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Ian Easton Architect

St Phillips Christian College, Gosford

Air Quality Assessment

29N-15-0139-TRP-519525-0

26 Feb 2016

Air Quality Assessment **St Phillips Christian College, Gosford**		
DOCUMENT NO: 29N-15-0139-TRP-519525-0 **PREPARED FOR:** Ian Easton Architect 112 The Lane Wickham, New South Wales, 2293, Australia **CONTACT:** Ian Easton **Tel:** +61 2 4969 1360 **Fax:** +61 2 4969 1359	**REPORT CODE:** TRP **PREPARED BY:** Vipac Engineers & Scientists Ltd. 4/5 Leo Lewis Close, Toronto, NSW 2283, Australia **Tel:** +61 2 4950 5833 **Fax**: +61 2 4950 4276	
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REVISION HISTORY		
Revision No.	Date Issued	Reason/Comments
0	26 Feb 2016	Initial Issue
1		
2		
DISTRIBUTION		
Copy No. 2	**Location**	
1	Project	
2	Client (PDF Format)	Uncontrolled Copy
3		
KEYWORDS:		

EXECUTIVE SUMMARY

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Ian Easton Architects to carry out an Air Quality Assessment of a proposed Junior School Building within the grounds of St. Phillips Christian College located at 2-30 Narara Creek Road, Narara. This assessment is a Level 2 assessment in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW using AusRoads modelling software. This assessment is conservative for the following reasons:

- The 100th percentile background concentrations from a site representative monitoring station with concurrent site specific meteorological conditions have been modelled;
- Traffic data from NSW have been used based on a typical diurnal traffic pattern using a high proportion of heavy vehicles;
- The $PM_{2.5}$ concentrations were derived from the PM_{10} concentrations at the Lindfield monitoring station. A ratio of 0.49 was applied based on the $PM_{10}/PM_{2.5}$ ratio at a nearby monitoring station;
- The 100th percentile predicted concentrations have been reported to provide the worst-case assessment.

The results show that the predicted concentrations comply with the relevant criteria for all pollutant and time periods. Overall, this assessment has determined that air quality at the prediction locations will not exceed any pollutant criteria. As such, no adverse impacts on health are expected from the road traffic emissions and air quality should not be considered a constraint to the proposed Junior School at this location.

TABLE OF CONTENTS

1 INTRODUCTION

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Ian Easton Architects to carry out an Air Quality Assessment of a proposed Junior School Building within the grounds of St. Phillips Christian College located at 2-30 Narara Creek Road, Narara (Lot 102 DP 832279) NSW 2250.

The development is proposed on land with a frontage to a classified road (Manns Road); therefore pursuant to clause 101 of the State Environmental Planning Policy an Air Quality Assessment has been requested. The purpose of this report is to assess the Air Quality at each classroom and auxiliary rooms within the proposed new Junior School from the traffic on nearby roads.

This assessment is a Level 2 assessment in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales using AusRoads modelling software. The site location (outlined in red) is shown in **Figure 1-1**.

Figure 1-1: Site Location

2 AIR EMISSIONS OF CONCERN

The pollutants investigated from the movement of vehicles along surrounding roads are those referred to as common air pollutants:

- **Carbon monoxide (CO)** - Produced from the incomplete combustion of fossil fuels. In the human body, CO combines with haemoglobin to form carboxyhaemoglobin that can deprive the body of oxygen. Short-term effects of CO include headaches and nausea.
- **Oxides of nitrogen (NO_x)** - Emitted by motor vehicles are comprised mainly of nitrogen oxide (NO) and nitrogen dioxide (NO_2). Nitrogen oxide is produced by the high temperature combustion in the presence of nitrogen and oxygen. Nitrogen oxide is converted to nitrogen dioxide in the atmosphere. Exposure to NO_2 can result in decreased lung function and increases in respiratory illness. Exposure can lead to hospital admissions and emergency room visits for respiratory and cardiovascular disease.
- **Particulate matter -** In the atmosphere, particles range in size from 0.1 to 50 µm. Particulate matter in the atmosphere can have an adverse effect on health and amenity. The impact that particles have upon health is largely related to the extent to which they can penetrate the respiratory tract. Particles with an aerodynamic diameter greater than 10 µm are generally screened out in the upper respiratory tract by adhering to mucus in the nose, mouth, pharynx and larger bronchi and from there are removed by either swallowing or expectorating. Very fine particles less than 2.5 µm can be deposited in the pulmonary region. It is these particles that are of greatest concern to health.
- **Sulfur dioxide (SO_2) -** Released during the combustion process of fuels for transport related emissions the release of sulfur dioxide is relatively small when compared to other gases. Sulfur dioxide can affect the respiratory system, the functions of the lungs and irritate eyes.
- **Hydrocarbons** are emitted from vehicles through the incomplete combustion of fuel. They collectively cover a wide range of pollutants. While hydrocarbons alone do not generally pose a problem at the concentrations commonly experienced, they do play a significant role in photochemical smog formation. Specific components such as benzene are known to have an adverse effect on human health.

3 ASSESSMENT CRITERIA

The Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales (Department of Environment & Conservation, 2005) define ambient air quality impact assessment criteria. The adopted criteria for all pollutants of concern are identified in **Table 3-1**.

Table 3-1: Adopted Air Quality Goals

Air Quality Indicator	Criteria	Averaging Time	Source
Nitrogen dioxide (NO_2)	246 µg/m^3	1 hour	NSW Approved Methods
	62 µg/m^3	Annual	NSW Approved Methods
Particulate matter (PM_{10})	50 µg/m^3	24-hour	NSW Approved Methods
	30 µg/m^3	Annual	NSW Approved Methods
Particulate matter ($PM_{2.5}$)	25 µg/m^3	24-hour	NEPC
Carbon monoxide (CO)	30 mg/m^3	1 hour	NSW Approved Methods
	10 mg/m^3	8 hour	NSW Approved Methods
Sulfur dioxide (SO_2)	570 µg/m^3	1 hour	NSW Approved Methods
	228 µg/m^3	24-hour	NSW Approved Methods
	60 µg/m^3	Annual	NSW Approved Methods
Benzene	0.029 mg/m^3	1 hour	NSW Approved Methods

4 METHODOLOGY

Modelling of emissions from vehicles was performed using the VIC EPA road emissions model AusRoads, which utilises the same algorithms as the United States Environmental Protection Agency line source model Caline4. AusRoads is widely used and is the recommended model for use in roadside air quality studies. AusRoads model was used instead of Caline4 due to the software's ability to include a full year of local meteorological data, thus providing a representative assessment.

Meteorological inputs were derived using The Air Pollution Model (TAPM), which is a 3-dimensional prognostic model developed and verified for air pollution studies by the CSIRO. The use of TAPM was in accordance with the Approved Methods document. The following parameters were used in the modelling:

- Centre Grid Location: -33 deg 24.5 min, 151 deg 20.0 min;
- Dates Modelled: 1st January 2014 to 31st December 2014;
- Number of Grid Points: 31 x 31:
- Outer Grid Spacing: 30,000 m x 30,000 m
- Number of Grid Domains: 5 (30,000, 10,000 m, 3,000, 1,000 m and 300 m); and
- Number of Vertical Grid Levels: 25 (from 10 m to 8,000 m).

The site-specific meteorological data for 2014 is presented in **Section 7**.

5 PREDICTION LOCATIONS

The prediction locations for the proposed school are summarised in **Table 5-1** and identified in **Figure 5-1** to **Figure 5-3**. These locations are the closest point for each room/use.

Table 5-1: Prediction Locations

Level	Description	Location (UTM)		
		Easting (X)	Northing (Y)	RL (Z)
Lower Level	Location 1: Practice Room 1	345247	6302178	40.6
	Location 2: Practice Room 2	345240	6302176	40.6
	Location 3: Music Room	345245	6302184	40.6
	Location 4: Art Room	345234	6302195	40.6
	Location 5: Year 4	345223	6302199	40.6
	Location 6: Year 3	345199	6302205	40.6
Entry Level	Location 7: Kinder	345199	6302205	44.1
	Location 8: Year 1	345223	6302199	44.1
	Location 9: Year 2	345245	6302184	44.1
	Location 10: Admin Building	345212	6302163	44.1
Air Conditioning Plant Locations	Location 11: AC near Kinder	345183	6302191	44.1
	Location 12: AC near Year 2	345224	6302178	44.1
Outdoor Areas	Location 13: Outdoor Area	345260	6302167	44.1
	Location 14: Covered Outdoor Area	345228	6302171	35.6

Figure 5-1: Prediction Locations for Lower Level

Figure 5-2: Prediction Locations for Entry Level

Figure 5-3: Additional Prediction Locations

6 BACKGROUND CONCENTRATIONS

To determine the total effect of emissions within the local area, background concentrations of pollutants should be considered. Ambient monitoring data has been obtained from the NSW Office of Environment & Heritage website for 2014. In accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales, the nearest and representative monitoring data was used.

The most representative monitoring location was deemed to be Lindfield which monitors nitrogen dioxide, sulfur dioxide, particular matter (PM_{10}) and ozone. Background concentrations for carbon monoxide were obtained from the Chullora monitoring station.

The maximum daily concentrations as well as annual averages were obtained for Lindfield and Chullora for 2014. The annual average concentrations are presented in **Table 6-1**. Pollutant concentrations were converted to micrograms using the conversion rate at 0˚C as provided in the Approved Methods document.

Table 6-1: Background Concentrations

Pollutant	Annual Average Ambient Concentration ($\mu g/m^3$)
Nitrogen Dioxide	16.4
Particles (as PM_{10})	14.1
Particles (as $PM_{2.5}$)	6.9
Sulfur Dioxide	2.8
Carbon Monoxide	375.0
Ozone	34.2

In order to estimate $PM_{2.5}$ concentrations in the project area, the ratio of PM_{10} to $PM_{2.5}$ measured at the Chullora monitoring station was calculated. The ratio between PM_{10} and $PM_{2.5}$ was 0.49. Based on experience, the ratio is typically between 0.3 and 0.4. Therefore this ratio of 0.49 is considered to be conservative and acceptable for this assessment.

The daily maximum background concentrations (i.e. 100th percentile) were modelled as hourly concentrations for all pollutants with concurrent meteorological data for 2014 in AusRoads modelling software. For example, if the daily maximum CO background concentration was 480 $\mu g/m^3$, each hour of that day was determined to be 480 $\mu g/m^3$ to provide a conservative assessment. Examples of the NO_2, PM_{10} and $PM_{2.5}$ background concentrations as used in the model are presented in **Figure 6-1** to **Figure 6-4**.

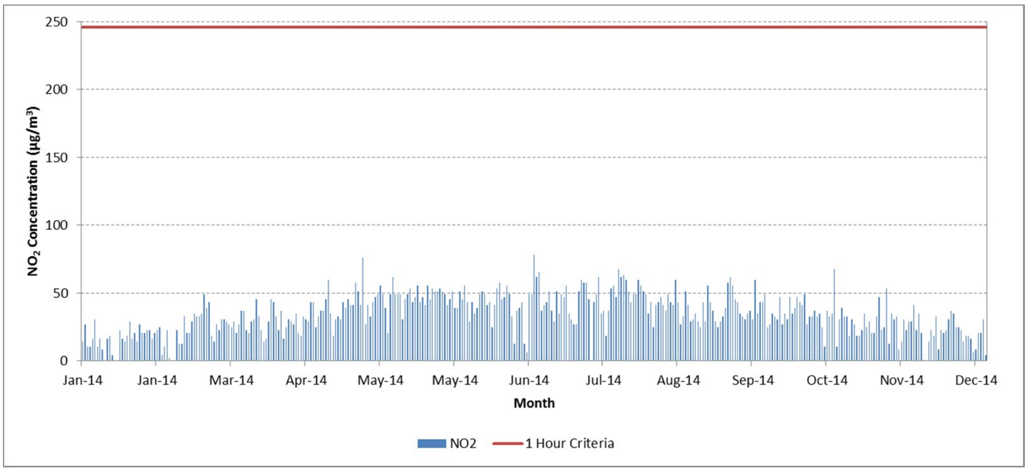


Figure 6-1: Maximum Daily NO_2 Concentrations from Lindfield Monitoring Station for 2014 with the 1 Hour Criteria

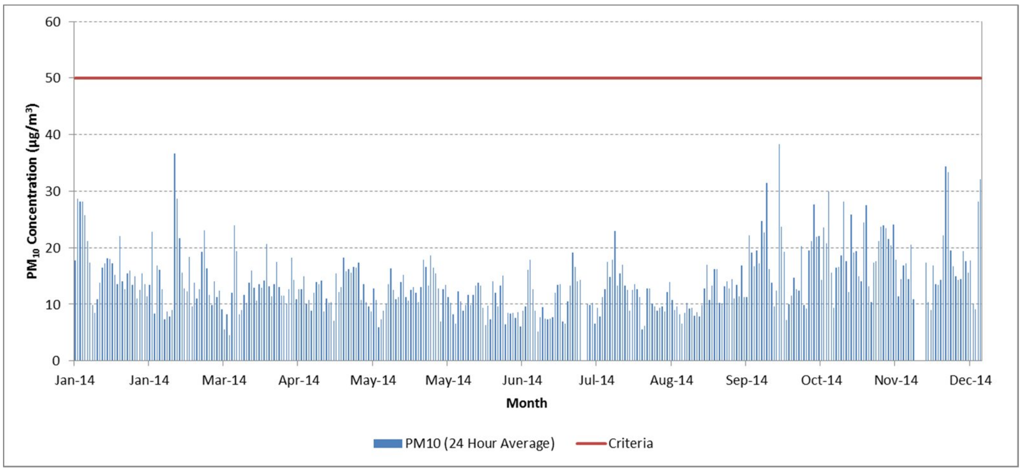


Figure 6-2: Daily Average PM_{10} Concentrations from Lindfield Monitoring Station for 2014 with the Daily Criteria

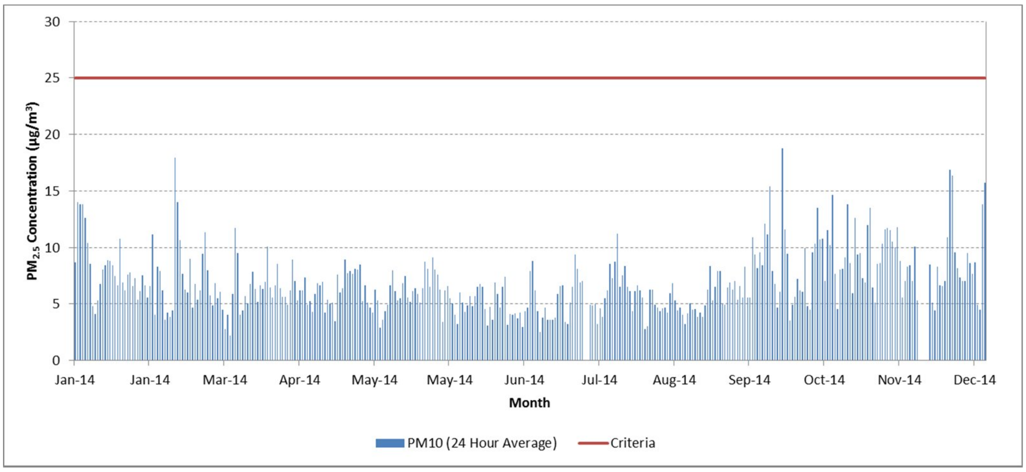


Figure 6-3: Daily Average $PM_{2.5}$ Concentrations using a 0.49 Ratio of the Lindfield PM_{10} Monitoring Station for 2014 with the Daily Criteria

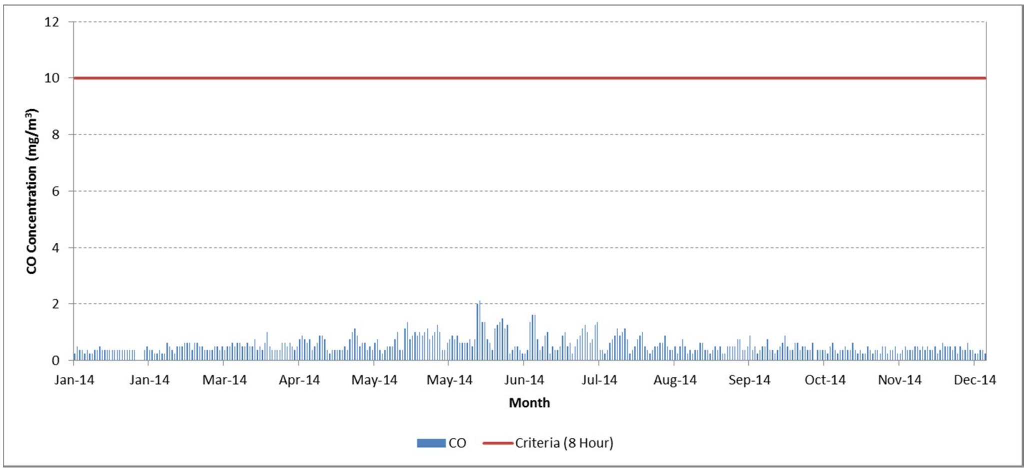


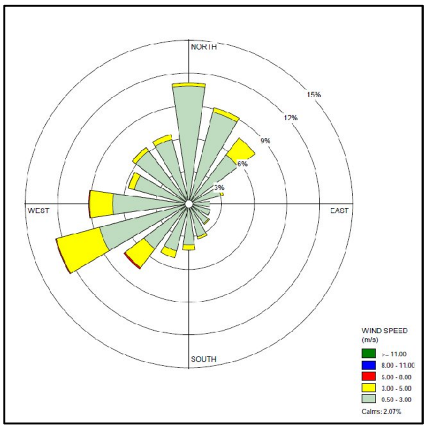
Figure 6-4: Maximum CO Concentrations from Chullora Monitoring Station for 2014 with the Daily Criteria

7 METEOROLOGY

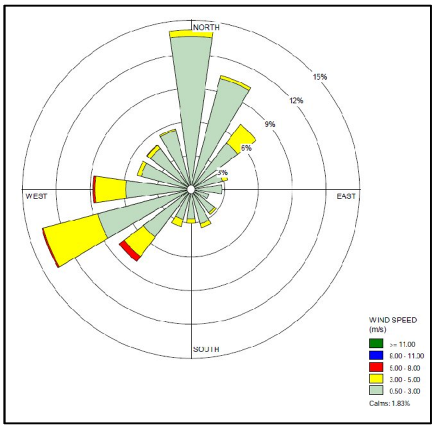
7.1 WIND SPEED & DIRECTION

Wind roses were generated using TAPM at the site for 2014 are presented in

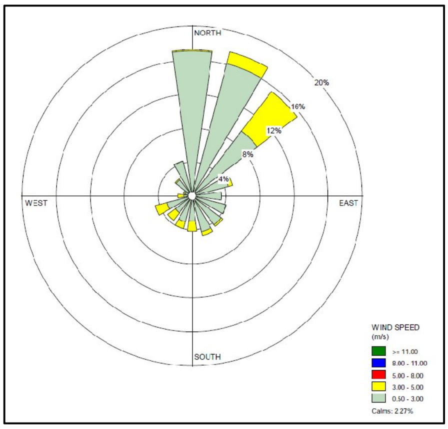
Figure *7-1* and show that winds blowing from a north easterly and northerly direction will carry the vehicle emissions towards the development; these winds are frequent during Summer and Autumn.



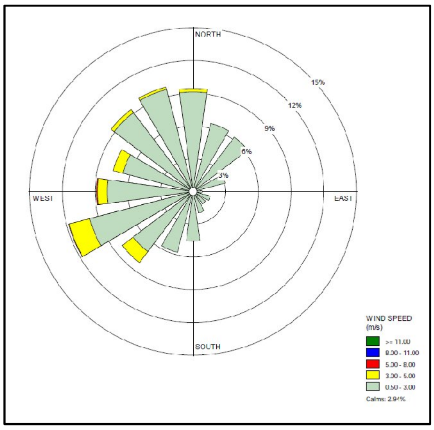
Annual (Calm – 2.07 %)



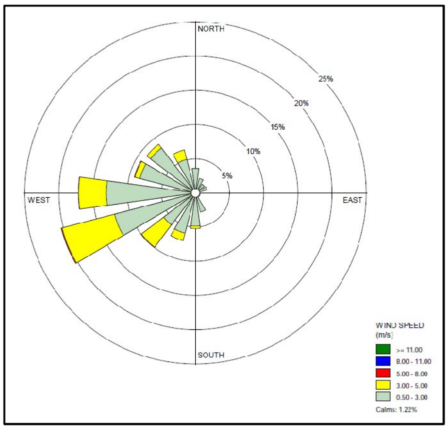
Spring (Calm – 1.83%)



Summer (Calm – 2.27%)



Autumn (Calm – 2.94%)



Winter (Calm – 1.22%)

Figure 7-1: Site-Specific Wind Roses by Season for 2014

7.2 STABILITY CLASS ANALYSIS

Atmospheric stability refers to the tendency of the atmosphere to resist or enhance vertical motion. The Pasquill-Turner assignment scheme identifies six Stability Classes (Stability Classes A to F), to categorise the degree of atmospheric stability. These classes indicate the characteristics of the prevailing meteorological conditions and are used as input into various air dispersion models. **Table 7-1** shows that stability class F is most common occurring for 32.37% of the annual hours.

Table 7-1: Stability Classes [TAPM, 2014]

Stability Class	Description	Frequency of Occurrence (%)	Average Wind Speed (m/s)
A	Very unstable low wind, clear skies, hot daytime conditions	1.70%	2.4
B	Unstable clear skies, daytime conditions	7.48%	2.5
C	Moderately unstable moderate wind, slightly overcast daytime conditions	9.53%	2.4
D	Neutral high winds or cloudy days and nights	42.09%	1.7
E	Stable moderate wind, slightly overcast night-time conditions	6.83%	2.0
F	Very stable low winds, clear skies, cold night-time conditions	32.37%	2.1

7.3 MIXING HEIGHT

Mixing height refers to the height above ground within which pollutants released at or near ground can mix with ambient air. During stable atmospheric conditions, the mixing height is often quite low and pollutant dispersion is limited to within this layer. Diurnal variations in mixing depths are illustrated in **Figure 7-2**. As would be expected, an increase in the mixing depth during the morning is apparent, arising due to the onset of vertical mixing following sunrise. Maximum mixing heights occur in the mid to late afternoon, due to the dissipation of ground-based temperature inversions and the growth of convective mixing layer.

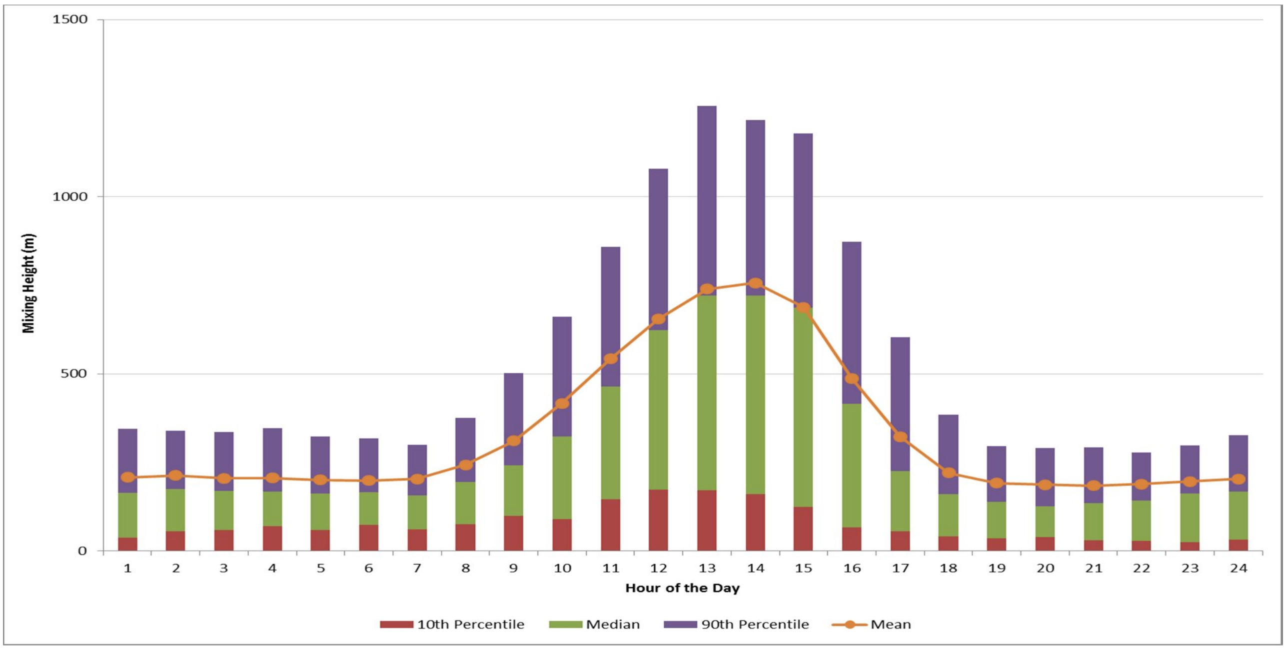


Figure 7-2: Mixing Height Data [TAPM, 2014]

8 TRAFFIC DATA & VEHICLE EMISSIONS

Traffic data for this assessment was obtained from the Parsons Brinckerhoff report on the Northern Sydney Freight Corridor Gosford Passing Loops – Traffic and Transport Assessment. This report provided values for Manns Road for a 2014 baseline. The traffic data was increased based on an annual increase of 1.6% as stated in the report.

The expected the occupant capacity of the existing college and proposed junior schools is 804 pupils with 95 equivalent full time staff. For the school traffic numbers it has been assumed that 60% of pupils and 95 staff will be dropped off or park at the site. For Mailwa Road and Narara Creek Road, estimated values were

Daily traffic data for the modelled roads are presented in **Table 8-1** with their corresponding heavy vehicles percentages.

Table 8-1: Traffic Data

Roads	Vehicles per Day	Heavy Vehicles (%)
Road through School	1,154	0
Narara creek Road	3,000	2.00%
Mailwa Road	1,577	2.00%
Manns Road	12,137	2.60%

Using typical diurnal traffic patterns, the daily traffic flows have been spilt on an hour-by-hour basis, as shown in **Table 8-2** and **Figure 8-1**. It can be seen that the highest hourly flow will occur at 18:00 hours and the traffic flow during this hour is approximately 10% of the daily flow.

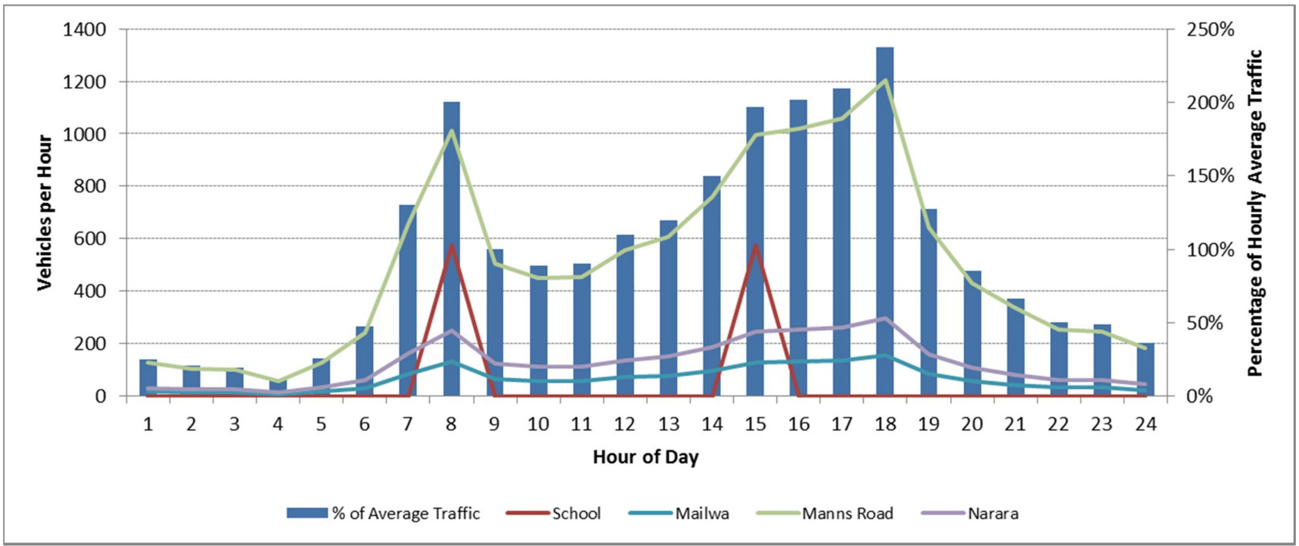


Figure 8-1: Diurnal Traffic Flow

For the school road it has been assumed that all vehicles will be using the road at the start and end of the school day.

Table 8-2: Hourly Traffic Flows based on Typical Travel Patterns

Hour of the Day	Percentage of Average Hourly Traffic	Road through School	Narara creek Road	Mailwa Road	Manns Road
1	31%	0	31	16	126
2	21%	0	26	14	106
3	20%	0	24	13	99
4	12%	0	15	8	59
5	26%	0	32	17	129
6	48%	0	59	31	241
7	95%	0	163	85	657
8	132%	577	250	131	1011
9	121%	0	125	66	506
10	89%	0	111	58	450
11	100%	0	113	59	455
12	150%	0	138	72	556
13	125%	0	150	79	607
14	162%	0	188	99	759
15	205%	577	246	129	995
16	202%	0	252	133	1022
17	210%	0	262	138	1060
18	238%	0	297	156	1203
19	127%	0	159	84	644
20	85%	0	107	56	431
21	66%	0	83	43	335
22	51%	0	63	33	256
23	49%	0	61	32	247
24	36%	0	46	24	184
Daily Traffic Flow		**1,154**	**3,000**	**1,577**	**12,138**

The National Pollution Inventory Emission Estimation Technique for Motor Vehicles was withdrawn in 2014 and replaced with the Australian Motor Vehicle Emission Inventory for the National Pollution Inventory (Department of Environment, 2014). This document presents the findings of a full inventory of motor vehicle emissions for Australia; however, it also provides general emission rates as grams per km travelled.

Emission rates are substantially affected by local driving conditions, vehicle mix, weather conditions and local fuel quality, and traffic volume. In order to determine more detailed local emissions, the Queensland Environmental Protection Agency (now Department of Environment, Heritage & Protection) Emissions Factors Spreadsheet has been used. This spreadsheet was specifically designed for use in determining composite emission rates for use in road emission modelling. The spreadsheet requires the input of heavy vehicle content, road gradient, season and average speed. Road gradients were applied to each road link based on available elevation data was used and “Hi-Temp” seasonal conditions were selected to represent worst-case conditions. The resultant vehicle emission rates are shown in **Table 8-3**.

Table 8-3: Emission Rates for Pacific Highway

Link Number	Name	Speed (km/hour)	Emission Factors from BCC Spreadsheet g/km/veh				
			NO_X	CO	HC*	PM_{10}	SO_2
Link1	School	15	3.58	36.24	2.19	0.11	0.18
Link2	School	15	2.09	29.78	2.19	0.09	0.16
Link3	School	15	3.58	36.24	2.19	0.11	0.18
Link4	School	15	3.58	36.24	2.19	0.11	0.18
Link5	School	15	3.58	36.24	2.19	0.11	0.18
Link6	School	15	5.18	45.74	2.26	0.14	0.21
Link7	School	15	2.09	29.78	2.19	0.09	0.16
Link8	School	15	1.76	29.77	2.28	0.09	0.15
Link9	School	15	2.09	29.78	2.19	0.09	0.16
Link10	School	15	3.58	36.24	2.19	0.11	0.18
Link11	School	15	5.18	45.74	2.26	0.14	0.21
Link12	School	15	3.58	36.24	2.19	0.11	0.18
Link13	School	15	3.58	36.24	2.19	0.11	0.18
Link14	School	15	3.58	36.24	2.19	0.11	0.18
Link15	School	15	3.58	36.24	2.19	0.11	0.18
Link16	School	15	1.76	29.77	2.28	0.09	0.15
Link17	School	15	1.76	29.77	2.28	0.09	0.15
Link18	School	15	1.76	29.77	2.28	0.09	0.15
Link19	Narara_Eastbound	40	3.98	18.81	0.77	0.09	0.12
Link20	Narara_Westbound	40	1.91	29.28	2.27	0.10	0.16
Link21	Mailwa_Eastbound	40	1.91	29.28	2.27	0.10	0.16
Link22	Mailwa_Westbound	40	3.98	18.81	0.77	0.09	0.12
Link23	Manns Road_Northbound	60	2.56	12.84	0.58	0.07	0.09
Link24	Manns Road_Northbound	60	1.28	10.54	0.60	0.05	0.06
Link25	Manns Road_Northbound	60	1.51	10.54	0.58	0.05	0.07
Link26	Manns Road_Northbound	60	1.51	10.54	0.58	0.05	0.07
Link27	Manns Road_Northbound	60	1.51	10.54	0.58	0.05	0.07
Link28	Manns Road_Southbound	60	1.84	10.05	0.52	0.05	0.08
Link29	Manns Road_Southbound	60	2.56	12.84	0.58	0.07	0.09
Link30	Manns Road_Southbound	60	3.72	16.21	0.59	0.09	0.11
Link31	Manns Road_Southbound	60	1.28	10.54	0.60	0.05	0.06

*Total Hydrocarbons

The ratio between PM_{10} and $PM_{2.5}$ has been derived using ambient monitoring data as discussed in **Section 4**.

9 RESULTS

9.1 NITROGEN DIOXIDE (NO_2)

Predictions of nitrogen dioxide (NO_2) at each prediction location are presented in **Table 9-1**. It can be seen from **Table 9-1** that the maximum one hour and annual concentration predictions are below the criteria at all prediction locations, with the highest one hour predicted concentration of 99.4 µg/m^3 to occur at the outdoor playing area closest to the Manns Road.

Table 9-1: NO_2 Predictions at Proposed Receptor Locations

Block	Floor	Predicted Pollutant Concentrations (µg/m^3) 100th percentile					
		NO_2		Criteria		Criteria Achieved	
		1 hour	Annual	1 hour	Annual	1 hour	Annual
Lower Level	Location 1	95.4	37.5	246	62	✓	✓
	Location 2	93.0	37.3	246	62	✓	✓
	Location 3	94.3	37.4	246	62	✓	✓
	Location 4	91.1	37.1	246	62	✓	✓
	Location 5	88.9	36.8	246	62	✓	✓
	Location 6	85.6	36.5	246	62	✓	✓
Entry Level	Location 7	84.5	36.4	246	62	✓	✓
	Location 8	87.7	36.6	246	62	✓	✓
	Location 9	92.5	37.0	246	62	✓	✓
	Location 10	86.6	36.5	246	62	✓	✓
Air Conditioning Plant Locations	Location 11	85.7	36.2	246	62	✓	✓
	Location 12	87.8	36.7	246	62	✓	✓
Outdoor Areas	Location 13	99.4	37.5	246	62	✓	✓
	Location 14	90.5	37.2	246	62	✓	✓

9.2 SULFUR DIOXIDE (SO_2)

The predicted SO_2 concentrations at each prediction location are presented in

Floor	Floor	Predicted Pollutant Concentrations (µg/m3) 100th percentile								
		SO2			Criteria			Criteria Achieved		
		1 hour	24 Hour	Annual	1 hour	24 Hour	Annual	1 hour	24 Hour	Annual
Lower Level	Location 1	66.1	63.6	7.2	570	228	60	✓	✓	✓
	Location 2	65.9	63.6	7.1	570	228	60	✓	✓	✓
	Location 3	66.1	63.6	7.1	570	228	60	✓	✓	✓
	Location 4	65.7	63.6	7.1	570	228	60	✓	✓	✓
	Location 5	65.4	63.5	7.0	570	228	60	✓	✓	✓
	Location 6	65.2	63.5	6.9	570	228	60	✓	✓	✓
Entry Level	Location 7	65.0	63.4	6.9	570	228	60	✓	✓	✓
	Location 8	65.3	63.5	7.0	570	228	60	✓	✓	✓
	Location 9	65.8	63.5	7.1	570	228	60	✓	✓	✓
	Location 10	65.1	63.4	6.9	570	228	60	✓	✓	✓
Air Con Plant Locations	Location 11	65.7	63.4	6.9	570	228	60	✓	✓	✓
	Location 12	65.3	63.5	7.0	570	228	60	✓	✓	✓
Outdoor Areas	Location 13	66.4	63.6	7.2	570	228	60	✓	✓	✓
	Location 14	65.7	63.6	7.1	570	228	60	✓	✓	✓

. It can be seen that the predicted results at all the proposed receptors comply with the relevant criteria, with the greatest one hour predicted SO_2 concentration of 66.4 µg/m^3 which will occur at the outdoor playing area.

Table 9-2: SO_2 Predictions at Proposed Receptor Locations

Floor	Floor	Predicted Pollutant Concentrations (µg/m^3) 100th percentile								
		SO_2			Criteria			Criteria Achieved		
		1 hour	24 Hour	Annual	1 hour	24 Hour	Annual	1 hour	24 Hour	Annual
Lower Level	Location 1	66.1	63.6	7.2	570	228	60	✓	✓	✓
	Location 2	65.9	63.6	7.1	570	228	60	✓	✓	✓
	Location 3	66.1	63.6	7.1	570	228	60	✓	✓	✓
	Location 4	65.7	63.6	7.1	570	228	60	✓	✓	✓
	Location 5	65.4	63.5	7.0	570	228	60	✓	✓	✓
	Location 6	65.2	63.5	6.9	570	228	60	✓	✓	✓
Entry Level	Location 7	65.0	63.4	6.9	570	228	60	✓	✓	✓
	Location 8	65.3	63.5	7.0	570	228	60	✓	✓	✓
	Location 9	65.8	63.5	7.1	570	228	60	✓	✓	✓
	Location 10	65.1	63.4	6.9	570	228	60	✓	✓	✓
Air Con Plant Locations	Location 11	65.7	63.4	6.9	570	228	60	✓	✓	✓
	Location 12	65.3	63.5	7.0	570	228	60	✓	✓	✓
Outdoor Areas	Location 13	66.4	63.6	7.2	570	228	60	✓	✓	✓
	Location 14	65.7	63.6	7.1	570	228	60	✓	✓	✓

9.3 CARBON MONOXIDE (CO)

The predicted CO concentrations at each prediction location are presented in **Table 9-3**. It can be seen that the predicted results at all the proposed receptors comply with the relevant criteria, with the highest one hour predicted CO concentration of 3 mg/m^3.

Table 9-3: CO Predictions at Proposed Receptor Locations

Block	Floor	Predicted Pollutant Concentrations (mg/m^3) 100th percentile					
		CO		Criteria		Criteria Achieved	
		1 hour	8 Hour	1 hour	8 Hour	1 hour	8 Hour
Lower Level	Location 1	2.9	2.4	30	10	✓	✓
	Location 2	2.8	2.4	30	10	✓	✓
	Location 3	2.9	2.4	30	10	✓	✓
	Location 4	2.8	2.4	30	10	✓	✓
	Location 5	2.7	2.4	30	10	✓	✓
	Location 6	2.7	2.3	30	10	✓	✓
Entry Level	Location 7	2.6	2.3	30	10	✓	✓
	Location 8	2.7	2.3	30	10	✓	✓
	Location 9	2.8	2.4	30	10	✓	✓
	Location 10	2.6	2.3	30	10	✓	✓
Air Conditioning Plant Locations	Location 11	2.6	2.3	30	10	✓	✓
	Location 12	2.7	2.3	30	10	✓	✓
Outdoor Areas	Location 13	3.0	2.4	30	10	✓	✓
	Location 14	3.0	2.4	30	10	✓	✓

9.5 PARTICULATE MATTER (PM_{10})

The predicted PM_{10} concentrations at each prediction location are presented in **Table 9-4**. It can be seen that the predicted results at all the proposed receptors comply with the relevant criteria.

It can be seen from **Table 9-4** that the maximum 24 hour and annual concentration predictions are below the criteria at all prediction locations, with the greatest 24 hour predicted PM_{10} concentration of 39 µg/m^3 to occur at the outside playing area and Practice Room 1.

Table 9-4: PM_{10} Predictions at Proposed Receptor Locations

Block	Floor	Predicted Pollutant Concentrations (µg/m^3) 100th percentile					
		PM_{10}		Criteria		Criteria Achieved	
		24 hour	Annual	24 hour	Annual	24 hour	Annual
Lower Level	Location 1	39.0	14.7	50	30	✓	✓
	Location 2	38.9	14.7	50	30	✓	✓
	Location 3	38.9	14.7	50	30	✓	✓
	Location 4	38.9	14.6	50	30	✓	✓
	Location 5	38.8	14.6	50	30	✓	✓
	Location 6	38.7	14.5	50	30	✓	✓
Entry Level	Location 7	38.7	14.5	50	30	✓	✓
	Location 8	38.8	14.6	50	30	✓	✓
	Location 9	38.9	14.6	50	30	✓	✓
	Location 10	38.7	14.5	50	30	✓	✓
Air Conditioning Plant Locations	Location 11	38.7	14.5	50	30	✓	✓
	Location 12	38.8	14.6	50	30	✓	✓
Outdoor Areas	Location 13	39.0	14.7	50	30	✓	✓
	Location 14	38.9	14.7	50	30	✓	✓

9.6 PARTICULATE MATTER ($PM_{2.5}$) AND BENZENE

The predicted $PM_{2.5}$ and benzene concentrations at each prediction location are presented in **Table 9-5**. It can be seen that the predicted results at all the proposed receptors comply with the relevant criteria.

The total emissions of hydrocarbons were modelled at all receptors; the results have been adjusted to take into consideration the exhaust profile for petrol vehicles (Queensland Environmental Protection Agency, 2003). This determines that for light vehicles, benzene is 6%[1] of the total hydrocarbons.

Table 9-5: $PM_{2.5}$ and Benzene Predictions at Proposed Receptor Locations

Block	Floor	Predicted Pollutant Concentrations 100th percentile					
		$PM_{2.5}$ (µg/m³)	Benzene (mg/m³)	Criteria		Criteria Achieved	
		24 hour	1 hour	$PM_{2.5}$	Benzene	$PM_{2.5}$	Benzene
Lower Level	Location 1	23.4	0.013	25	0.029	✓	✓
	Location 2	23.3	0.013	25	0.029	✓	✓
	Location 3	23.3	0.012	25	0.029	✓	✓
	Location 4	23.3	0.012	25	0.029	✓	✓
	Location 5	23.3	0.013	25	0.029	✓	✓
	Location 6	23.2	0.013	25	0.029	✓	✓
Entry Level	Location 7	23.2	0.013	25	0.029	✓	✓
	Location 8	23.3	0.012	25	0.029	✓	✓
	Location 9	23.3	0.012	25	0.029	✓	✓
	Location 10	23.3	0.014	25	0.029	✓	✓
Air Conditioning Plant Locations	Location 11	23.2	0.013	25	0.029	✓	✓
	Location 12	23.3	0.014	25	0.029	✓	✓
Outdoor Areas	Location 13	23.4	0.014	25	0.029	✓	✓
	Location 14	23.3	0.017	25	0.029	✓	✓

[1] The benzene concentration has not been adjusted for the reduction in benzene as per the Fuel Standards (Petrol) Determination which limits benzene to 1%. Therefore this concentration is conservative.

10 RECOMMENDATIONS

Reviewing the proposed development layout, it can be concluded at the location and separation of the buildings has been designed to allow air flow between the buildings which prevents the accumulation of pollutants. This design is considered to be in accordance with the Development near Rail Corridors and Busy Roads – Interim Guideline (Department of Planning, 2008).

If the buildings are to be fitted with mechanical ventilation it is recommended that the location of the fresh air inlets are placed as far away from the road source as possible and the requirements of Australian Standard AS 1668 – The Use of Ventilation and Air Conditioning in Buildings (Standards Australia, 2002) is adhered to.

11 CONCLUSIONS

Vipac Engineers and Scientists Ltd (Vipac) was commissioned by Ian Easton Architects to carry out an air quality assessment of a proposed junior school building within the grounds of St. Phillips Christian College located at 2-30 Narara Creek Road, Narara. This assessment is a Level 2 assessment in accordance with the Approved Methods for the Modelling and Assessment of Air Pollutants in NSW using AusRoads modelling software. This assessment is conservative for the following reasons:

- The 100th percentile background concentrations from a site representative monitoring station with concurrent site specific meteorological conditions have been modelled;
- Traffic data from NSW have been used based on a typical diurnal traffic pattern using high proportion of heavy vehicles;
- The $PM_{2.5}$ concentrations were derived from the PM_{10} concentrations at the Lindfield monitoring station. A ratio of 0.49 was applied based on the $PM_{10}/PM_{2.5}$ ratio at a nearby monitoring station;
- The 100th percentile predicted concentrations have been reported to provide the worst-case assessment.

The results show that the predicted concentrations comply with the relevant criteria for all pollutant and time periods. Overall, this assessment has determined that air quality at the prediction locations will not exceed any pollutant criteria. As such, no adverse impacts on health are expected from the road traffic emissions and air quality should not be considered a constraint to the proposed junior school at this location.

12 BIBLIOGRAPHY

Department of Environment & Conservation. (2005). *Approved Methods for the Modelling and Assessment of Air Pllutants in New South Wales.* Sydney: Department of Environment & Conservation (NSW).

Department of Planning. (2008). Development Near Rail Corridors and Busy Roads - Interim Guideline. Sydney, NSW, Australia: Department of Planning.

Queensland Environmental Protection Agency. (2003). *South-East Queensland Motor Vehicle Emissions Inventory Final Report.* Brisbane: Queensland Environmental Protection Agency.

Standards Australia. (2002). Australian Standard AS 1668 – The Use of Ventilation and Air Conditioning in Buildings . Canberra, Australia: Standards Australia.

UniQuest. (2014, August 2). Australian Motor Vehicle Emission Inventory for the National Pollution Inventory (NPI). St. Lucia, QLD, Australia: Department of Environment.