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Air Quality Assessment - Proposed Development Site at 167 Hume Highway, Greenacre (with comments on proposed setback), update of Report CN181262

167 Hume Highway Greenacre

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1 INTRODUCTION

CETEC was engaged by Iris Capital to provide an air quality report for the proposed development site at 167 Hume Highway, Greenacre (Lot 402, DP 631754).

The objective of this report is to determine whether external air pollution could impact on the client's proposed 10 m setback from the boundary at the ground plane (13 m from the Hume Highway gutter) for the residential component of the site-specific planning proposal (PP) and for the client's preferred 5 m setback for the commercial component of the same PP (8 m from the Hume Highway gutter). The proposed general layout can be seen in Figure 5.

CETEC would also provide preliminary recommendations for the mitigation of impacts within the site arising from external pollution sources.

The scope of works and deliverables are as follows:

- Discuss potential vehicle emissions impacts from the adjacent classified road (the Hume Highway at the border of Chullora and Greenacre).
- Discuss local ambient air quality.
- Provide preliminary recommendations for mitigating air quality impacts within the proposed development site.
- Provide preliminary recommendations for further assessment of air quality impacts and / or verification of features designed to mitigate vehicle emissions impacts.

2 DEVELOPMENT PROPOSAL

As part of the development application, this report will aid designers in the design of the facility and provide baseline Air Quality Parameters (based on available information by the EPA).

The subject site is legally described as Lot 402, DP 631754 with a street address of 167 Hume Highway Greenacre.

At the time of preparing this report (N2020020) it was understood by CETEC that the client's proposal was to have a 10 m setback from the Hume Highway boundary at the ground plane for the residential units on Level 1 of Buildings A and B (the closest buildings to the Hume Highway within the proposed development). This would represent a distance of 13 m to the Hume Highway gutter. There would be a 5 m setback from the Hume Highway boundary at the ground plane (8 m setback from the Hume Highway gutter) for the commercial units of Buildings A and B at ground level. There were to be no residential units on the ground level. The proposed general layout can be seen in Figure 5, which is to be found in Section 4.

3 LOCAL AIR QUALITY

The NSW Office of Environment and Heritage (OEH) monitors air quality from 28 air monitoring stations in NSW. The air pollutants measured include ozone (O_3), nitrogen dioxide (NO_2), visibility (NEPH), carbon monoxide (CO), sulphur dioxide (SO_2) and particulates (PM_{10} and $PM_{2.5}$) although not every monitoring station measures all these pollutants. As indicated in the previous section, many of these pollutants are relevant to motor vehicle exhaust emissions but it also should be noted that they may also be generated from other diffuse or point sources.

The Office of Environment & Heritage (OEH) has set the following Air Quality Standards (Goals) as an Air Quality Index (AQI).[1]

Table 1 Standards/Goals for AQ (from OEH Web site)

Pollutant	Averaging period	Maximum Concentration or Standard	Goal (maximum allowable exceedances)
Carbon Monoxide	8 hours	9.0 ppm	1 day a year
Nitrogen Dioxide	1 hour	0.12 ppm	1 day a year
	1 year	0.03 ppm	none
Ozone	1 hour	0.10 ppm	1 day a year
	4 hours	0.08 ppm	1 day a year
Sulphur Dioxide	1 hour	0.20 ppm	1 day a year
	1 day	0.08 ppm	1 day a year
	1 year	0.02 ppm	None
PM_{10}	1 day	50 µg/m^3	None
	1 year	25 µg/m^3	None
$PM_{2.5}$	1 day	25 µg/m^3	None
	1 year	8 µg/m^3	None
Visibility (as b_{sp}) (NEPH)	1 hour	2.1 x 10^{-4} m^{-1}	Not applicable

Notes for Table 1:

The above information was taken from the Office for Environment and Heritage web site in January 2019.

ppm = parts per million by volume (that is, parts of pollutant per million parts of air)

PM_{10} = particles less than 10 micrometres in diameter

1 https://www.environment.nsw.gov.au/topics/air/understanding-air-quality-data/standards-and-goals

$PM_{2.5}$ = particles less than 2.5 micrometres in diameter

$\mu g/m^3$ = micrograms per cubic metre

b_{sp} = coefficient of light scattering due to particles. The lower the b_{sp} value, the lower the level of suspended particles and the better the visibility. The NSW OEH visibility standard of 2.1 x 10^{-4} m^{-1} corresponds to a visual distance of approximately nine kilometres

It should be pointed out that for nitrogen dioxide, sulphur dioxide, and ozone the concentrations are published on the OEH web site in units of "parts per hundred million" but this has been taken into account when assessing the published data.

At the time of revising this report, the NSW Air Quality Statement for the year 2019 had just become available. The NSW Air Quality Statement 2019[2] indicated that:

Air quality in New South Wales (NSW) was greatly affected by the continuing intense drought conditions and unprecedented extensive bushfires during 2019. The poorer air quality than 2018 was primarily due to elevated particle pollution throughout the State.

The bushfire emergency saw around 4 million hectares burnt in NSW from July to December 2019, resulting in widespread smoke impacts on many regions through spring and early summer. In addition, continuing intense drought has led to an increase in widespread dust events throughout the year. A further source of particles came from hazard reduction burns in and around Sydney in the cooler months.

Levels of nitrogen dioxide, sulfur dioxide and carbon monoxide easily met national standards, with the exception of an exceedance of the hourly nitrogen dioxide standard at the new Goulburn station during the bushfire emergency period.

Ozone levels increased compared with the previous year, due to effects of warm and dry weather and climatic conditions together with other factors such as emissions from extensive bushfires in the year, meeting the national standards on 91% of all days. The original version of this report focussed on a 12-month period of air pollution data that most of 2018 and part of 2019. That period remains the focus of this report. The air monitoring stations closest to the site that's the subject of this report are as follows (see also Appendix B):

- Chullora – approximately north, 0.69 km from the site.
- Earlwood – approximately east, 8.16 km from the site.
- Rozelle – approximately east, 11.06 km the site.
- Parramatta North – approximately north, 11.85 km from the site

CETEC has compiled available data for the four monitoring stations in question and these are presented in Table 2. A map showing the relative locations of the four sites can be found in Appendix B.

The single ozone exceedance at the Chullora station is, according to Table 1, the maximum "allowable" number of exceedances for the year. The OEH does not set a maximum number of

2https://www.environment.nsw.gov.au/topics/air/air-quality-statement

allowable exceedances for PM_{10} and $PM_{2.5}$ levels, even though it does set maximum concentrations allowable as indicated.

Table 2 Assessment of data from the four nominated sites for the 12-month period 7/01/2018 to 6/01/2019 (inclusive)

Measured Parameter	Air Monitoring Station Location and Number of Single-Day Exceedances			
	Chullora	Earlwood	Rozelle*	Parramatta North
Sulphur dioxide (1 hour)	0		0	0
Sulphur dioxide (1 day)	0	No data	0	0
Sulphur dioxide (1year)	0		0	0
Nitrogen dioxide (1 hour)	0	0	0	0
Nitrogen dioxide (1 year)	0	0	0	0
Ozone (1 hour average)	0	0	0	2
Ozone (4 hour average)	1	0	0	2
PM_{10} (1 day average)	7	5	3	7
PM_{10} (1 year average)	0	0	0	0
$PM_{2.5}$ (1 day average)	3	5	0	5
$PM_{2.5}$ (1 year average)	1	0	0	1
Carbon monoxide (8-hour rolling average)	0	0	0	0

Notes for Table 2:
Each exceedance (other than for a 1-year average) indicates the number of days on which the indicated average exceeded, at least once in those days, the corresponding "maximum concentration or standard" in Table 1. For example, there was one single day at the Chullora monitoring station when the 4-hour average for ozone exceeded the maximum allowable concentration of 0.08 ppm. In the case of 1-year averages, a value of '1' indicates that the target average was exceeded for the entire year.

At the Chullora station there were seven days when the allowable PM_{10} 1-day average was exceeded and three days when the allowable $PM_{2.5}$ 1-day average was exceeded. In the case of the PM_{10} measurements, the exceedances were on the following dates in 2018: February 15, March 19th and 20th, July 18th to 20th and November 22nd.

The day in February corresponds with bushfires in NSW, and the other three monitoring stations also recorded exceedances on the same day. Likewise the days in March corresponded with further bushfires in NSW, and exceedances were also recorded at the Earlwood and Parramatta North points (the Rozelle monitoring station was offline during that period).

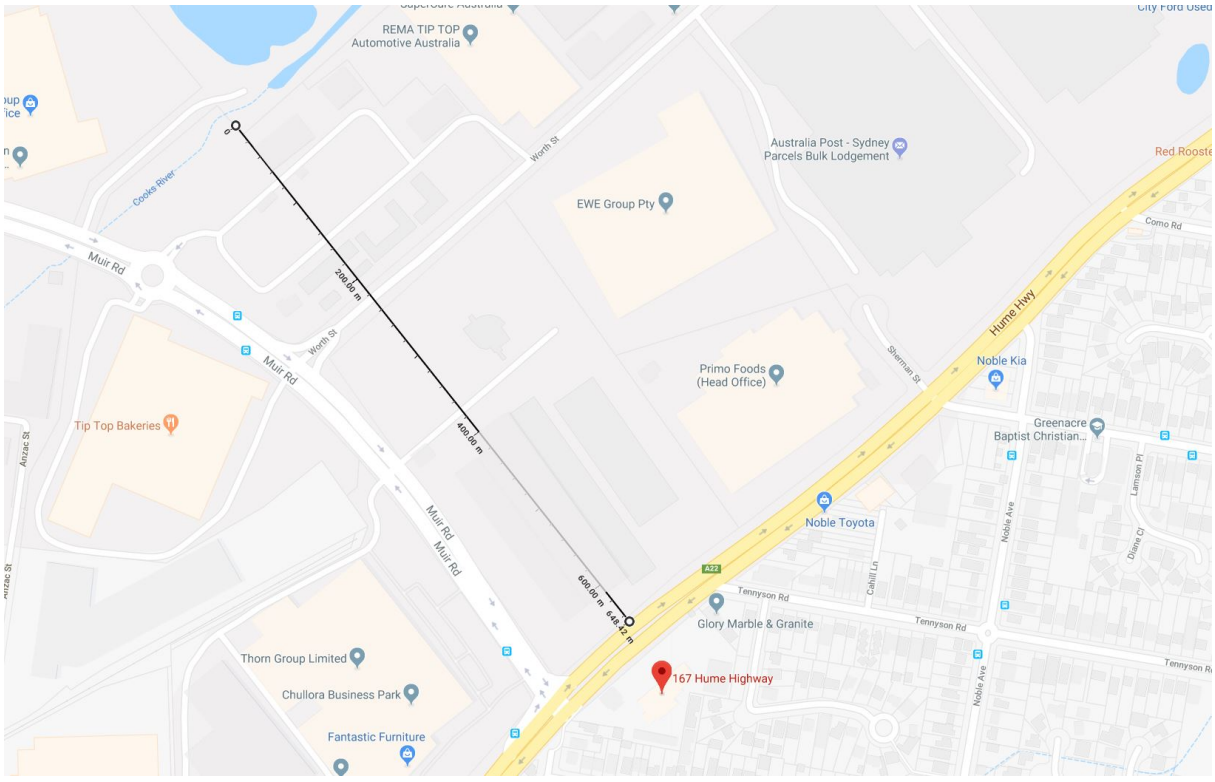
The three days in July corresponded to a period of widespread backburning within the Sydney basin. Again, exceedances were also recorded on at least one of the three days at the Earlwood and Parramatta North points (the Rozelle monitoring station was still offline).

The exceedances in November were attributable to the widely reported dust storm on the day, and the other three monitoring stations also recorded exceedances on the same day.

It's possible to conclude from this that PM_{10} exceedances recorded at the Chullora monitoring station during 2018 were not attributable to conditions that were unique to the location.

The same applies to the $PM_{2.5}$ readings for Chullora. Exceedances were recorded on May 28th and 29th, and on July 14th. Exceedances were also recorded on at least one of the two May days at the Parramatta North and Earlwood points (the Rozelle station was off-line at the time). These days corresponded to the commencement of a period of backburning in the Sydney basin. Similarly, the July exceedance corresponded to a period of elevated levels at each of the monitoring points that coincided with several backburning operations around Sydney.

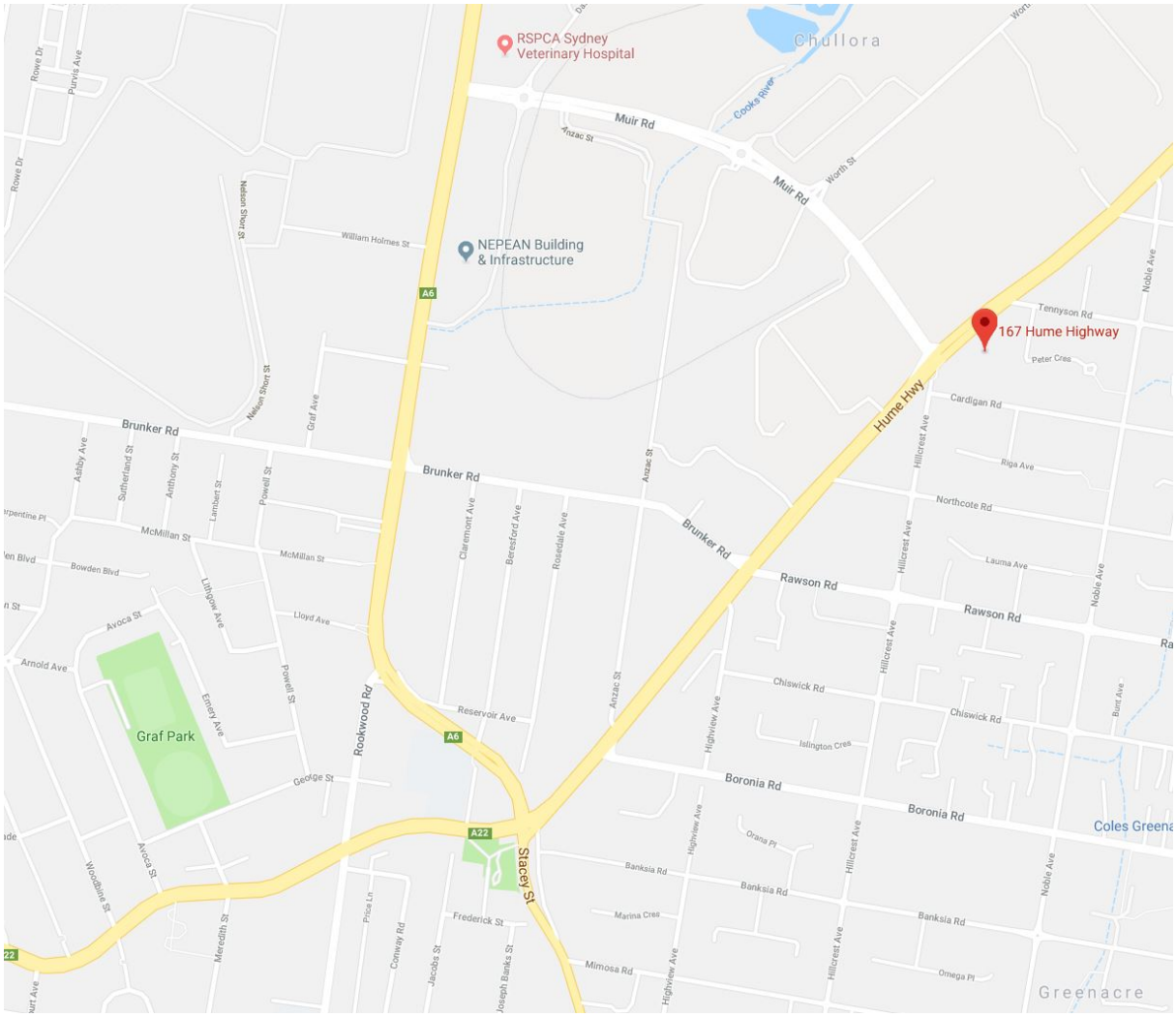
Figure 1: map showing site location and as distance from EPA monitoring point to north (at end of black line)



The Chullora measurement point is located just west of Muir Road and less than one kilometre from the site of the proposed development (as shown in Figure 1). Figure 2 shows a larger scale map and

indicates the position of main roads. The EPA monitoring point lies close to and to the northeast of Muir Road (for which traffic data was not available), to the east of Rookwood Road and to the north of the Hume Highway. The entire length of each of these roads would act as a continuous source of pollution from vehicular traffic, depending on the wind direction. South-easterly winds from the Hume Highway and Westerly winds from Rookwood Road would drive a continuous front of exhaust emissions towards the monitoring point from these roads and only upwards dispersion of pollutants would reduce their concentration when reaching the monitoring point. Horizontal dispersion would not reduce their concentration because the lengths of these roads are far greater than the distance from each road to the monitoring point. For all but very low wind speeds, upwards vertical dispersion of the pollutants would be limited. For example, at a distance of 650 m, particulates driven by a 10 kph southerly wind from the Hume Highway would take roughly 4 minutes to reach the Chullora monitoring point, by which time vertical dispersion would have reduced the particulate concentration (from vehicular sources) to some degree, perhaps by a factor of up to 10. However, as argued in the next section, the vehicular component of total particulates in the Sydney area is of the order of 10% or less, so the measured concentrations at the Chullora monitoring point are not likely to have been greatly influenced by vehicular emissions.

Figure 2 larger scale map of area showing positions of main roads (including Stacey Street)



In the case of the proposed development itself, similar logic would apply: that the entire length of the Hume Highway adjacent to the development would form the source of particulates from vehicles, and that winds from the northwest would lead to dispersion only in the vertical direction, and to a limited degree. As a result, the mitigating effect of the proposed 13 m setback from the Hume Highway gutter for the residential part of the development on dispersion of pollutants would be fairly limited. Wind directions ranging from westerly to northerly would bring pollutants from the length of the highway facing the site directly towards the building. Even in this situation there would be some degree of vertical dispersion over a distance of 13 m, and as a result the concentrations of particulate matter at a distance of 13 metres would be lower than at a distance of 5 m (for example).

4 VEHICLE EMISSIONS

The average motor vehicle will emit a mixture of carbon dioxide (CO_2), carbon monoxide (CO), hydrocarbons, oxides of nitrogen (NO_x), sulphur dioxide (especially from diesel vehicles) and particulate matter. These can lead to visible smog, exhaust odours, and adverse health impacts such as respiratory illness, cardiovascular disease and cancer.

The RMS Traffic Volume Viewer includes two key monitoring points: one on the Hume Highway just east of the corner with Stacey Street, roughly 1.3 km from the proposed development site and monitoring traffic in both directions. The other is located on Stacey Street, just south of the intersection with the Hume Highway, monitoring northbound traffic (which would include some traffic continuing north to Rookwood Road, and some turning onto the Hume Highway in both directions).

The Hume Highway monitoring point recorded an average of 57,472 car and truck movements per day (both directions) in 2018 while the Stacey Street point recorded an average of 22,213 car and truck movements per day in the northerly direction in 2018. The web page that formed the source of this data is reproduced in Appendix a. Somewhat further north from the Stacey Street point, Rookwood Road continues into Olympic Drive in Lidcombe, where northbound car and truck movements northbound averaged 22,238 per day in 2018. This suggests that a lot of the vehicle movements measured on Stacey Street are for vehicles continuing north into Rookwood Road, or that corresponding numbers of vehicles turn off Stacey Street onto the Hume Highway and off the highway to travel on Stacey Street and Rookwood Road.

As a comparison, Centenary Drive in Homebush continues north into Concord Road in Rhodes which then continues north to become Lane Cove Road in North Ryde. These are non-motorway arterial roads and Macquarie Park, just to the north of North Ryde, is one of Sydney's major industrial centres. Car and truck movements in Centenary Drive Homebush, Concord Road Rhodes (recording traffic crossing the Ryde Bridge) and Lane Cove Road at North Ryde averaged (in both directions) 95,324, 98,995 and 56,090 per day respectively in 2018.

The source of particulate matter in the Sydney area was summarised in a report published in 2012 by the then EPA (now the OEH)[3]. The report concluded that in terms of tonnages of emissions of the analytes shown in Table 1, most was human-made. For example, 81% of PM_{10} emissions and 92% of $PM_{2.5}$ emissions were believed to be human made. The sources of various pollutants are summarised later in the report. Figure ES-23 from the report is reproduced as Figure 3 below. As the pie chart shows, only 3.6% of PM10 emissions were believed to originate from 'heavy-duty commercial diesel exhaust'. If the 'other' includes diesel exhaust from passenger vehicles, then this contribution is likely to fall as engine technology improves.

Figure ES-28 from the report is reproduced as Figure 4 below. As the pie chart shows, only 5.3% of $PM_{2.5}$ emissions were believed to originate from 'heavy-duty commercial diesel exhaust' while 2.2% were believed to originate from 'light-duty diesel exhaust', such as would originate from diesel-powered passenger cars.

In both cases, the highest single contribution to PM10 and PM2.5 emissions was 'solid fuel burning (domestic)'. If this source was to be completely removed as an input to the total, then 'heavy-duty commercial diesel exhaust' would constitute 5.5% of the PM_{10} emissions and 10.7% of $PM_{2.5}$ emissions. The 'solid fuel burning (domestic)' source may be mainly restricted to the colder months of the year and may have been reduced to some degree since 2008 so as a contribution to total emissions these percentages may be more realistic in the present day. If we assume a 5.5% contribution from 'heavy-duty commercial diesel exhaust', then at a location on the Hume Highway at Chullora, the contribution from this source is likely to be relatively higher than at the nearby EPA monitoring point owing to the proximity of heavy trucks. If the PM_{10} concentration was to increase by a factor of five at locations on the highway itself, then the PM_{10} concentration would increase by 22%, and the percent contribution would increase to 22.5%. Applying the same principle to the $PM_{2.5}$ concentration, the actual concentration would increase by 42.8% as the percent contribution increases from 10.2% to 37.5%.

The mean PM_{10} and $PM_{2.5}$ concentrations for the entire year for the Chullora monitoring point were 21.9 µg/m³ and 8.7 µg/m³ respectively. The latter value exceeded the AQI target average value for the year for $PM_{2.5}$, which is 8.0 µg/m³. Applying the logic in the previous paragraph, if there was to be a five-fold increase in vehicular emissions within the Hume Highway boundary compared to the vehicular emission component at the Chullora monitoring point then, as already estimated, yearly mean PM_{10} and $PM_{2.5}$ would increase to 26.7 µg/m³ and 12.4 µg/m³ respectively.

These represent worst-case calculations of the effect of proximity to the Hume Highway and are levels that are unlikely to be reached even within the highway boundaries, and less so at distances of greater than 10 m.

3 Technical Report No. 1; Air Emissions Inventory for the Greater Metropolitan Region in NSW, 2008 Calendar Year; Consolidated Natural and Human-Made Emissions: Results. EPA 2012/0255, published August 2012

The World Health Organisation (WHO) publishes guideline limits for PM_{10} and $PM_{2.5}$ as follows:

PM_{10}	20 µg/m³ annual mean	50 µg/m³ 24-hour mean
$PM_{2.5}$	10 µg/m³ annual mean	25 µg/m³ 24-hour mean

The worst-case calculation indicates that it's possible that excessive vehicle emissions from the Hume Highway at the road boundary could elevate yearly average particulate concentrations to above the WHO guideline values (shown above) as well as elevating them above the AQI Targets. However, CETEC maintains that it's very unlikely that the proximity of the Hume Highway would cause such elevated local concentrations under normal wind conditions, especially given the other sources of particulate matter in Sydney as shown in Figure 3 and Figure 4. It's shown in Section 6 that prevailing wind directions would be likely to draw pollutants in the opposite direction (away from the site of the proposed development) for roughly half of any 12-month period, so the overall effect of increased particulate emissions by vehicles on the Hume Highway would be further diminished.

Figure 3: pie chart from EPA report showing make-up of human-made PM_{10} in the Sydney region

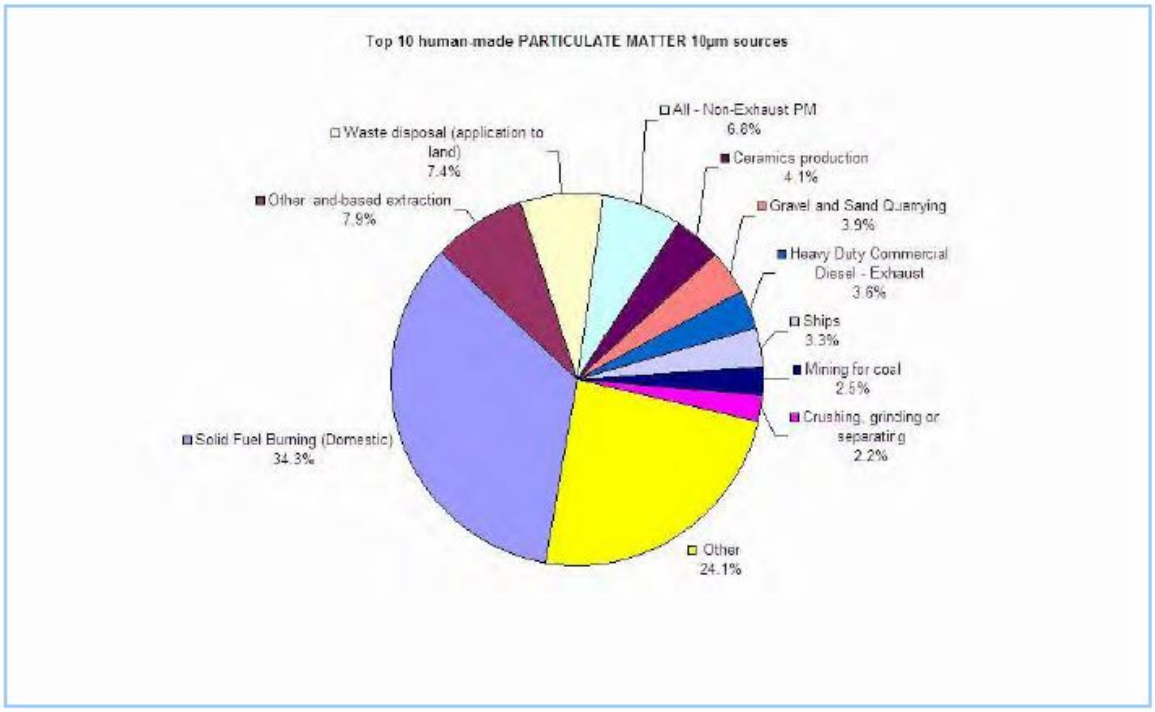


Figure ES-23: Top 10 human-made sources of particulate matter ≤ 10 µm in the Sydney region

Figure 4 pie chart from EPA report showing make-up of human-made $PM_{2.5}$ in the Sydney region

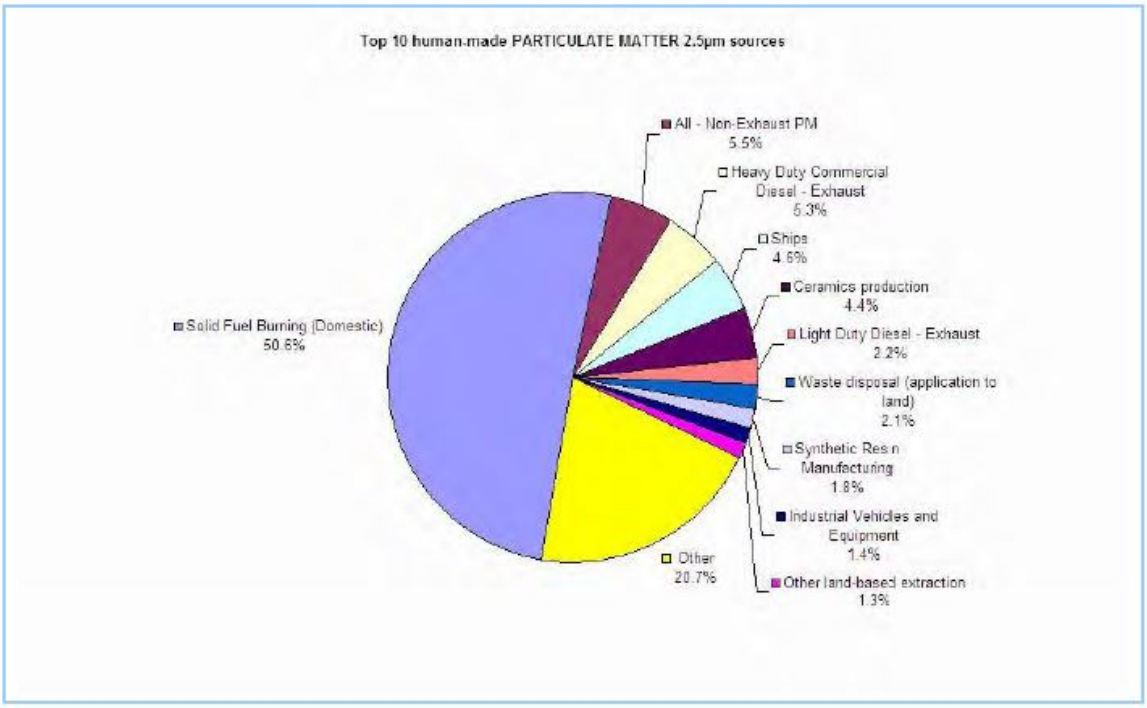


Figure ES-28: Top 10 human-made sources of particulate matter ≤ 2.5 µm in the Sydney region

The proposed general layout can be seen in Figure 5. In Section 2 it's pointed out that for Buildings A and B, residential use is proposed for Levels 1 and higher, while commercial use is proposed for ground level in both buildings. The residential units will be set back 10 m from the Hume Highway boundary (13 m from the gutter) while the ground level units will be set back 5 m from the boundary.

Concentrations of particulates attributable to vehicles on the Hume Highway would progressively diminish with distance from the highway boundary, but the magnitude of this diminishment would be dependent on factors such as wind direction, wind speed and air temperatures (which affect the buoyancy of vehicle exhaust fumes).

The 5 m setback for commercial use would be considered acceptable by CETEC in terms of pollutant concentrations as the typical pollutant concentrations at the monitoring point would be acceptable in workplaces. For example, the maximum 1-hour average concentration of carbon monoxide at the Chullora monitoring point for the specified yearly period was 3.6 ppm, with a mean of 0.2 ppm, compared to the time-weighted average (TWA) exposure limit for an 8-hour shift of 30 ppm (as published by Safework Australia.

The question of whether the 10 m setback from the residential units also needs to be considered. The WHO Guidelines for carbon monoxide in indoor air are showin in Table 3. These are taken from the WHO Guidelines For Indoor Air Quality: Selected Pollutants, World Health Organization 2010. This shows an indoor guideline limit of 6.0 ppm for a 24-hour period. CETEC has analysed the carbon

monoxide concentrations at the Bradfield monitoring point, which is located centrally between, and within a horizontal distance of 2.5 metres from, the Bradfield Highway and Cahill Expressway, north of the Sydney Harbour Bridge. The maximum carbon monoxide concentration at this monitoring point in the year 2019 was 4.9 (as a 1-hour average), with a yearly mean of 0.35 ppm. This was despite some severe bushfire-related events that caused elevated concentrations of carbon monoxide, PM2.5 and PM10. This monitoring point would be expected to be the one that shows the worst impacts of vehicle pollution in Sydney and yet at no point within 2019 did it show a 1-hourly average carbon monoxide concentration that would have been unacceptable in an indoor setting over 24 hours. Based on this, CETEC considers a 10 m setback for residential units to be acceptable in terms of carbon monoxide emissions.

Table 3: Indoor Guidelines Limits for Carbon Monoxide, as published by WHO.

WHO indoor carbon monoxide guidelines (from Table 2.5 of the WHO Guidelines For Indoor Air Quality: Selected Pollutants, World Health Organization 2010)			
Averaging time	Conc. (ppm, 20°C)	Conc. (mg/m³)	Comments
15 minutes	85.9	100	Excursions to this level should not occur more than once per day
1 hour	30.0	35	Excursions to this level should not occur more than once per day
8 hours	8.6	10	Arithmetic mean concentration
24 hours	6.0	7	Arithmetic mean concentration

Similarly, the WHO Indoor Guidelines provide an indoor guideline limit for nitrogen dioxide (1-hour average) of 0.20 mg/m³, which is equivalent to 10.5 parts per hundred million (ppmh) of the gas. The maximum at the Chullora monitoring point for the specified 12-month period was 5.7 ppmh. The Bradfield Highway monitoring point recorded mean and maximum values for nitrogen dioxide of 2.5 and 15.3 ppmh respectively. There were three bush-fire affected days in December 2019 on which nitrogen dioxide concentrations exceeded 10.5 ppmh while for the rest of the year that value was not exceeded. Again, at the most traffic-affected monitoring point in Sydney the nitrogen dioxide concentrations would have satisfied indoor guideline limits on all but three days.

The maximum for sulphur dioxide within the yearly period was 0.021 ppm, with a mean value of 0.001 ppm. The TWA for sulphur dioxide is 2 ppm in comparison. In both cases, if concentrations were elevated by a factor of 5 within 20 metres of the Hume Highway boundary the TWA exposure limits would not be exceeded for the entire year.

In the case of ozone concentrations at the Chullora monitoring point, both the maximum and mean concentrations exceed the TWA for ozone. However, ozone tends to be generated photochemically and not directly by vehicles. As a result, the proximity of the proposed site to the Hume Highway is not likely to lead to elevated concentrations of ozone.

Based on these discussions, CETEC considers a 10 m setback for residential units to be acceptable in terms of emissions of nitrogen dioxide, sulphur dioxide and ozone.

CETEC has looked at the particulate emissions for a 12-month period at the Bradfield monitoring point, which (as discussed) is in close proximity to the Bradfield Highway and the Cahill Expressway (within about 2.5 m of each road boundary) and compared them to the same 12-month period at the Chullora monitoring point. The comparison is shown in Table 4. It can be seen that the mean and median PM10 concentrations over the period are very similar: the mean for the Bradfield point is 2.3% lower than at the Chullora point while the median is 4.2% higher. The difference is greater for the PM2.5 concentrations: the mean and median at the Bradfield point are higher by 14.4% and 22.0% respectively. The median values may be a better measure of differences between the points as they're less sensitive to the days of extremely high particulate concentrations that occurred in November and December 2019 in large areas of the Sydney basin. At worst, these data suggest that the effect of the close proximity of vehicular traffic at the Bradfield point could be elevating the PM2.5 concentrations by around 25%. At the very worst the elevation in concentrations could be 50% at a horizontal distance from two major road boundaries of 2.5 m, compared to a horizontal distance of 13 m from the Hume Highway gutter to the proposed residential units on Levels 1 and above in Buildings A and B.

Based on this discussion, CETEC considers a 13 m setback for residential units from the Hume Highway gutter to be not likely to lead to unacceptable increases in exposure to PM10 or PM2.5 particulates by residents in those units.

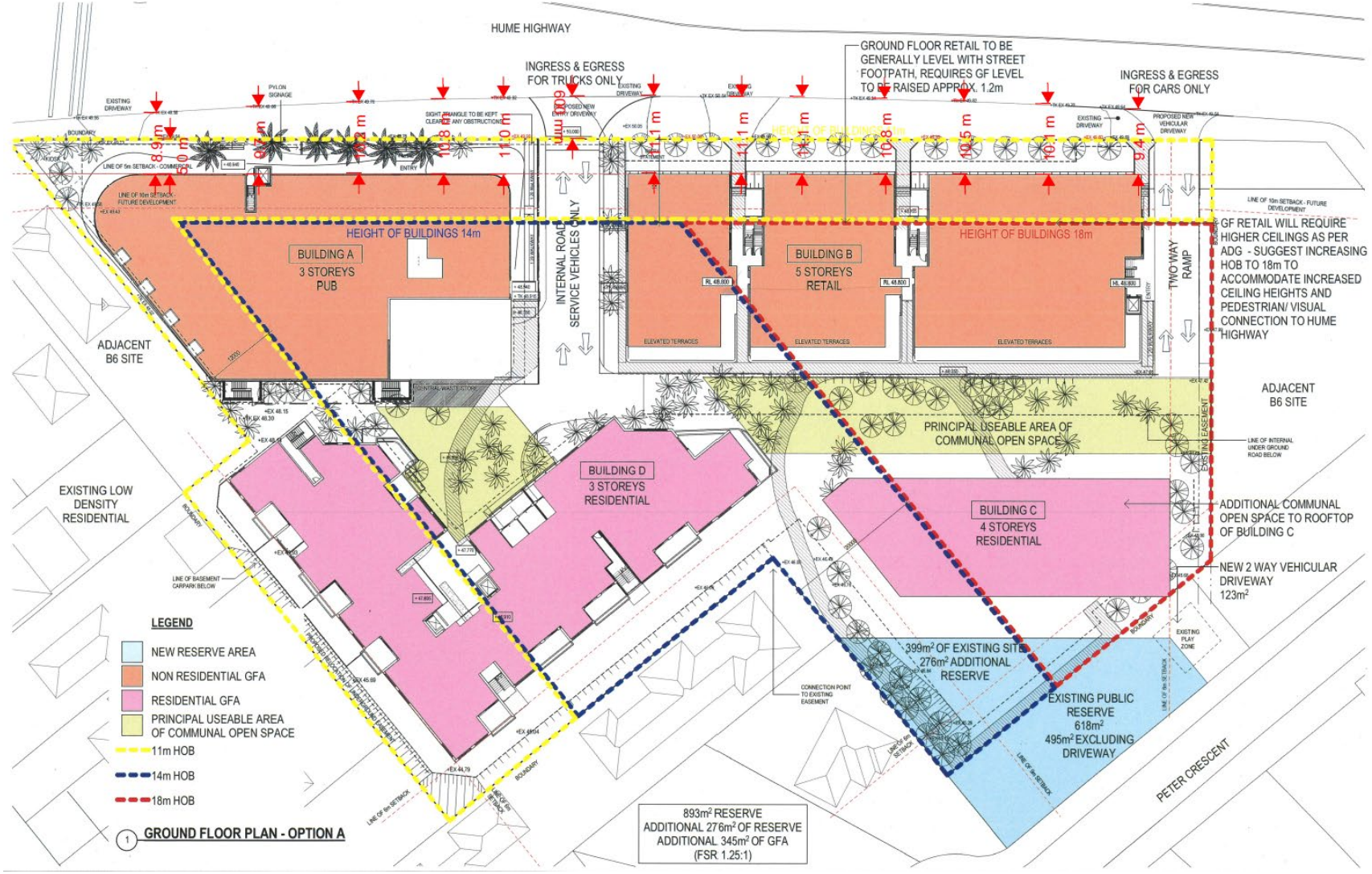
Table 4

PM2.5 and PM10 average (mean) and median concentrations over specified 12-month periods at Bradfield Highway and Chullora monitoring points			
PM2.5 concentrations:			
Monitoring point	Period	Mean (µg/m³)	Median (µg/m³)
Bradfield Highway	Jan. 1st 2019 to Dec. 31st 2019	13.1 µg/m³	10.0 µg/m³
Chullora		11.5 µg/m³	8.2 µg/m³
PM10 concentrations:			
Monitoring point	Period	Mean (µg/m³)	Median (µg/m³)
Bradfield Highway	Jan. 1st 2019 to Dec. 31st 2019	24.0 µg/m³	20.3 µg/m³
Chullora		24.6 µg/m³	19.5 µg/m³

CETEC maintains that on any given day the exposure of the proposed residential units to pollutants from traffic would depend to a large degree on the wind direction, and that if the wind direction results in pollutants being drawn towards the proposed units then the degree of the setback (whether it's 13 m or, for example, as little as 5 m) would reduce the level of pollutants originating from vehicles. The Hume Highway is not a point source as it would form a continuous source of pollutants along its entire length but there nevertheless would be progressively greater wind dispersion of pollutants with distance. Only on days when the wind speed is extremely low would

other dispersive forces such as vehicle movements and diffusion become significant. Based on all considerations within this section of the report, CETEC is satisfied that a residential setback 10 m from the Hume Highway boundary would be acceptable and would not lead to unacceptable risk to the health of occupants at that distance or greater.

Figure 5: drawing (as supplied to CETEC) with mark-ups showing set-back distances to the Hume Highway boundary



5 SITE OBSERVATIONS AND NEIGHBOURING EMISSION SOURCES

The site of the proposed development is located on the southern side of the Hume Highway at the border of Greenacre and Chullora, just east of the intersection with Muir Road. To the immediate south is a residential area of mainly detached single and two-storey dwellings while to the north of the Hume Highway is an extensive industrial area. This area includes a newsprint facility, the head office of a smallgoods distributor, a logistics warehouse and other warehouses. There's also a TAFE college and the head office of Volkswagen Australia. There appear to be no industries that would be expected to emit significant quantities of air pollutants in excess of normal vehicular movements.

6 ANALYSIS OF WIND DIRECTIONS

CETEC also analysed hourly average wind directions at the Chullora EPA monitoring point over the same period for which pollution parameters had been analysed (the 12-month period 7/01/2018 to 6/01/2019 (inclusive). It was estimated from available maps that the direction of the Hume Highway at the proposed site forms a perpendicular direction when looking towards the Hume Highway from the proposed site, that's roughly 318° in a clockwise direction from true north (with north considered to be zero degrees and south 180 degrees). That's approximately northwest (which would represent 315° from the northerly direction clockwise).

Analysis of the wind directions for the measurement period indicated that wind directions would have directed pollutants from the Hume Highway towards the proposed site, to some degree at least, for 52% of the total measurement period. For the remainder of that period the prevailing winds would have directed pollutants away from the site.

7 CONCLUSION AND RECOMMENDATIONS

Based on the desktop assessment and site inspection the following has been determined concerning ambient air quality at the site of the proposed development:

Although it is likely that vehicle emissions from the Hume Highway will impact air quality at the site, CETEC is of the opinion that the impact on indoor air quality will not be influenced to any significant degree by the degree of setback of the residential component of the development from the Hume Highway.

The nearby Chullora EPA monitoring point registered several exceedances in 2018 for particulate matter concentrations, measured as both PM_{10} and $PM_{2.5}$. However, these exceedances coincided with known Sydney-wide phenomena that included bushfires, back-burning and a significant dust event. The three nearest EPA monitoring points registered similar effects. Using NSW OEH data from 2008 (and which is soon to be updated) it was shown that vehicular sources of emission account for less than 10% of particulate emissions in the Sydney area and that as a result, a worst-case five-fold

increase in particulate concentrations of vehicular origin in the vicinity of the road would increase emissions by 23% and 43% for PM_{10} and $PM_{2.5}$ respectively. As the roads surrounding the proposed development represent linear sources of emission of pollutants (rather than point sources), a wide range of wind directions would propel the pollutants towards the proposed development and that this would limit the effect of small changes in the setback of the proposed development from the Hume Highway.

It was further shown that the Bradfield Highway monitoring point, located within roughly 5 m-wide strip between the Bradfield Highway and Cahill Expressway in one of Sydney's busiest traffic corridors north of the Sydney Harbour Bridge, records levels of nitrogen dioxide, carbon monoxide that would be acceptable throughout the year within an indoor setting according to WHO guidelines. Furthermore, concentrations of sulfur dioxide at that point are completely acceptable by any current guideline value and concentrations of particulates (PM2.5 and PM10) were not significantly elevated throughout the whole of 2019 compared to those at the Chullora monitoring point.

CETEC concludes that air quality data obtained from EPA monitoring points support the planning proposal for a 10 m setback for the closest boundary of residential units from the Hume Highway boundary (13 m from the gutter of the Hume Highway). The overall difference in air quality between a 10 m setback and, for example, a 12 m setback from the Hume Highway boundary would in CETEC's opinion be negligible in terms of air quality impacts. These arguments are presented in this report. In addition, CETEC would support a 5 m setback to the Hume Highway boundary for ground floor commercial use of the building (equivalent to 8 m to the gutter of the Hume Highway).

Initial proposals included a mound/fence at floor level in front of Building B. It's understood that this is not included in the most recent proposal (at the time of re-issuing this report). Based on the discussion in this report, CETEC does not consider that the removal of the mound/fence will lead to adverse impacts on occupants of the building resulting from air pollutants originating from the Hume Highway. This is especially so given that there is to be no residential occupancy of the ground floors of Buildings A and B.

However, CETEC also takes the view that any mitigation of the effects of pollutant sources originating from the Hume Highway and from more diffuse sources would be desirable, and some degree of mitigation would be achieved if the following recommendations are applied to the design and construction of the proposed development:

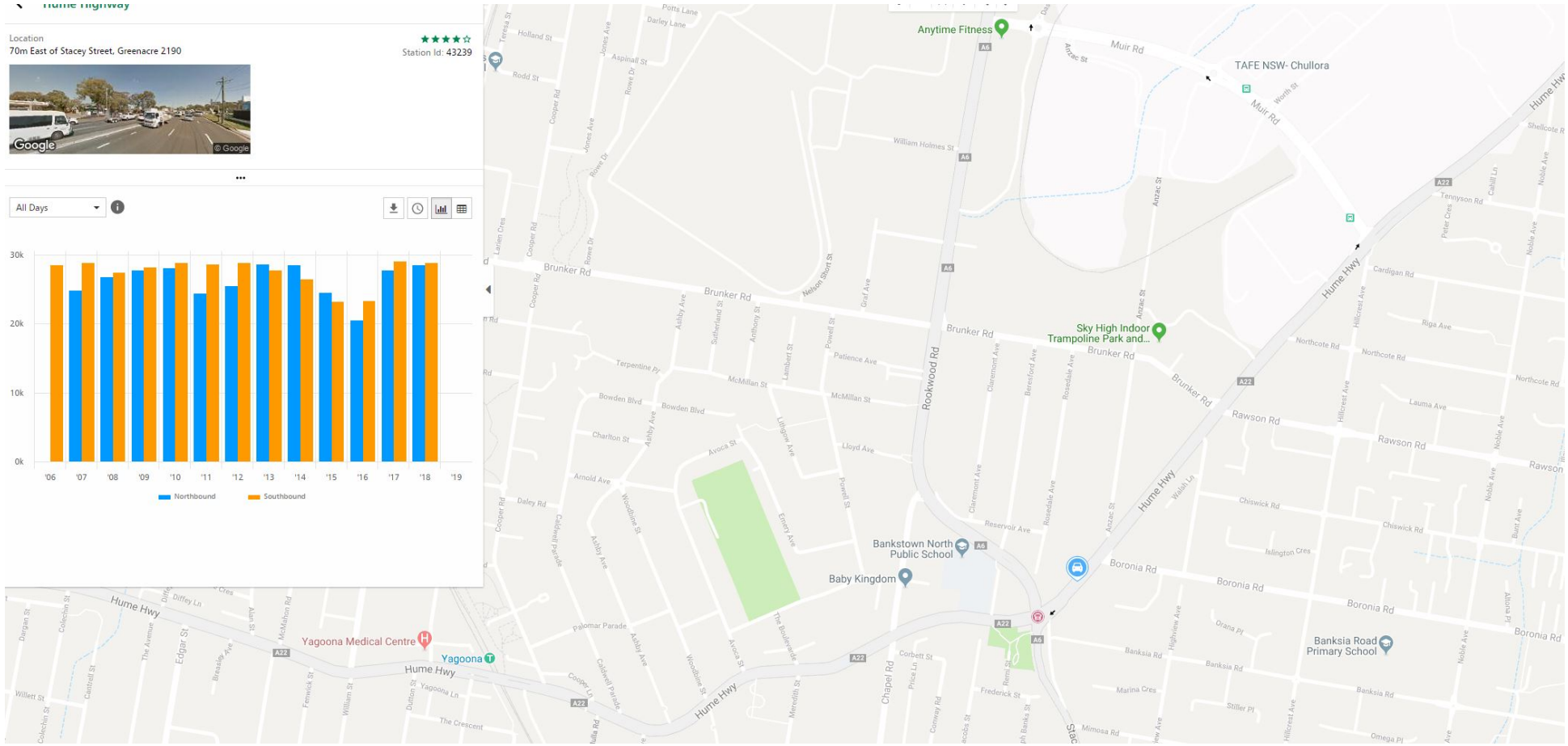
- Overall when considering the site observations on the day, it would be expected that the site will comply with acceptable air quality guidelines on days of 'normal' weather conditions. i.e. days when extreme temperatures are not occurring as these days are more likely to produce very hot, still conditions whereby the vehicular hot exhaust is more likely to possess similar buoyancy to the hot ambient and is therefore less likely to dissipate.

- When external air quality is poor, infiltration of air through the building envelope may diminish indoor air quality to some degree and it's therefore recommended that the design

and construction of the building meets building air tightness standards such as Green Star, ATTMA or NIBS. The air leakage rate can be measured during the construction phase and/or after completion to confirm compliance with air leakage standards.

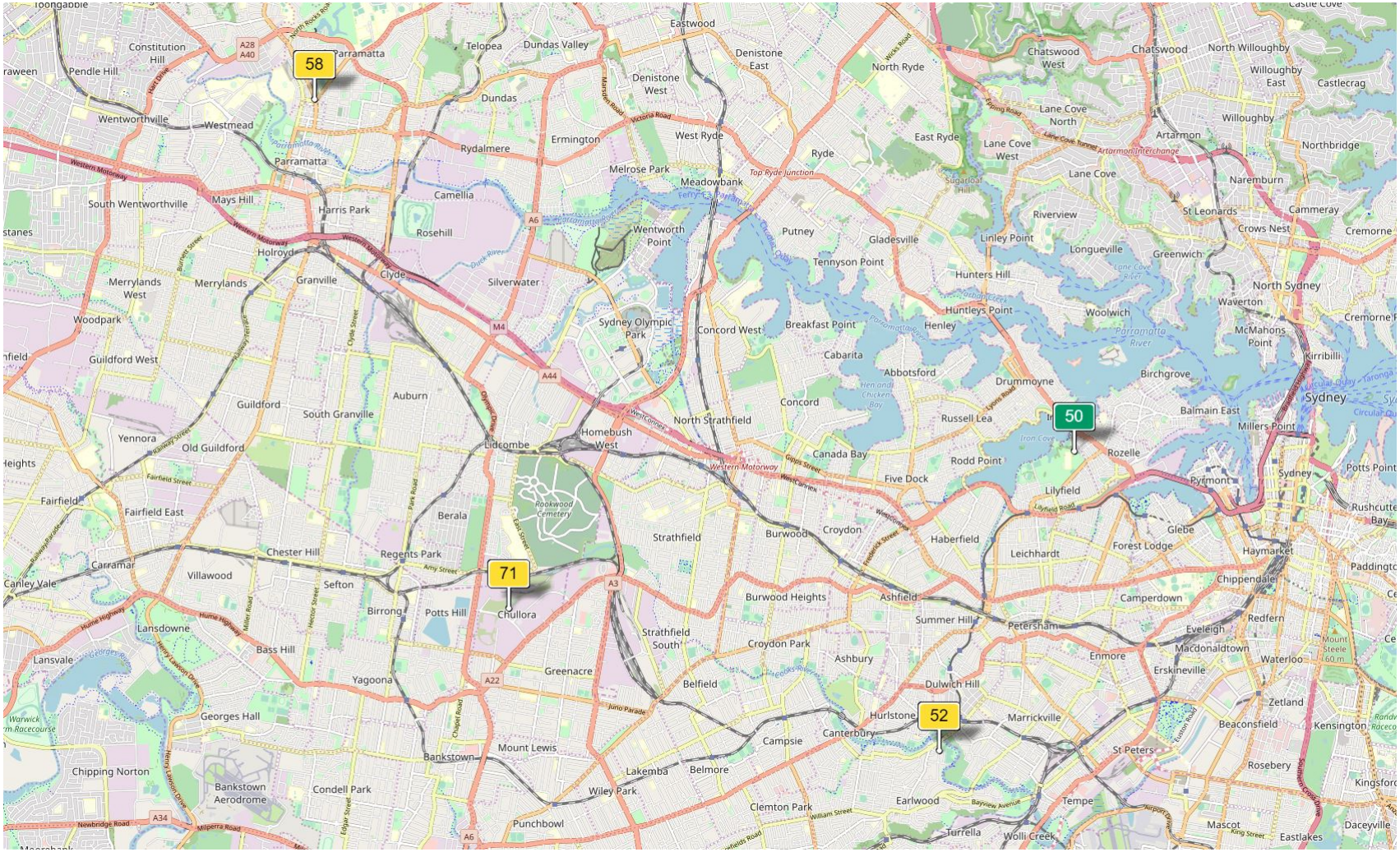
- To prevent airborne particulates being drawn into the building through the mechanical ventilation system (if installed), appropriately designed particulate filters are recommended, e.g. MERV 13 or higher.
- If installed, the mechanical design should consider the pressure differential between outdoors and indoors.
- The design of the main entrance (i.e. the main entrance facing the Hume Highway) should limit the flow of unfiltered air from the outside.
- Indoor air quality testing should be conducted after construction is complete and mechanical systems are operating normally to confirm indoor air quality is acceptable at the site.

APPENDIX A: TRAFFIC VOLUME MONITORING SITES: HUME HIGHWAY EAST OF STACEY STREET



Source: https://www.rms.nsw.gov.au/about/corporate-publications/statistics/traffic-volumes/aadt-map/index.html#/?z=16&lat=-33.90205594293282&lon=151.03778256608143&ix=1&id=43239

APPENDIX B: LOCAL AIR QUALITY MONITORING SITES



Source: http://aqicn.org/map/sydney/#@g/-33.8913/151.1461/14z

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