. The annual average maximum and minimum temperatures experienced are 23.3°C and 12.1°C. January is the warmest month with a mean daily maximum temperature of 28.3°C and July is the coolest with a mean daily minimum temperature of 6.2°C.

Rainfall data show that February is on average the wettest month, with a mean rainfall reading of 106.1 mm, over 11.8 raindays. July is the driest month with an average rainfall of 45.7 mm, over an average of 7.8 raindays. The average annual rainfall is 962.6 mm and the average number of rain days annually is 120.5. These data are only of peripheral interest for the current review and will not be discussed further in this report.

[c] The term mixed-layer height refers the height of the turbulent layer of air near the earth's surface, into which ground-level emissions will be rapidly mixed. A plume emitted above the mixed-layer will remain isolated from the ground until such time as the mixed-layer reaches the height of the plume. The height of the mixed-layer is controlled mainly by convection (resulting from solar heating of the ground) and by mechanically generated turbulence as the wind blows over the rough ground.

6 APPROACH TO ASSESSMENT

The first step in assessing air quality was to determine whether or not SO_2 emissions from nearby industry contribute significantly to ground-level concentrations at the proposed development site. In general the emissions from tall stacks are adequately dispersed before reaching ground-level. Modelling studies undertaken for Shell (**HAS, 2007**) indicated that concentrations of SO_2 are unlikely to be exceeded at the development site, as shown below:

- 100 µg/m^3 (10-minute average)
- 50 µg/m^3 (1-hour average)
- 6 µg/m^3 (24-hour average)
- 1 µg/m^3 (annual average).

These concentrations are too low to be of concern at this location and so the question now becomes one as to whether emissions from roadways could give rise to concentrations that would cause concern at the site.

In order to determine this, the CALINE4 dispersion model has been used to estimate the maximum concentrations of CO, NO_2 and PM_{10}, likely to occur in the vicinity of the proposed development site. This model is an upgrade of CALINE3 the most recent US EPA approved model, and is a steady state Gaussian model which can determine concentrations at receptor locations downwind of "at grade", "fill", "bridges" and "cut section" highways located in relatively uncomplicated terrain. The model is applicable for any wind direction, roadway orientation and receptor location.

The approach in this report has been to identify worst case conditions which comprise 1-hour peak hour traffic flow, combined with the poorest dispersion conditions, equivalent to atmospheric inversions with very light winds. This has been done for each of the major roadways in the vicinity of the development site, namely the M4 Motorway, Parramatta Road, Woodville Road and Church Street. The traffic flows have been assumed to be constant (at peak levels), and although this is clearly a simplification, it is a reasonable approximation to what could happen in practice. Traffic volumes were taken from the NSW Roads and Traffic Authority (RTA) database of measurements made in 2005 (**RTA, 2010**). These are the latest data available.

7 EMISSION ESTIMATES

This section provides a brief description of the methods used to calculate the major emissions from vehicles, namely CO, NO_2 and PM_{10}. This information is required as input to the dispersion models used to predict ground-level concentrations of the various pollutants.

Vehicle emission data from PIARC[d] (**PIARC, 2004**) were adjusted to reflect the NSW vehicle fleet. The modified tables include emissions of CO, NO_x and PM_{10} by age and type of vehicle. The ages of vehicles are categorised into seven periods which correspond to the introduction of emission standards. The types of vehicle are categorised into light and heavy vehicle groups.

Proportions of traffic within each age category for 2010 have been extrapolated from the proportions of traffic within each age category using New South Wales traffic registration data from the Australian Bureau of Statistics Motor Vehicle Census (**ABS, 2005**). No future improvements in vehicle technology or fuel standards have been included in the emission estimates.

Annual average daily traffic (AADT) volumes for each of the roadways in the vicinity of the development site have been taken from the RTA's database on their web site (**RTA, 2010**) and relate to data for 2005 (the most recent data available). These values are listed in **Table 7.1**. Traffic would very likely increase over time in the immediate future, but emission controls on vehicles are improving and so emissions are likely to remaining more or less constant in the next few years.

Table 7.1: Annual average daily traffic (AADT) volumes for selected roads

Roadway name	2005 AADT
Parramatta Road at Bold Street Granville	55,736
Woodville Road south of Parramatta Road	45,385
Church Street north of the M4	35,805
M4 at Wentworthville	116,406

The modelling assumptions for these calculations are as follows:

- The traffic flows are the values shown in **Table 7.1**.
- The traffic speed for the M4 is 110 km/s, for all other roads is 60 km/h.
- The percentage of heavy vehicles in the peak hour traffic is 7% (a judgement based on professional experience[e] on roadway projects).
- Peak hour is traffic is 10% of the AADT (a judgement based on professional experience on roadway projects).

[d] The acronym PIARC refers to the Permanent International Association of Road Congress. While this body is now known as the World Road Association, the PIARC acronym has been retained.

[e] The percentage of heavy vehicles in Sydney's traffic flows vary depending on the time of day at which the observations are made. Generally the percentages tend to be lower during peak hour when traffic flows are high and higher during business part of the day outside the peak hours when traffic flow is lower. The selected figure of 7% has been chosen as the calculations are based on estimated peak-hour traffic conditions.

- In the absence of directional flow data it was assumed that this traffic was split evenly in each direction, and also between each lane.
- The development site is more than 100 m from the M4 Motorway, 10 m from Parramatta Road, more than 200 m from Church Street and more than 200 m from Woodville Road (see **Figure 2.2**).

The analysis that follows is not highly sensitive to these assumptions but they need to be stated so that they can be assessed for reasonableness or used by third parties to confirm the calculations if required. Emission estimates are summarised in **Table 7.2**.

Table 7.2: Estimated peak hour traffic emissions for each roadway – (kg/km/v)

Roadway Name	Carbon Monoxide	Nitrogen Oxides	Particulate Matter
Parramatta Road	4.55	1.07	0.07
Woodville Road	4.55	1.07	0.07
Church Street	4.55	1.07	0.07
M4 Motorway	7.75	1.69	0.06

In determining the effects of these emissions on air quality at the development site, it should be noted that the locations of the roads are such that only one road would affect the site at any one time. For example the M4 is on one side of the site and Parramatta Road is on the other (see **Figure 2.1**), so emissions from both roads would not affect the site at the same time. Emissions from Woodville Road and Church Street could reach the site under the same general wind direction but the assessment assumes that roads are effectively infinitely long and so when interpreting the effect of the roads only one road should be considered at a time. To assess the worst case, the road producing the highest predicted concentrations should be used.

8 ESTIMATING BACKGROUND LEVELS

In assessing air quality at any particular site, some account also needs to be taken of the background pollutant level that occurs from sources other than the road being modelled. For most pollutants (for example CO, SO_2 or NO_2) this is simple enough and estimates of an appropriate background level can be set by reviewing monitoring data. In most circumstances the background concentrations will not exceed the assessment criteria and one can determine the acceptability or otherwise of a new source by ensuring that the background concentration plus the specific source being considered do not cause the concentration to exceed the assessment criteria.

However, for 24-hour PM_{10} concentrations in Sydney (and other Australian cities) the maximum 24-hour background concentrations will, from time-to-time, exceed the 24-hour PM_{10} assessment criterion of 50 µg/m^3, regardless of the emissions from specific sources (e.g. Parramatta Road). This will occur whenever the city is affected by smoke from large bushfires or a remote dust storm. Under these conditions emissions from traffic on Parramatta Road would cause the assessment criteria of 24-hour PM_{10} concentrations to be exceeded or worsen an exceedance that would have already occurred due to these regional factors.

In selecting the background level to be added to the effect of the road we have taken the 90th-percentile of the 24-hour PM_{10} concentrations measured at Westmead, that is, a concentration that is exceeded on only 10% of the days in the year. The predicted 24-hour average PM_{10} concentrations due only to emissions from Parramatta Road at the most affected area of the proposed development (i.e. the residential units and retail area facing Parramatta Road), would likely comply with the assessment criterion. However, when the 24-hour average background PM_{10} level exceeds the 90-percentile level (as it will do 10-percent of the time) then the 24-hour PM_{10} concentration could exceed the assessment criterion.

9 ASSESSMENT OF IMPACTS

The detailed results of the CALINE4 model runs are provided in **Appendix A**. A summary of the results is provided in **Table 9.1**. Assuming a wind speed of 1.0 m/s and that F-class stability conditions occur, the model has been set to determine the worst-case wind angle.

Estimating NO_2 concentrations is more complicated than estimating CO and PM_{10} concentrations. Nitrogen oxides are initially emitted as a mixture of nitric oxide (NO) and other oxides of nitrogen (NO_x), which are oxidised to NO_2. At the point of emission the mixture is generally about 5% NO_2 by mass. However, while the maximum concentrations of total NO_x generally occur during peak hour, this is not necessarily the case for NO_2. An extensive monitoring program undertaken by the NSW RTA (**RTA, 1997**) indicates that during peak hour the percentage NO_2 at 10 m from the roadway edge is likely to be about 5%. The conversion rate from nitric oxide to NO_2 at other times of the day may be significantly higher than this although the total NO_x levels may be significantly lower than peak hour levels. It is necessary therefore to assume some intermediate value for a worst-case assessment.

Data from the RTA program indicates that at 10m from the roadway a conversion rate of 15% by weight is still conservative but more realistic than the 20% assumed in previous EIS studies. At distances of 30 – 60 m from the roadway the 20% conversion rate appears to be appropriate. A conversion rate of 15% has been used at 10 m, while a rate of 20% has been assumed for distances of 20 m or more.

It can be seen from the results in **Table 9.1**, that there are no predicted exceedances of any of the relevant DECCW criteria at the proposed development site.

It should also be noted that there are not expected to be any increases to pollutant concentrations at the residences along Victoria Street. In fact, concentrations due to emissions from Parramatta Road are likely to be lower than currently experienced, due to some shielding provided by the new development.

Table 9.1: Predicted increases in ground-level concentrations due to vehicle emissions

Roadway and distance from roadway	Pollutant and averaging time	Predicted concentration due to nominated road	Estimated background	Total cumulative impact	Assessment criteria
M4 Motorway at 100 m	Maximum 1-hour average CO (mg/m^3)	2.3	1.0	3.3	30
	Maximum 8-hour average CO (mg/m^3)	1.6	0.9	2.5	10
	Maximum 1-hour average NO_2 [f] ($\mu g/m^3$)	101	48	149	246
	Annual average NO_2 ($\mu g/m^3$)	20	26	46	62
	Maximum 24-hour average PM_{10} ($\mu g/m^3$)	8.8	30	39	50
	Annual average PM_{10} ($\mu g/m^3$)	3.5	20	24	30
Parramatta Road at 10 m	Maximum 1-hour average CO (mg/m^3)	2.3	1.0	3.3	30
	Maximum 8-hour average CO (mg/m^3)	1.6	0.9	2.5	10
	Maximum 1-hour average NO_2 ($\mu g/m^3$)	80	48	128	246
	Annual average NO_2 ($\mu g/m^3$)	16	26	42	62
	Maximum 24-hour average PM_{10} ($\mu g/m^3$)	17	30	47	50
	Annual average PM_{10} ($\mu g/m^3$)	6.7	20	27	30
Woodville Road at 200 m (actual road is 280 m away)	Maximum 1-hour average CO (mg/m^3)	0.4	1.0	1.4	30
	Maximum 8-hour average CO (mg/m^3)	0.3	0.9	1.2	10
	Maximum 1-hour average NO_2 ($\mu g/m^3$)	20	48	68	246
	Annual average NO_2 ($\mu g/m^3$)	4.0	26	30	62
	Maximum 24-hour average PM_{10} ($\mu g/m^3$)	3.1	30	33	50
	Annual average PM_{10} ($\mu g/m^3$)	1.3	20	21	30
Church Street at 200 m (actual road is 280 m away)	Maximum 1-hour average CO (mg/m^3)	0.3	1.0	1.3	30
	Maximum 8-hour average CO (mg/m^3)	0.2	0.9	1.1	10
	Maximum 1-hour average NO_2 ($\mu g/m^3$)	16	48	64	246
	Annual average NO_2 ($\mu g/m^3$)	3.2	26	29	62
	Maximum 24-hour average PM_{10} ($\mu g/m^3$)	2.5	30	33	50
	Annual average PM_{10} ($\mu g/m^3$)	1.0	20	21	30

[f] Assumed to be 15% by weight of total nitrogen oxides at at 10 m and 20% at 20 m, 30 m and 50 m.

10 CONCLUSIONS

Due to the setback distance of the proposed development relative to major roads and the volume of traffic on surrounding roadways, it is considered that the Infrastructure SEPP and corresponding DoP Guidelines apply.

The Guidelines have been considered for this proposed development and an assessment has been made of potential air quality at the proposed site by comparison of modelled results with DECCW air quality criteria. Modelling has been conducted under worst case dispersion conditions and peak traffic volumes and the predictions are summarised in this report.

Based on these predictions it is concluded that the emissions from traffic on roads adjacent to the proposed development, will not adversely affect air quality at the site. Also, there is not expected to be measureable impact on air quality at residences along Victoria Street, due to the proposed development.

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Appendix A: CALINE4 Model Results

M4 Motorway

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 CALINE4: TOOL FOR ROADSIDE AIR QUALITY
 -------Version 8.05.0113-----------


CONFIGURATION SETTINGS

 Simulation name               : Caline4 simulation
 Emission calculation method   : PIARC
 Number of lanes               : 6
 Traffic volume units          : per hour
 Traffic for each lane         : 1940 1940 1940 1940 1940 1940
 Heavy vehicles per lane (%)   : 7 7 7 7 7 7
 Vehicle speed per lane (km/h): 110 110 110 110 110 110
 Road grade for each lane (%)  : 0 0 0 0 0 0
 Median strip                  : no
 Year of assessment            : 2011
 Landuse                       : Residential
 Air quality environment       : WESTMEAD


METEOROLOGICAL CONDITIONS

 Wind direction                : Worst case wind angle
 Wind speed                    : 1 m/s
 Atmospheric stability         : F class
 Temperature                   : 15 deg C


COMPOSITE EMISSION FACTORS (g/km/v)

          CO     NOx     PM10
Lane 1   7.75   1.69    0.06
Lane 2   7.75   1.69    0.06
Lane 3   7.75   1.69    0.06
Lane 4   7.75   1.69    0.06
Lane 5   7.75   1.69    0.06
Lane 6   7.75   1.69    0.06


RESULTS FROM SIMULATION **

Predicted maximum 1-hour average concentrations due to emissions from vehicles on road
Distance from road,   CO due to traffic (mg/m3)
  At kerb (0 m)    ,             13.33
  10 m from kerb   ,              6.44
  20 m from kerb   ,              4.83
  30 m from kerb   ,              4.05
  40 m from kerb   ,              3.56
  50 m from kerb   ,              3.21
  75 m from kerb   ,              2.67
 100 m from kerb   ,              2.32
 150 m from kerb   ,              1.89
 200 m from kerb   ,              1.60

Distance from road,  NO2 due to traffic (ug/m3)
  At kerb (0 m)    ,            290.94
  10 m from kerb   ,            210.79
  20 m from kerb   ,            210.59
  30 m from kerb   ,            176.55
  40 m from kerb   ,            155.17
  50 m from kerb   ,            140.13
  75 m from kerb   ,            116.38
```

100 m from kerb	,	101.34
150 m from kerb	,	82.33
200 m from kerb	,	69.67

Distance from road,		PM10 due to traffic (ug/m3)
At kerb (0 m)	,	101.31
10 m from kerb	,	48.93
20 m from kerb	,	36.66
30 m from kerb	,	30.74
40 m from kerb	,	27.02
50 m from kerb	,	24.40
75 m from kerb	,	20.26
100 m from kerb	,	17.64
150 m from kerb	,	14.33
200 m from kerb	,	12.13

** The user should refer to the guidance provided in the TRAQ user manual for interpretation of these hourly average predictions.

FINAL INTERPRETATION

The following tables provide some results for the cumulative pollutant concentrations at various distances from the roadway. These results can be compared with the air quality criteria relevant for each pollutant and averaging time.

The process for generation of these data was as follows:
- Conversion of 1-hour average model results to other averaging times
- Addition of background levels derived from monitoring data or specified by the user

It should be noted that the conversion of the model's 1-hour averages to other averaging times is not rigorous and provides indicative results only.

Predicted cumulative pollutant concentrations near roadway

1-hour average CO (mg/m3). Assessment criteria = 30 mg/m3

Distance from road,		Due to road traffic,	Background (90th %ile of 1h averages)	, Total
At kerb (0 m)	,	13.33	1.00	14.33
10 m from kerb	,	6.44	1.00	7.44
20 m from kerb	,	4.83	1.00	5.83
30 m from kerb	,	4.05	1.00	5.05
40 m from kerb	,	3.56	1.00	4.56
50 m from kerb	,	3.21	1.00	4.21
75 m from kerb	,	2.67	1.00	3.67
100 m from kerb	,	2.32	1.00	3.32
150 m from kerb	,	1.89	1.00	2.89
200 m from kerb	,	1.60	1.00	2.60

8-hour average CO (mg/m3). Assessment criteria = 10 mg/m3

Distance from road,		Due to road traffic, (1h x 0.7)	Background (90th %ile of 8h averages)	, Total
At kerb (0 m)	,	9.33	0.90	10.23
10 m from kerb	,	4.51	0.90	5.41
20 m from kerb	,	3.38	0.90	4.28
30 m from kerb	,	2.83	0.90	3.73
40 m from kerb	,	2.49	0.90	3.39
50 m from kerb	,	2.25	0.90	3.15
75 m from kerb	,	1.87	0.90	2.77
100 m from kerb	,	1.63	0.90	2.53
150 m from kerb	,	1.32	0.90	2.22

200 m from kerb ,	1.12	0.90	2.02

1-hour average NO2 (ug/m3). Assessment criteria = 246 ug/m3

Distance from road,	Due to road traffic,	Background (90th %ile of 1h averages)	, Total
At kerb (0 m) ,	290.94	48.20	339.14
10 m from kerb ,	210.79	48.20	258.99
20 m from kerb ,	210.59	48.20	258.79
30 m from kerb ,	176.55	48.20	224.75
40 m from kerb ,	155.17	48.20	203.37
50 m from kerb ,	140.13	48.20	188.33
75 m from kerb ,	116.38	48.20	164.58
100 m from kerb ,	101.34	48.20	149.54
150 m from kerb ,	82.33	48.20	130.53
200 m from kerb ,	69.67	48.20	117.87

Annual average NO2 (ug/m3). Assessment criteria = 62 ug/m3

Distance from road,	Due to road traffic, (1h x 0.2)	Background (average)	, Total
At kerb (0 m) ,	58.19	26.20	84.39
10 m from kerb ,	42.16	26.20	68.36
20 m from kerb ,	42.12	26.20	68.32
30 m from kerb ,	35.31	26.20	61.51
40 m from kerb ,	31.03	26.20	57.23
50 m from kerb ,	28.03	26.20	54.23
75 m from kerb ,	23.28	26.20	49.48
100 m from kerb ,	20.27	26.20	46.47
150 m from kerb ,	16.47	26.20	42.67
200 m from kerb ,	13.93	26.20	40.13

24-hour average PM10 (ug/m3). Assessment criteria = 50 ug/m3

Distance from road,	Due to road traffic, (1h x 0.5)	Background (90th %ile of 24h averages)	, Total
At kerb (0 m) ,	50.65	30.00	80.65
10 m from kerb ,	24.47	30.00	54.47
20 m from kerb ,	18.33	30.00	48.33
30 m from kerb ,	15.37	30.00	45.37
40 m from kerb ,	13.51	30.00	43.51
50 m from kerb ,	12.20	30.00	42.20
75 m from kerb ,	10.13	30.00	40.13
100 m from kerb ,	8.82	30.00	38.82
150 m from kerb ,	7.17	30.00	37.17
200 m from kerb ,	6.06	30.00	36.06

Annual average PM10 (ug/m3). Assessment criteria = 30 ug/m3

Distance from road,	Due to road traffic, (1h x 0.2)	Background (average)	, Total
At kerb (0 m) ,	20.26	20.00	40.26
10 m from kerb ,	9.79	20.00	29.79
20 m from kerb ,	7.33	20.00	27.33
30 m from kerb ,	6.15	20.00	26.15
40 m from kerb ,	5.40	20.00	25.40
50 m from kerb ,	4.88	20.00	24.88
75 m from kerb ,	4.05	20.00	24.05
100 m from kerb ,	3.53	20.00	23.53
150 m from kerb ,	2.87	20.00	22.87
200 m from kerb ,	2.43	20.00	22.43

Parramatta Road

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 CALINE4: TOOL FOR ROADSIDE AIR QUALITY
 -------Version 8.05.0113-----------


CONFIGURATION SETTINGS

 Simulation name               : Caline4 simulation
 Emission calculation method   : PIARC
 Number of lanes               : 4
 Traffic volume units          : per hour
 Traffic for each lane         : 1393 1393 1393 1393
 Heavy vehicles per lane (%)   : 7 7 7 7
 Vehicle speed per lane (km/h): 060 060 060 060
 Road grade for each lane (%) : 0 0 0 0
 Median strip                  : no
 Year of assessment            : 2011
 Landuse                       : Residential
 Air quality environment       : WESTMEAD


METEOROLOGICAL CONDITIONS

 Wind direction                : Worst case wind angle
 Wind speed                    : 1 m/s
 Atmospheric stability         : F class
 Temperature                   : 15 deg C


COMPOSITE EMISSION FACTORS (g/km/v)

          CO     NOx    PM10
Lane 1   4.55   1.07   0.07
Lane 2   4.55   1.07   0.07
Lane 3   4.55   1.07   0.07
Lane 4   4.55   1.07   0.07


RESULTS FROM SIMULATION **

Predicted maximum 1-hour average concentrations due to emissions from vehicles on road
Distance from road,   CO due to traffic (mg/m3)
  At kerb (0 m)    ,            5.05
  10 m from kerb   ,            2.26
  20 m from kerb   ,            1.65
  30 m from kerb   ,            1.36
  40 m from kerb   ,            1.19
  50 m from kerb   ,            1.07
  75 m from kerb   ,            0.88
 100 m from kerb   ,            0.75
 150 m from kerb   ,            0.59
 200 m from kerb   ,            0.49

Distance from road,  NO2 due to traffic (ug/m3)
  At kerb (0 m)    ,          118.83
  10 m from kerb   ,           79.58
  20 m from kerb   ,           77.54
  30 m from kerb   ,           64.09
  40 m from kerb   ,           56.17
  50 m from kerb   ,           50.41
  75 m from kerb   ,           41.29
 100 m from kerb   ,           35.29
 150 m from kerb   ,           27.85
```

200 m from kerb	,	23.29

Distance from road, PM10 due to traffic (ug/m3)

Distance from road		PM10 due to traffic (ug/m3)
At kerb (0 m)	,	75.40
10 m from kerb	,	33.66
20 m from kerb	,	24.60
30 m from kerb	,	20.33
40 m from kerb	,	17.82
50 m from kerb	,	15.99
75 m from kerb	,	13.10
100 m from kerb	,	11.20
150 m from kerb	,	8.83
200 m from kerb	,	7.39

** The user should refer to the guidance provided in the TRAQ user manual for interpretation of these hourly average predictions.

FINAL INTERPRETATION

The following tables provide some results for the cumulative pollutant concentrations at various distances from the roadway. These results can be compared with the air quality criteria relevant for each pollutant and averaging time.

The process for generation of these data was as follows:
- Conversion of 1-hour average model results to other averaging times
- Addition of background levels derived from monitoring data or specified by the user

It should be noted that the conversion of the model's 1-hour averages to other averaging times is not rigorous and provides indicative results only.

Predicted cumulative pollutant concentrations near roadway

1-hour average CO (mg/m3). Assessment criteria = 30 mg/m3

Distance from road,		Due to road traffic,	Background (90th %ile of 1h averages)	, Total
At kerb (0 m)	,	5.05	1.00	6.05
10 m from kerb	,	2.26	1.00	3.26
20 m from kerb	,	1.65	1.00	2.65
30 m from kerb	,	1.36	1.00	2.36
40 m from kerb	,	1.19	1.00	2.19
50 m from kerb	,	1.07	1.00	2.07
75 m from kerb	,	0.88	1.00	1.88
100 m from kerb	,	0.75	1.00	1.75
150 m from kerb	,	0.59	1.00	1.59
200 m from kerb	,	0.49	1.00	1.49

8-hour average CO (mg/m3). Assessment criteria = 10 mg/m3

Distance from road,		Due to road traffic, (1h x 0.7)	Background (90th %ile of 8h averages)	, Total
At kerb (0 m)	,	3.54	0.90	4.44
10 m from kerb	,	1.58	0.90	2.48
20 m from kerb	,	1.15	0.90	2.05
30 m from kerb	,	0.95	0.90	1.85
40 m from kerb	,	0.84	0.90	1.74
50 m from kerb	,	0.75	0.90	1.65
75 m from kerb	,	0.61	0.90	1.51
100 m from kerb	,	0.53	0.90	1.43
150 m from kerb	,	0.41	0.90	1.31
200 m from kerb	,	0.35	0.90	1.25

1-hour average NO2 (ug/m3). Assessment criteria = 246 ug/m3

Distance from road,	Due to road traffic,	Background (90th %ile of 1h averages)	, Total
At kerb (0 m) ,	118.83	48.20	167.03
10 m from kerb ,	79.58	48.20	127.78
20 m from kerb ,	77.54	48.20	125.74
30 m from kerb ,	64.09	48.20	112.29
40 m from kerb ,	56.17	48.20	104.37
50 m from kerb ,	50.41	48.20	98.61
75 m from kerb ,	41.29	48.20	89.49
100 m from kerb ,	35.29	48.20	83.49
150 m from kerb ,	27.85	48.20	76.05
200 m from kerb ,	23.29	48.20	71.49

Annual average NO2 (ug/m3). Assessment criteria = 62 ug/m3

Distance from road,	Due to road traffic, (1h x 0.2)	Background (average)	, Total
At kerb (0 m) ,	23.77	26.20	49.97
10 m from kerb ,	15.92	26.20	42.12
20 m from kerb ,	15.51	26.20	41.71
30 m from kerb ,	12.82	26.20	39.02
40 m from kerb ,	11.23	26.20	37.43
50 m from kerb ,	10.08	26.20	36.28
75 m from kerb ,	8.26	26.20	34.46
100 m from kerb ,	7.06	26.20	33.26
150 m from kerb ,	5.57	26.20	31.77
200 m from kerb ,	4.66	26.20	30.86

24-hour average PM10 (ug/m3). Assessment criteria = 50 ug/m3

Distance from road,	Due to road traffic, (1h x 0.5)	Background (90th %ile of 24h averages)	, Total
At kerb (0 m) ,	37.70	30.00	67.70
10 m from kerb ,	16.83	30.00	46.83
20 m from kerb ,	12.30	30.00	42.30
30 m from kerb ,	10.17	30.00	40.17
40 m from kerb ,	8.91	30.00	38.91
50 m from kerb ,	8.00	30.00	38.00
75 m from kerb ,	6.55	30.00	36.55
100 m from kerb ,	5.60	30.00	35.60
150 m from kerb ,	4.42	30.00	34.42
200 m from kerb ,	3.69	30.00	33.69

Annual average PM10 (ug/m3). Assessment criteria = 30 ug/m3

Distance from road,	Due to road traffic, (1h x 0.2)	Background (average)	, Total
At kerb (0 m) ,	15.08	20.00	35.08
10 m from kerb ,	6.73	20.00	26.73
20 m from kerb ,	4.92	20.00	24.92
30 m from kerb ,	4.07	20.00	24.07
40 m from kerb ,	3.56	20.00	23.56
50 m from kerb ,	3.20	20.00	23.20
75 m from kerb ,	2.62	20.00	22.62
100 m from kerb ,	2.24	20.00	22.24
150 m from kerb ,	1.77	20.00	21.77
200 m from kerb ,	1.48	20.00	21.48

Woodville Road

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 CALINE4: TOOL FOR ROADSIDE AIR QUALITY
 -------Version 8.05.0113-----------


CONFIGURATION SETTINGS

 Simulation name              : Caline4 simulation
 Emission calculation method  : PIARC
 Number of lanes              : 4
 Traffic volume units         : per hour
 Traffic for each lane        : 1135 1135 1135 1135
 Heavy vehicles per lane (%)  : 7 7 7 7
 Vehicle speed per lane (km/h): 060 060 060 060
 Road grade for each lane (%) : 0 0 0 0
 Median strip                 : no
 Year of assessment           : 2011
 Landuse                      : Residential
 Air quality environment      : WESTMEAD


METEOROLOGICAL CONDITIONS

 Wind direction               : Worst case wind angle
 Wind speed                   : 1 m/s
 Atmospheric stability        : F class
 Temperature                  : 15 deg C


COMPOSITE EMISSION FACTORS (g/km/v)

          CO     NOx    PM10
Lane 1   4.55   1.07   0.07
Lane 2   4.55   1.07   0.07
Lane 3   4.55   1.07   0.07
Lane 4   4.55   1.07   0.07


RESULTS FROM SIMULATION **

Predicted maximum 1-hour average concentrations due to emissions from vehicles on road
Distance from road,   CO due to traffic (mg/m3)
  At kerb (0 m)    ,             4.26
  10 m from kerb   ,             1.93
  20 m from kerb   ,             1.42
  30 m from kerb   ,             1.18
  40 m from kerb   ,             1.03
  50 m from kerb   ,             0.92
  75 m from kerb   ,             0.75
 100 m from kerb   ,             0.64
 150 m from kerb   ,             0.50
 200 m from kerb   ,             0.42

Distance from road,  NO2 due to traffic (ug/m3)
  At kerb (0 m)    ,           100.14
  10 m from kerb   ,            68.21
  20 m from kerb   ,            66.89
  30 m from kerb   ,            55.55
  40 m from kerb   ,            48.31
  50 m from kerb   ,            43.42
  75 m from kerb   ,            35.21
 100 m from kerb   ,            30.12
 150 m from kerb   ,            23.67
```

200 m from kerb	19.76

Distance from road,	PM10 due to traffic (ug/m3)
At kerb (0 m)	63.54
10 m from kerb	28.86
20 m from kerb	21.22
30 m from kerb	17.62
40 m from kerb	15.33
50 m from kerb	13.78
75 m from kerb	11.17
100 m from kerb	9.56
150 m from kerb	7.51
200 m from kerb	6.27

** The user should refer to the guidance provided in the TRAQ user manual for interpretation of these hourly average predictions.

FINAL INTERPRETATION

The following tables provide some results for the cumulative pollutant concentrations at various distances from the roadway. These results can be compared with the air quality criteria relevant for each pollutant and averaging time.

The process for generation of these data was as follows:

- Conversion of 1-hour average model results to other averaging times
- Addition of background levels derived from monitoring data or specified by the user

It should be noted that the conversion of the model's 1-hour averages to other averaging times is not rigorous and provides indicative results only.

Predicted cumulative pollutant concentrations near roadway

1-hour average CO (mg/m3). Assessment criteria = 30 mg/m3

Distance from road,	Due to road traffic,	Background (90th %ile of 1h averages)	Total
At kerb (0 m)	4.26	1.00	5.26
10 m from kerb	1.93	1.00	2.93
20 m from kerb	1.42	1.00	2.42
30 m from kerb	1.18	1.00	2.18
40 m from kerb	1.03	1.00	2.03
50 m from kerb	0.92	1.00	1.92
75 m from kerb	0.75	1.00	1.75
100 m from kerb	0.64	1.00	1.64
150 m from kerb	0.50	1.00	1.50
200 m from kerb	0.42	1.00	1.42

8-hour average CO (mg/m3). Assessment criteria = 10 mg/m3

Distance from road,	Due to road traffic, (1h x 0.7)	Background (90th %ile of 8h averages)	Total
At kerb (0 m)	2.98	0.90	3.88
10 m from kerb	1.35	0.90	2.25
20 m from kerb	1.00	0.90	1.90
30 m from kerb	0.83	0.90	1.73
40 m from kerb	0.72	0.90	1.62
50 m from kerb	0.65	0.90	1.55
75 m from kerb	0.52	0.90	1.42
100 m from kerb	0.45	0.90	1.35
150 m from kerb	0.35	0.90	1.25
200 m from kerb	0.29	0.90	1.19

1-hour average NO2 (ug/m3). Assessment criteria = 246 ug/m3

Distance from road	Due to road traffic	Background (90th %ile of 1h averages)	Total
At kerb (0 m)	100.14	48.20	148.34
10 m from kerb	68.21	48.20	116.41
20 m from kerb	66.89	48.20	115.09
30 m from kerb	55.55	48.20	103.75
40 m from kerb	48.31	48.20	96.51
50 m from kerb	43.42	48.20	91.62
75 m from kerb	35.21	48.20	83.41
100 m from kerb	30.12	48.20	78.32
150 m from kerb	23.67	48.20	71.87
200 m from kerb	19.76	48.20	67.96

Annual average NO2 (ug/m3). Assessment criteria = 62 ug/m3

Distance from road	Due to road traffic (1h x 0.2)	Background (average)	Total
At kerb (0 m)	20.03	26.20	46.23
10 m from kerb	13.64	26.20	39.84
20 m from kerb	13.38	26.20	39.58
30 m from kerb	11.11	26.20	37.31
40 m from kerb	9.66	26.20	35.86
50 m from kerb	8.68	26.20	34.88
75 m from kerb	7.04	26.20	33.24
100 m from kerb	6.02	26.20	32.22
150 m from kerb	4.73	26.20	30.93
200 m from kerb	3.95	26.20	30.15

24-hour average PM10 (ug/m3). Assessment criteria = 50 ug/m3

Distance from road	Due to road traffic (1h x 0.5)	Background (90th %ile of 24h averages)	Total
At kerb (0 m)	31.77	30.00	61.77
10 m from kerb	14.43	30.00	44.43
20 m from kerb	10.61	30.00	40.61
30 m from kerb	8.81	30.00	38.81
40 m from kerb	7.66	30.00	37.66
50 m from kerb	6.89	30.00	36.89
75 m from kerb	5.58	30.00	35.58
100 m from kerb	4.78	30.00	34.78
150 m from kerb	3.75	30.00	33.75
200 m from kerb	3.13	30.00	33.13

Annual average PM10 (ug/m3). Assessment criteria = 30 ug/m3

Distance from road	Due to road traffic (1h x 0.2)	Background (average)	Total
At kerb (0 m)	12.71	20.00	32.71
10 m from kerb	5.77	20.00	25.77
20 m from kerb	4.24	20.00	24.24
30 m from kerb	3.52	20.00	23.52
40 m from kerb	3.07	20.00	23.07
50 m from kerb	2.76	20.00	22.76
75 m from kerb	2.23	20.00	22.23
100 m from kerb	1.91	20.00	21.91
150 m from kerb	1.50	20.00	21.50
200 m from kerb	1.25	20.00	21.25

Church Street

```
 ----------------------------------
 CALINE4: TOOL FOR ROADSIDE AIR QUALITY
 -------Version 8.05.0113-----------
```

CONFIGURATION SETTINGS

```
 Simulation name               : Caline4 simulation
 Emission calculation method   : PIARC
 Number of lanes               : 4
 Traffic volume units          : per hour
 Traffic for each lane         : 895 895 895 895
 Heavy vehicles per lane (%)   : 7 7 7 7
 Vehicle speed per lane (km/h): 060 060 060 060
 Road grade for each lane (%) : 0 0 0 0
 Median strip                  : no
 Year of assessment            : 2011
 Landuse                       : Residential
 Air quality environment       : WESTMEAD
```

METEOROLOGICAL CONDITIONS

```
 Wind direction                : Worst case wind angle
 Wind speed                    : 1 m/s
 Atmospheric stability         : F class
 Temperature                   : 15 deg C
```

COMPOSITE EMISSION FACTORS (g/km/v)

	CO	NOx	PM10
Lane 1	4.55	1.07	0.07
Lane 2	4.55	1.07	0.07
Lane 3	4.55	1.07	0.07
Lane 4	4.55	1.07	0.07

RESULTS FROM SIMULATION **

Predicted maximum 1-hour average concentrations due to emissions from vehicles on road

```
Distance from road,   CO due to traffic (mg/m3)
  At kerb (0 m)    ,            3.47
  10 m from kerb   ,            1.60
  20 m from kerb   ,            1.18
  30 m from kerb   ,            0.97
  40 m from kerb   ,            0.85
  50 m from kerb   ,            0.76
  75 m from kerb   ,            0.62
 100 m from kerb   ,            0.52
 150 m from kerb   ,            0.41
 200 m from kerb   ,            0.34

Distance from road,  NO2 due to traffic (ug/m3)
  At kerb (0 m)    ,           81.51
  10 m from kerb   ,           56.45
  20 m from kerb   ,           55.52
  30 m from kerb   ,           45.81
  40 m from kerb   ,           39.95
  50 m from kerb   ,           35.78
  75 m from kerb   ,           29.00
 100 m from kerb   ,           24.68
 150 m from kerb   ,           19.43
```

```
 200 m from kerb  ,              16.04

Distance from road, PM10 due to traffic (ug/m3)
  At kerb (0 m)   ,              51.72
  10 m from kerb  ,              23.88
  20 m from kerb  ,              17.62
  30 m from kerb  ,              14.53
  40 m from kerb  ,              12.67
  50 m from kerb  ,              11.35
  75 m from kerb  ,               9.20
 100 m from kerb  ,               7.83
 150 m from kerb  ,               6.17
 200 m from kerb  ,               5.09

** The user should refer to the guidance provided in the TRAQ user
   manual for interpretation of these hourly average predictions.


FINAL INTERPRETATION

 The following tables provide some results for the cumulative
 pollutant concentrations at various distances from the
 roadway. These results can be compared with the air quality
 criteria relevant for each pollutant and averaging time.

 The process for generation of these data was as follows:
 - Conversion of 1-hour average model results to other averaging times
 - Addition of background levels derived from monitoring data or specified by the user

 It should be noted that the conversion of the model's 1-hour
 averages to other averaging times is not rigorous and provides
 indicative results only.

 Predicted cumulative pollutant concentrations near roadway

---------------------------------------------------------------------------------
  1-hour average CO (mg/m3). Assessment criteria = 30 mg/m3
Distance from road,  Due to road traffic,       Background               ,  Total
                                          (90th %ile of 1h averages)
  At kerb (0 m)   ,           3.47                 1.00                   4.47
  10 m from kerb  ,           1.60                 1.00                   2.60
  20 m from kerb  ,           1.18                 1.00                   2.18
  30 m from kerb  ,           0.97                 1.00                   1.97
  40 m from kerb  ,           0.85                 1.00                   1.85
  50 m from kerb  ,           0.76                 1.00                   1.76
  75 m from kerb  ,           0.62                 1.00                   1.62
 100 m from kerb  ,           0.52                 1.00                   1.52
 150 m from kerb  ,           0.41                 1.00                   1.41
 200 m from kerb  ,           0.34                 1.00                   1.34

---------------------------------------------------------------------------------
  8-hour average CO (mg/m3). Assessment criteria = 10 mg/m3
Distance from road,  Due to road traffic,       Background               ,  Total
                         (1h x 0.7)       (90th %ile of 8h averages)
  At kerb (0 m)   ,           2.43                 0.90                   3.33
  10 m from kerb  ,           1.12                 0.90                   2.02
  20 m from kerb  ,           0.83                 0.90                   1.73
  30 m from kerb  ,           0.68                 0.90                   1.58
  40 m from kerb  ,           0.59                 0.90                   1.49
  50 m from kerb  ,           0.53                 0.90                   1.43
  75 m from kerb  ,           0.43                 0.90                   1.33
 100 m from kerb  ,           0.37                 0.90                   1.27
 150 m from kerb  ,           0.29                 0.90                   1.19
 200 m from kerb  ,           0.24                 0.90                   1.14
```

1-hour average NO2 (ug/m3). Assessment criteria = 246 ug/m3

Distance from road,	Due to road traffic,	Background (90th %ile of 1h averages)	, Total
At kerb (0 m) ,	81.51	48.20	129.71
10 m from kerb ,	56.45	48.20	104.65
20 m from kerb ,	55.52	48.20	103.72
30 m from kerb ,	45.81	48.20	94.01
40 m from kerb ,	39.95	48.20	88.15
50 m from kerb ,	35.78	48.20	83.98
75 m from kerb ,	29.00	48.20	77.20
100 m from kerb ,	24.68	48.20	72.88
150 m from kerb ,	19.43	48.20	67.63
200 m from kerb ,	16.04	48.20	64.24

Annual average NO2 (ug/m3). Assessment criteria = 62 ug/m3

Distance from road,	Due to road traffic, (1h x 0.2)	Background (average)	, Total
At kerb (0 m) ,	16.30	26.20	42.50
10 m from kerb ,	11.29	26.20	37.49
20 m from kerb ,	11.10	26.20	37.30
30 m from kerb ,	9.16	26.20	35.36
40 m from kerb ,	7.99	26.20	34.19
50 m from kerb ,	7.16	26.20	33.36
75 m from kerb ,	5.80	26.20	32.00
100 m from kerb ,	4.94	26.20	31.14
150 m from kerb ,	3.89	26.20	30.09
200 m from kerb ,	3.21	26.20	29.41

24-hour average PM10 (ug/m3). Assessment criteria = 50 ug/m3

Distance from road,	Due to road traffic, (1h x 0.5)	Background (90th %ile of 24h averages)	, Total
At kerb (0 m) ,	25.86	30.00	55.86
10 m from kerb ,	11.94	30.00	41.94
20 m from kerb ,	8.81	30.00	38.81
30 m from kerb ,	7.27	30.00	37.27
40 m from kerb ,	6.34	30.00	36.34
50 m from kerb ,	5.68	30.00	35.68
75 m from kerb ,	4.60	30.00	34.60
100 m from kerb ,	3.91	30.00	33.91
150 m from kerb ,	3.08	30.00	33.08
200 m from kerb ,	2.54	30.00	32.54

Annual average PM10 (ug/m3). Assessment criteria = 30 ug/m3

Distance from road,	Due to road traffic, (1h x 0.2)	Background (average)	, Total
At kerb (0 m) ,	10.34	20.00	30.34
10 m from kerb ,	4.78	20.00	24.78
20 m from kerb ,	3.52	20.00	23.52
30 m from kerb ,	2.91	20.00	22.91
40 m from kerb ,	2.53	20.00	22.53
50 m from kerb ,	2.27	20.00	22.27
75 m from kerb ,	1.84	20.00	21.84
100 m from kerb ,	1.57	20.00	21.57
150 m from kerb ,	1.23	20.00	21.23
200 m from kerb ,	1.02	20.00	21.02

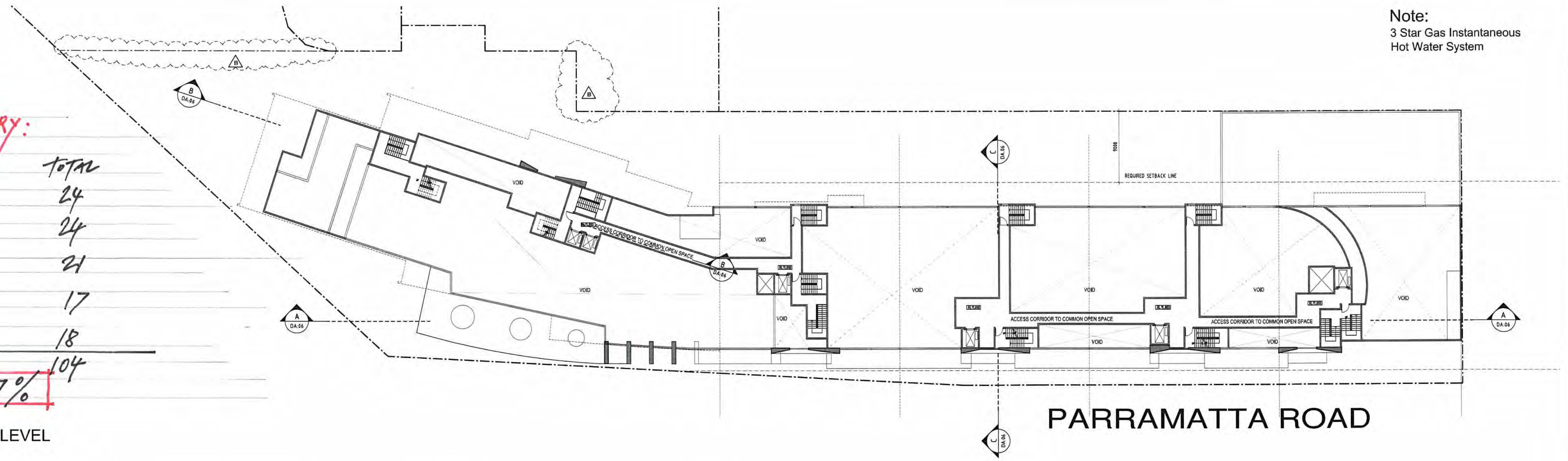
Attachment 2

Note:
3 Star Gas Instantaneous
Hot Water System

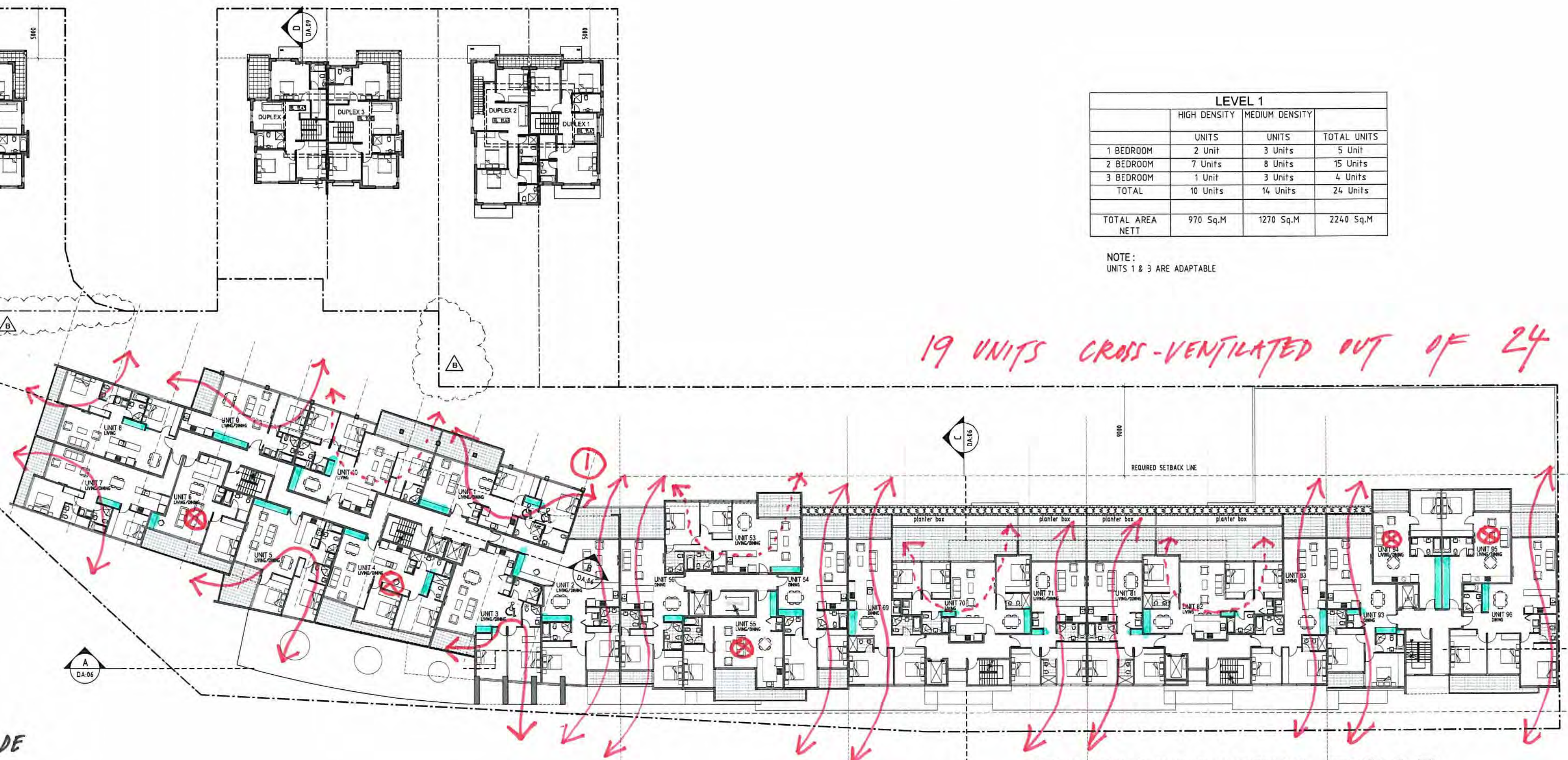
CROSS-VENTILATION SUMMARY:

	CROSS-VENTILATED	TOTAL
LEVEL 1	19	24
LEVEL 2	19	24
LEVEL 3	17	21
LEVEL 4	16	17
LEVEL 5-7	16	18
	87	104

CROSS-VENTILATION = 83.7%



MEZZANINE LEVEL
SCALE 1:300
A1



LEVEL 1			
	HIGH DENSITY	MEDIUM DENSITY	
	UNITS	UNITS	TOTAL UNITS
1 BEDROOM	2 Unit	3 Units	5 Unit
2 BEDROOM	7 Units	8 Units	15 Units
3 BEDROOM	1 Unit	3 Units	4 Units
TOTAL	10 Units	14 Units	24 Units
TOTAL AREA NETT	970 Sq.M	1270 Sq.M	2240 Sq.M

NOTE:
UNITS 1 & 3 ARE ADAPTABLE

LEGEND:
- STORAGE WITHIN UNITS
- CROSS-VENTILATED APARTMENT
- SINGLE ASPECT CROSS-VENTILATED APARTMENT AS PER NATURAL VENTILATION REPORT.
- CROSS-VENTILATED APARTMENT THROUGH OPENABLE CEILING SKYLIGHT.
- NON CROSS-VENTILATED APPARTMENT

NOTES:
1 - CROSS-VENTILATED THROUGH HOPPER IN SIDE WALL; TRANSLUCENT GLASS FOR PRIVACY.

LEVEL 1 FLOOR PLAN
SCALE 1:300
A1

SKETCH SK 01 rev. A 17.05.10

ISSUE	AMENDMENT	DATE	DRAWN
B	AMENDMENT AS PER COUNCIL REQ.	MAR 10	GS
A	DA ISSUE TO COUNCIL	FEB 10	GS

GENERAL NOTES
Figured dimensions shall be taken in preference to scaling.
Drawing to be read in conjunction with information on first page.
Check all dimensions and levels on site before commencing work or ordering materials.
All existing ground lines & trees location are approximate, therefore to be verified on-site by the builder.
Any discrepancies to be verified back to Zhinar Architects before proceeding.
All workmanship and materials shall comply with all relevant codes, ordinances, Australian Standards and manufactures instructions.
Unless noted 'Issued for construction' drawing not to be used for construction.

NORTH

SHEET TITLE:
LEVEL 1 FLOOR PLAN

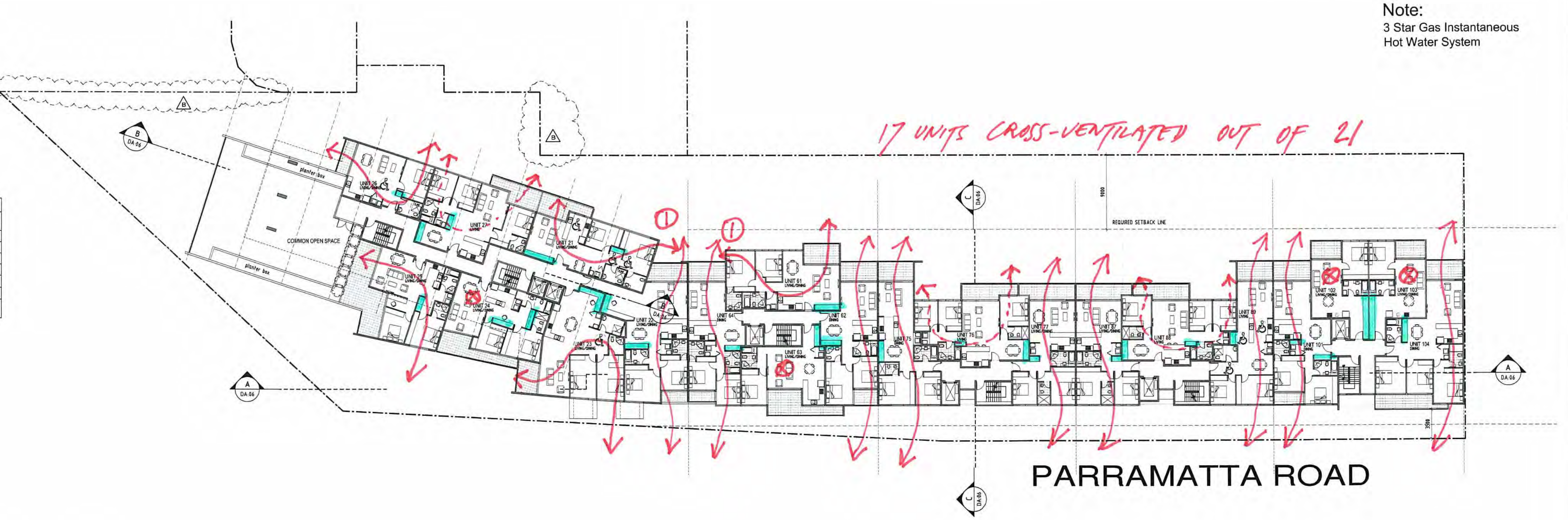
DRAWN: GS
CHECKED: JK
DATE: FEB 10
SCALE: 1:300

L.G.A: PARRAMATTA COUNCIL

zhinar ARCHITECTS
A Division of TRM Group Pty Ltd ACN 076 351 696
ZHINAR ARCHITECTS
1/142 JAMES RUSE DRIVE, ROSEHILL 2142
TEL: (02) 9687 8787 FAX: (02) 9687 9393

PROPOSED MIXED USE DEVELOPMENT
AT 171-189 PARRAMATTA ROAD
GRANVILLE
JOB No.
ISSUE:

Note:
3 Star Gas Instantaneous Hot Water System

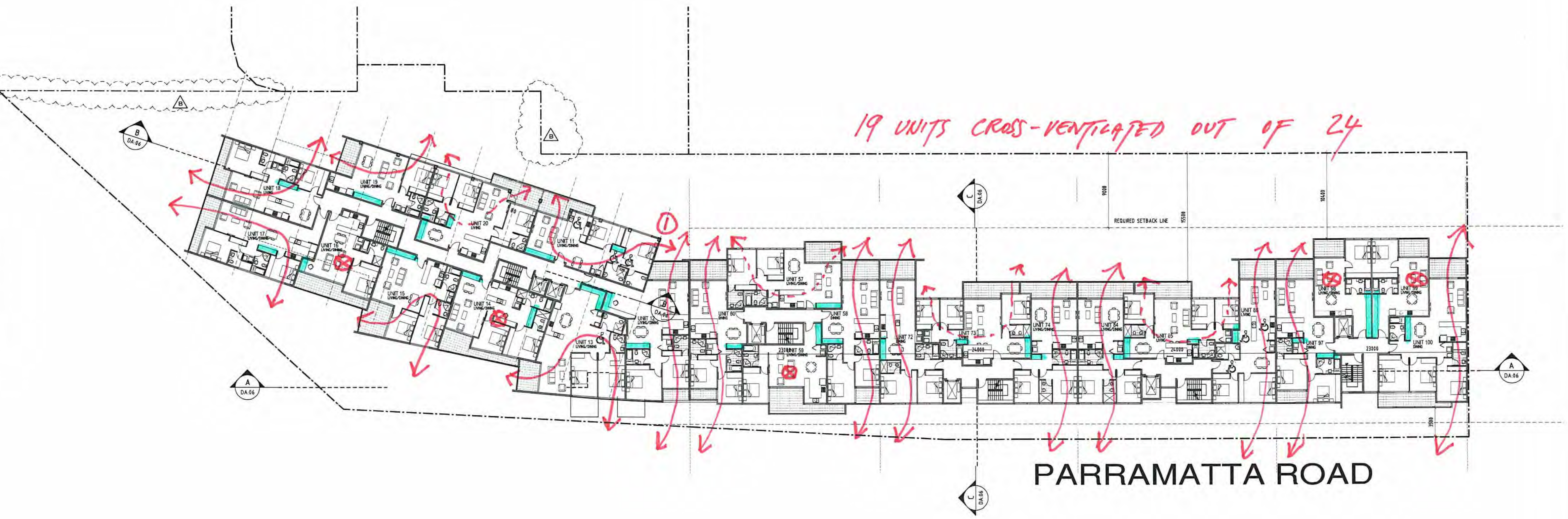


LEVEL 3			
	HIGH DENSITY	MEDIUM DENSITY	
	UNITS	UNITS	TOTAL UNITS
1 BEDROOM	1 Unit	3 Units	4 Unit
2 BEDROOM	5 Units	8 Units	13 Units
3 BEDROOM	1 Unit	3 Units	4 Units
TOTAL	7 Units	14 Units	21 Units
TOTAL AREA NETT	745 Sq.M	1280 Sq.M	2025 Sq.M

NOTE :
UNITS 21 , 23 , 26 & 89 ARE ADAPTABLE

LEVEL 3 FLOOR PLAN
SCALE 1:300
A1

LEGEND :
- REFER TO SKETCH SK 01.



LEVEL 2			
	HIGH DENSITY	MEDIUM DENSITY	
	UNITS	UNITS	TOTAL UNITS
1 BEDROOM	2 Unit	3 Units	5 Unit
2 BEDROOM	7 Units	8 Units	15 Units
3 BEDROOM	1 Unit	3 Units	4 Units
TOTAL	10 Units	14 Units	24 Units
TOTAL AREA NETT	995 Sq.M	1280 Sq.M	2275 Sq.M

NOTE :
UNITS 11 , 13 & 86 ARE ADAPTABLE

LEVEL 2 FLOOR PLAN
SCALE 1:300
A1

SKETCH SK 02 rev. A 17.05.10

ISSUE	AMENDMENT	DATE	DRAWN
B	AMENDMENT AS PER COUNCIL REQ.	MAR 10	GS
A	DA ISSUE TO COUNCIL	FEB 10	GS

GENERAL NOTES
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Drawing to be read in conjunction with information on first page.
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NORTH

SHEET TITLE:
LEVEL 2 & 3 FLOOR PLANS

DRAWN: GS | CHECKED: JK | DATE: FEB 10 | SCALE: 1:300

L.G.A. PARRAMATTA COUNCIL

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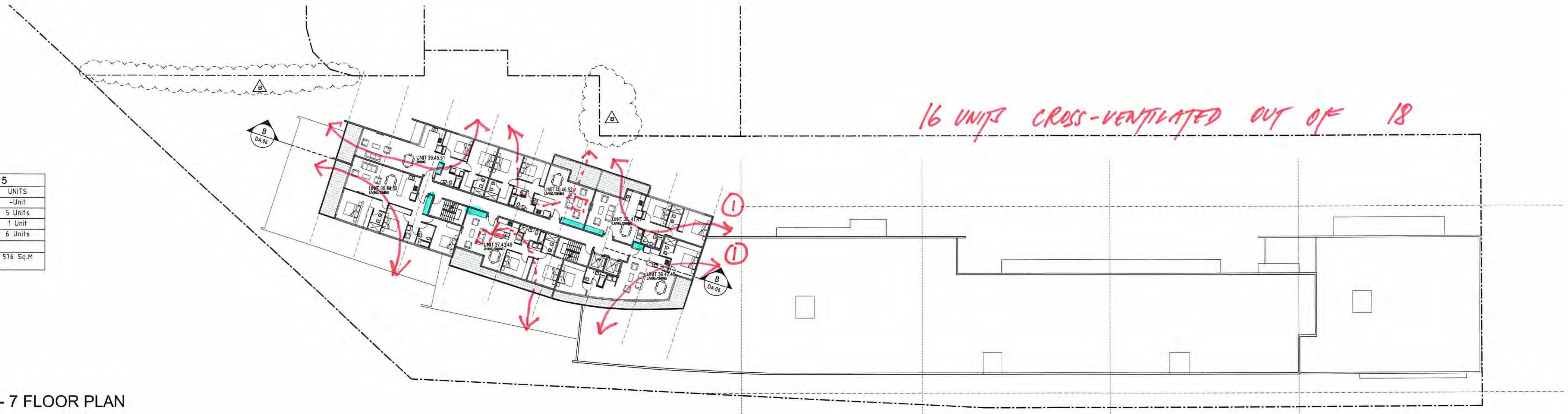
PROPOSED MIXED USE DEVELOPMENT AT 171-189 PARRAMATTA ROAD GRANVILLE
JOB No.
ISSUE:

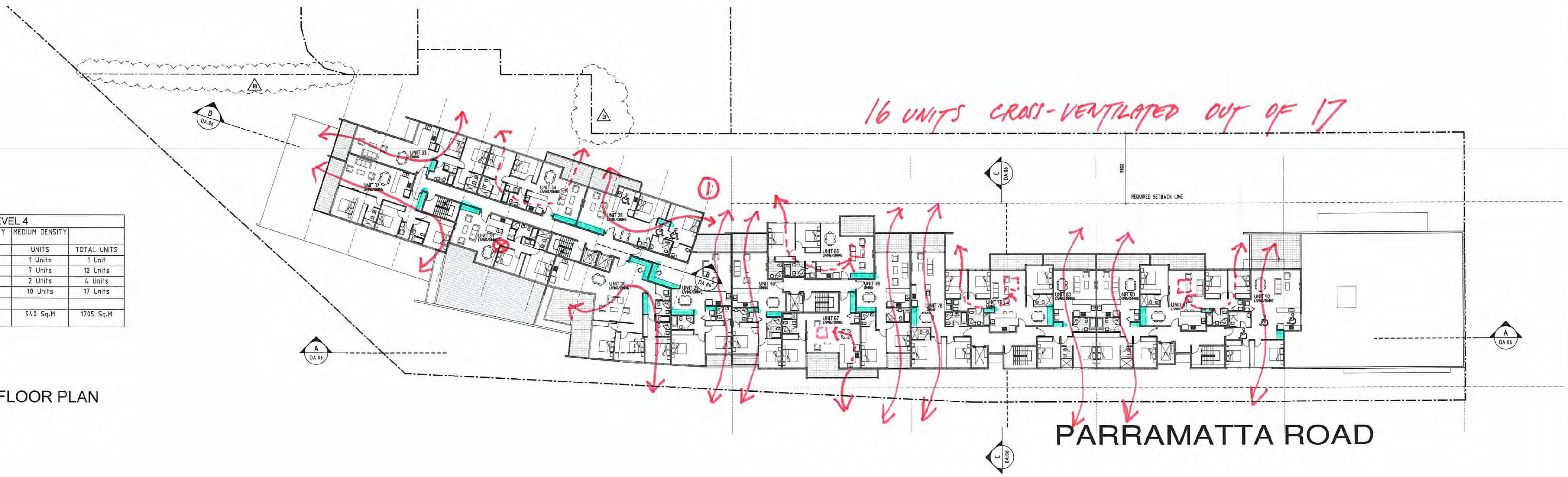
Note:
3 Star Gas Instantaneous
Hot Water System



LEVEL 5	
	UNITS
1 BEDROOM	-Unit
2 BEDROOM	5 Units
3 BEDROOM	1 Unit
TOTAL UNITS	6 Units
TOTAL AREA NETT	576 Sq.M

LEVEL 5 - 7 FLOOR PLAN
SCALE 1:300
A1

LEGEND:
- REFER TO SKETCH SK01



LEVEL 4			
	HIGH DENSITY	MEDIUM DENSITY	
	UNITS	UNITS	TOTAL UNITS
1 BEDROOM	-Unit	1 Units	1 Unit
2 BEDROOM	5 Units	7 Units	12 Units
3 BEDROOM	2 Unit	2 Units	4 Units
TOTAL	7 Units	10 Units	17 Units
TOTAL AREA NETT	765 Sq.M	940 Sq.M	1705 Sq.M

NOTE:
UNITS 28 & 92 ARE ADAPTABLE

LEVEL 4 FLOOR PLAN
SCALE 1:300
A1

SKETCH SK03 rev. A 17.05.10

ISSUE	AMENDMENT	DATE	DRAWN
B	AMENDMENT AS PER COUNCIL REQ.	MAR 10	GS
A	DA ISSUE TO COUNCIL	FEB 10	GS

GENERAL NOTES
Figured dimensions shall be taken in preference to scaling.
Drawing to be read in conjunction with information on first page.
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NORTH

SHEET TITLE:
LEVEL 4 - 7 FLOOR PLANS

DRAWN:	CHECKED:	DATE:	SCALE:
GS	JK	FEB 10	1:300

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PROPOSED MIXED USE DEVELOPMENT
AT 171-189 PARRAMATTA ROAD
GRANVILLE
JOB No.
ISSUE: