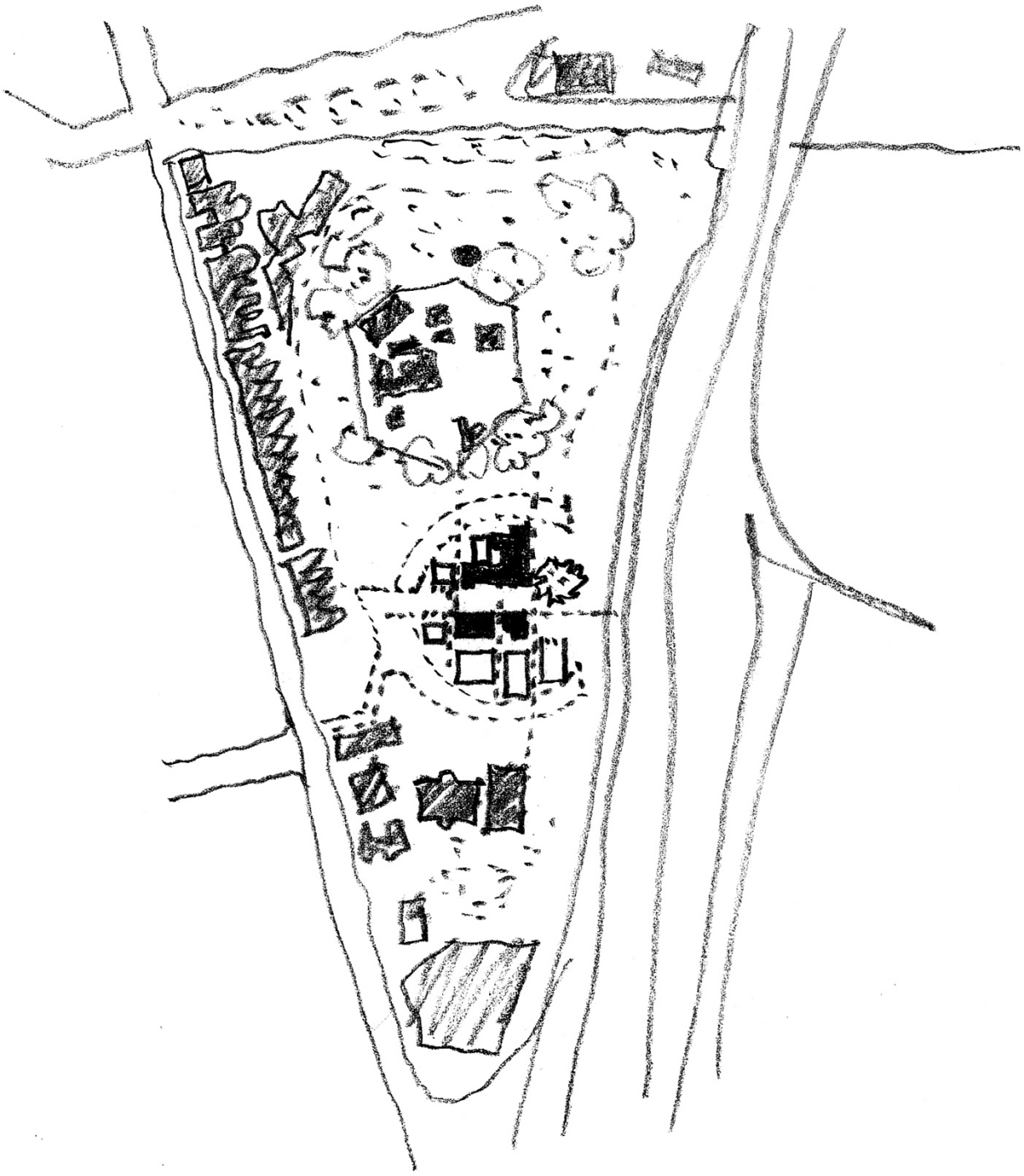
Fort Street Public School
Air Quality Assessment

SSD 10340
Prepared by Arup
For School Infrastructure NSW
18 March 2020



School Infrastructure NSW

Fort Street Public School

Air Quality Assessment

Issue | 18 March 2020

Job number 266969-00

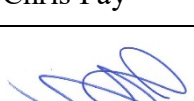
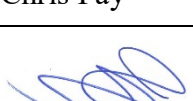
Arup Australia Pty Ltd ABN 76 625 912 665

Arup
Level 5
151 Clarence Street
Sydney NSW 2000
Australia
www.arup.com

ARUP

Document verification

ARUP

Job title		Fort Street Public School			**Job number** 266969-00
Document title		Air Quality Assessment			**File reference**
Document ref					
Revision	**Date**	**Filename**	Air Quality Report Draft Issue.docx		
Draft 1	12 Nov 2019	**Description**	Draft for review		
			Prepared by	Checked by	Approved by
		Name	Lesley-Anne Stone	Chris Fay	Chris Fay
		Signature			
Draft 2	3 Feb 2020	**Filename**	Air Quality Report_Draft_Feb2020.docx		
		Description	Air Quality Assessment Required for SSDA		
			Prepared by	Checked by	Approved by
		Name	Lesley-Anne Stone	Chris Fay	Chris Fay
		Signature			
Issue	28 Feb 2020	**Filename**	Air Quality Report_Issue_Feb2020.docx		
		Description	For ToA		
			Prepared by	Checked by	Approved by
		Name	Lesley-Anne Stone	Chris Fay	Chris Fay
		Signature			
Issue	18 Mar 2020	**Filename**	Air Quality Report_Issue_Feb2020.docx		
		Description	Addressing SINSW comments		
			Prepared by	Checked by	Approved by
		Name	Lesley-Anne Stone	Chris Fay	Chris Fay
		Signature			
				Issue Document verification with document	✓

Contents

1 Introduction

The NSW Department of Education has commissioned Arup to develop an air quality assessment for the Fort Street Public School project (hereafter referred to as the proposed development). The site is located at Observatory Hill in Millers Point, within the City of Sydney local government area. The existing school has been in operation since 1849 making it one of the oldest government schools in Australia.

1.1 Proposed development

Approval is sought for the expansion of Fort Street Public School to accommodate a total of 550 primary school students. Specifically:

Site preparation, demolition and excavation

- Site remediation.
- Demolition of the southernmost school building, the garage and storage shed west and east of the Bureau of Meteorology Building (the Met/the Met Building), and the toilet block adjoining the main school building.
- Selective removal of various elements of the main school building, as well as minor and insignificant elements of the Met Building and the Messenger's Cottage to facilitate refurbishment and future use of these buildings.
- Bulk excavation works to facilitate the new southern buildings and onsite detention.
- Tree removal.
- Installation of hydraulic and electrical services.

Land use

- Use of all buildings for the purpose of a school.

Existing buildings

- Retention, refurbishment and extension of the existing Fort Street Public School, including construction of a new roof and rooftop additions.
- Retention and refurbishment of the Met Building and internal alterations and additions.
- Retention and minor alterations and additions to the Messenger's Cottage.

Construction of New buildings

- Construction of one new building on the western part of the site for a staff room.
- Construction of two new, interconnected school buildings on the southern third of the site.
- Construction of a new communal hall and canteen building.

Landscaping

- Retention of the existing large fig tree.
- Landscaping works throughout the site, including construction of a new amphitheatre, new central plaza, and a multi-purpose forecourt.
- Landscaping of roof gardens on top of the new southern buildings and the existing Met Building.

Other works

- Works to the existing entrance road, including alterations to the Bradfield Tunnel Services Building.
- Modifications to existing pick-up/drop-off arrangements.
- Provision of signage zones.
- Installation of onsite detention.

1.2 Scope

This air quality assessment has been prepared as a specialist study to accompany the environmental impact statement (EIS) prepared as part of a State significant development application (SSDA). It has been prepared to:

- Address relevant Secretary's environmental assessment requirement (SEARs refer to section 2).
- Ensure the proposed development demonstrates compliance with the NSW *Protection of the Environment Operations Act 1997* and the Protection of the Environment Operations (Clean Air) Regulation 2010.

The assessment has considered the presence of existing airborne pollutants; generation of airborne pollutants during operation of the proposed development; and the site's suitability for the proposed land use. These considerations have been made by:

- Reviewing air quality legislation in NSW that applies to the proposed development.
- Defining existing air quality conditions at the proposed development site using information from onsite and offsite air quality monitoring.
- Confirming the local meteorological conditions to understand how dispersion maybe affected.
- Carrying out a qualitative assessment of potential operational impacts.
- Recommending management and mitigation measures to avoid, reduce and monitor likely development-related air quality impacts.

Following completion of the air quality assessment, Environmental Risk Sciences Pty Ltd (enRiskS) reviewed monitored pollutant concentrations both onsite and offsite to determine and potential health based effects.

2 Assessment requirements

The proposed development was declared State Significant Development (SSD) due to its capital investment value exceeding $20 million pursuant to Schedule 1(15-2) of State Environmental Planning Policy (State and Regional Development) 2011. This means it is subject to approval either by the Minister for Planning and Places or the Independent Planning Commission.

To secure development consent, SSD is subject to a process of environmental assessment. The first step is preparing a scoping report to secure Secretary's environmental assessment requirements (SEARs). The SEARs were issued in November 2019 as per the following:

- Application Number SSD: 10340
- Proposal Name: Fort Street Public School
- Location: Upper Fort Street within City of Sydney
- Applicant: Department of Education

This report addresses the following assessment requirements.

Table 1: SEARs relating to air quality

SEARs	Document Reference
4. Built form and urban design Provide an air quality assessment that demonstrates that there would be satisfactory conditions for students and staff in consideration of the immediacy of the Cahill cut and the Sydney Harbour Bridge locations. This should have regard to precedent studies (including longitudinal studies) and benchmarking including relevant NSW Health guidelines.	Section 4.1 presents the methodology for establishing existing conditions. Section 6.1 concludes the suitability of these conditions for the exposure of staff and students.
19. Sediment, erosion and dust controls Detail measures and procedures to minimise and manage the generation and off-site transmission of sediment, dust and fine particles, during demolition, site preparation, bulk excavation and construction phase. Relevant Policies and Guidelines: • Managing Urban Stormwater – Soils & Construction Volume 1 2004 • Approved Methods for the Modelling and Assessment of Air Pollutants in NSW[1]	Air quality impacts during construction are not included in this assessment, please see Appendix W of the Environmental Impact Statement prepared for the project to understand mitigation measures for erosion and sediment control.

[1] (NSW DEC, 2005)

3 Air quality legislation and sources of pollution

3.1 Legislation

The National Environment Protection (Ambient Air Quality) Measure[2] (NEPM) sets standards to provide adequate protection for human health and wellbeing.

In NSW, the Approved Methods and Guidance for the Modelling and Assessment of Air Pollutants in NSW[3] (hereafter referred to as the 'Approved Methods') provide criteria for assessing air pollution impacts. The impact assessment criteria in the Approved Methods have been used to determine if measured pollutant concentrations would have a significant impact on local air quality and subsequently the health of staff and students.

The key pollutants of concern, given the site's sensitivity and local pollution sources (i.e. major roads) are particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO) and nitrogen dioxide (NO_2). In addition, sulphur dioxide (SO_2) was included in the suite of pollutants monitored onsite given the proximity of maritime transport emissions from Sydney Harbour. Table 2 lists the impact assessment criteria for these pollutants.

Some pollutants have criteria expressed as annual average concentrations due to the chronic way in which they potentially affect health, or the natural environment. Others have criteria expressed as 24-hour, one-hour or 15-minute averaging periods due to the acute way in which they affect health or the natural environment. Those pollutants assessed here have standards expressed in terms of both long-term and short-term concentrations.

Table 2: Approved methods impact assessment criteria

Pollutant	Standard (µg/m^3)	Averaging period
PM_{10}	50	24-hour
	25	Annual
$PM_{2.5}$	25	24-hour
	8	Annual
CO	100,000	15-minute
	30,000	1-hour
	10,000	8-hour
NO_2	246	1-hour
	62	Annual

[2] National Environment Protection Council, N*ational Environment Protection (Ambient Air Quality) Measure,* February 2016
[3] (NSW DEC, 2005)

Pollutant	Standard (µg/m^3)	Averaging period
SO_2	712	10-minute
	570	1-hour
	228	24-hour
	60	Annual

Note: µg/m^3 – micrograms per cubic metre.

3.2 Sources of pollution

The SEARs require an air quality assessment due to the proximity of the proposed development to major roads such as the Cahill Expressway and the Western Distributor. The Cahill Expressway circles the proposed development form north to south before joining the Western Distributor. The Cahill Expressway starts in cutting to the north of the proposed development rising to become at-grade where it joins the Western Distributor 30 metres to the east of the proposed development. Further details of the key pollutants generated by road traffic, noted in section 3.1, and their potential impacts are provided below.

Nitrogen oxide (NOx)

NOx is generated by the combustion of fuel and is therefore generated by motor vehicles, as well as other transportation and industrial processes. NOx oxidises in the atmosphere in the presence of ozone (O_3) to generate nitrogen dioxide (NO_2). About 80% of the NO_2 in urban areas such as the centre of Sydney comes from motor vehicles.

NO_2 is the primary NOx of concern for health. In elevated concentrations it can lead to respiratory problems, including asthma and lung infections. This is the reason the approved methods set criteria for NO_2 rather than NOx.

No exceedances of the annual average NO_2 standards have been recorded in Sydney in recent years. Occasional exceedances of the 1-hour NO_2 standard have been recorded however.

Carbon monoxide (CO)

Motor vehicles are the dominant source of CO in urban areas; however, CO can also be generated by bushfires and some industrial activities. Due to improvements in vehicle fuel technology, CO released from motor vehicles has declined in recent years.

Elevated concentrations of CO can reduce the amount of oxygen carried in the blood which results in vital organs not receiving enough oxygen to work properly.

No exceedances of the CO standards have been recorded in Sydney in recent years. Elevated CO concentrations have been recorded recently near significant bushfire areas outside of Sydney.

Sulphur dioxide (SO_2)

Due to improvements in motor vehicle fuel technology, SO_2 is no longer generated at levels to cause concern, however marine diesel can contain higher sulphur concentrations as this is not so stringently regulated. This pollutant was included due to the proposed development's proximity to emissions from maritime transport, noting however there are restrictions for SO_2 content from fuels used by ships in Sydney Harbour.

SO_2 affects health over a short-term exposure period and can irritate the nose, throat and airways.

No exceedances of the SO_2 standards have been recorded in Sydney in recent years.

Particulate matter (PM_{10} and $PM_{2.5}$)

Health impacts form particulate matter is generally associated with PM_{10} (particulate matter with an aerodynamic diameter of less than 10µm) and $PM_{2.5}$, (particulate matter with an aerodynamic diameter of less than 2.5µm). As this particulate matter is so small, it has the potential to enter the respiratory system and can penetrate the lungs.

While particulate matter is generated by motor vehicles as well as other transportation methods, it can also be formed from natural sources key of which are dust, soil, pollen, sea spray and smoke (from bushfires). These sources can impact urban areas due to the way particulate matter is dispersed through the atmosphere.

Exceedances of the particulate matter standards are common across NSW and other states in Australia and are increasing due to long-running drought conditions, climate change and significant bushfires.

4 Method

The overall assessment approach comprised a:

- Review of the existing air quality conditions at, and near, the proposed development site through onsite and offsite air quality monitoring.
- Assessment of the potential changes in air quality arising from the proposed development's operation.

4.1 Method for determining existing conditions

This section describes how the existing ambient air quality was confirmed onsite.

4.1.1 NSW Government air quality monitoring

Ambient air quality monitoring is undertaken by the NSW Government at several locations across Sydney. Figure 1 shows the closest monitoring locations to the proposed development site that have been used to define the local airshed considered as part of this assessment. The local airshed assessed covers an area of approximately 9 km, this is considered to represent the central urban area of Sydney where local topography and meteorology condition are similar.

Figure 1: Ambient air quality monitoring undertaken in the proximity of the proposed development

This monitoring station is at a roadside location 2 km north of the proposed development site between the Bradfield Highway and the Cahill Expressway. The station was commissioned in 2018 and it monitors the key pollutants of concern associated with traffic emissions discussed in chapter 3. Monitoring data available from this station provides information of conditions immediately adjacent to a major road.

The Rozelle monitoring station is located 3.7 km south west of the proposed development site. The station was commissioned in 1970 and as such it has a comprehensive set of historical data measured in the local area. This station monitors the key pollutants of concern associated with traffic emissions discussed in chapter 3.

The Cook and Phillip Sydney CBD monitoring station is located 1.6 km south east of the proposed development site. Data from this station is available from September 2019 onwards. This station monitors the key pollutants of concern associated with traffic emissions discussed in chapter 3. This station represents an urban area and is centrally located within the CBD.

The Randwick monitoring station is located 8.6 km south east of the proposed development site. This monitoring station was commissioned in 1995 and monitors all key pollutants discussed in chapter 3 except for CO.

The most recent full year of data (2019) were obtained to provide annual average concentrations for comparison with the Approved Methods impact assessment criteria. In addition, monitored data from these stations was obtained over the six-month period when onsite monitoring was carried out to allow direct comparison to be undertaken.

4.1.2 Onsite air quality monitoring

Real-time onsite air quality monitoring has been undertaken to assist with establishing local air quality conditions and to assess the suitability of these conditions for staff and students.

The AQ Mesh monitoring system[4] was installed onsite at the start of August 2019. It continues to monitor NO_2, PM_{10} and $PM_{2.5}$, CO, and SO_2 at 15-minute intervals. Gaseous pollutants are passively monitored using an electrochemical sensor. Particulate matter is monitored using an optical particle counter which actively pulls air through the device to obtain a sample. While this system does not meet Australian Standards[5] for air quality monitoring, it provides indicative data that can be used to complement data available from the nearby reference monitoring stations discussed in section 4.1.1.

Prior to installation, the onsite monitors were collocated with a reference monitoring station at Concord Oval, 8 km south west of the proposed development site to calibrate and improve their accuracy. The performance

[4] https://www.ecotech.com/aqmesh
[5] The installation of a reference air quality monitoring station onsite in compliance with Australian Standards was determined to be prohibitively expensive for the project.

specifications for the AQ Mesh monitoring system including limits of detection and accuracy tolerances are shown in Table 3.

Table 3: Performance specifications for the AQ Mesh monitoring system

Pollutant sensor	Limit of Detection	Typical precision	Typical mean accuracy
PM_{10}	0 µg/m^3	> 0.75 R^2	± 30µg/m^3 variable
$PM_{2.5}$	0 µg/m^3	> 0.85 R^2	± 20 µg/m^3 variable
CO	<50 ppb	> 0.8 R^2	± 0.05 ppm
NO_2	<10 ppb	> 0.85 R^2	± 10 ppb
SO_2	<10 ppb	> 0.7 R^2	± 5 ppb

µg/m^3 = microgram per cubic metre

ppb = parts per billion

ppm = parts per million

R^2 = R squared is the output of regression analysis undertaken to provide direct, quantitative measures of the precision of its expectation.

Note: The gaseous pollutant sensors report results in the units shown in the table above. These results have been converted to µg/m^3 for comparison with the impact assessment criteria.

As the AQ Mesh system is not compliant with Australian Standards, AQ Mesh pods were installed at four locations onsite as shown in Figure 2. The monitors were placed across the proposed development site at a height of around two metres above ground level to be representative of respiratory height while not interfering with the operation of the school for staff and students. Figure 3 shows photographs of each AQ Mesh monitor in-situ.

Four pods were installed to ensure effective data capture for the site and to understand the variability across pods on site. As the AQ Mesh pods provide indicative data[6], and all monitoring devices are within 80 metres of each other, it was determined that a calculated average concentration would be most appropriate to determine local air quality conditions onsite. This has been done for all pollutants and averaging periods assessed.

[6] Variability in measured concentrations can occur between pods and they should not be used for compliance or regulatory purposes

Onsite air quality monitoring will continue until the end of July 2020 to provide a full year of data. This air quality assessment will be updated on completion of a full year of monitoring data as requested by DPIE.

Figure 2: AQ Mesh monitoring locations onsite

	
Monitoring Location 1 – Attached to boundary fencing. This location is separated from the Cahill Expressway cutting by a small buffer of vegetation screening.	**Monitoring Location 2 – Attached to the downpipe of the School canteen adjacent to an existing open play space. Approximately 20 metres from the Cahill Expressway cutting.**

Monitoring Location 3 – Attached to a lamppost adjacent to the School office in the middle of the site

Monitoring Location 4 – Located at the entrance to the Environment Education Centre (EEC) on the southern side of the site, adjacent to the Cahill Expressway cutting.

Figure 3: Photos of the AQMesh monitors during installation

4.2 Local meteorology

Local meteorology conditions have been determined using long term historic data obtained from the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) located at Observatory Hill next to the proposed development site.

The anemometer at Observatory Hill was removed in 1995 and wind data reported for Observatory Hill is taken from Fort Denison. This anemometer is non-standard in its type, location, height and mounting.

Historic wind speed and direction has been reviewed from Fort Denison. Considering the above, typical wind direction and speed have also been reviewed from the BoM standardised AWS at Sydney Airport; 8 km south of the proposed development.

4.3 Method of operational phase assessment

This section describes the operational impact assessment method.

4.3.1 Impacts on users

As noted in chapter 1, the site has operated as a school since the 1849 and currently caters for around 200 students. As part of the proposed development its capacity would increase to house up to 550 students.

The potential for students and staff to be exposed to elevated pollutant concentrations has been investigated through onsite and offsite air quality monitoring described in section 4.1. The outcome of this is shown in section 5.1.

These data were also used to develop the proposed development's ventilation design. This aims to minimise student and staff exposure to elevated pollutant concentrations when using indoor areas of the proposed development.

The layout of school buildings across the site was also considered in the design to ensure that locations where students and staff would spend the most time, i.e. internal classrooms, are located as far away from surrounding pollution sources as practicable.

Section 6.1 discusses the outcome of these design considerations and their expected impact on exposure of staff and students.

4.3.2 Impacts from the proposed development

Air quality impacts from the proposed development are anticipated to be similar to the existing situation, as the site already operates as a school. These arise primarily from traffic travelling to and from the site and any emissions from the onsite combustion plant (i.e. gas-fired condensing boilers included for back-up energy purposes).

A qualitative assessment has been undertaken to determine potential impacts from operation of the proposed development.

5 Existing environment

This chapter describes the ambient air quality and meteorological conditions in the local airshed.

5.1 Air quality

The NSW Air Quality Statement 2019[7] shows that Sydney was greatly affected by the effects of climate change, including the continuing intense drought conditions and impacts from bushfires throughout the year but particularly in the final quarter of 2019.

The air quality index provides a method to classify regional air quality based on monitored pollutant concentrations as well as visibility.

- Air quality was classified as being good for 86% of the time in the Sydney region.
- However, 55 days were identified as being 'poor', 'very poor' or 'hazardous' in the final quarter of 2019.

Figure 4 shows the timing of hazard reduction burns, bushfires and dust storms that impacted the Sydney airshed in 2019. Significant impacts from bushfires and dust storms were recorded in the Sydney airshed from the end of October 2019 onwards. This has continued into the beginning of 2020.

[7] NSW Government, NSW Annual Air Quality Statement 2019, https://www.environment.nsw.gov.au/topics/air/air-quality-statement

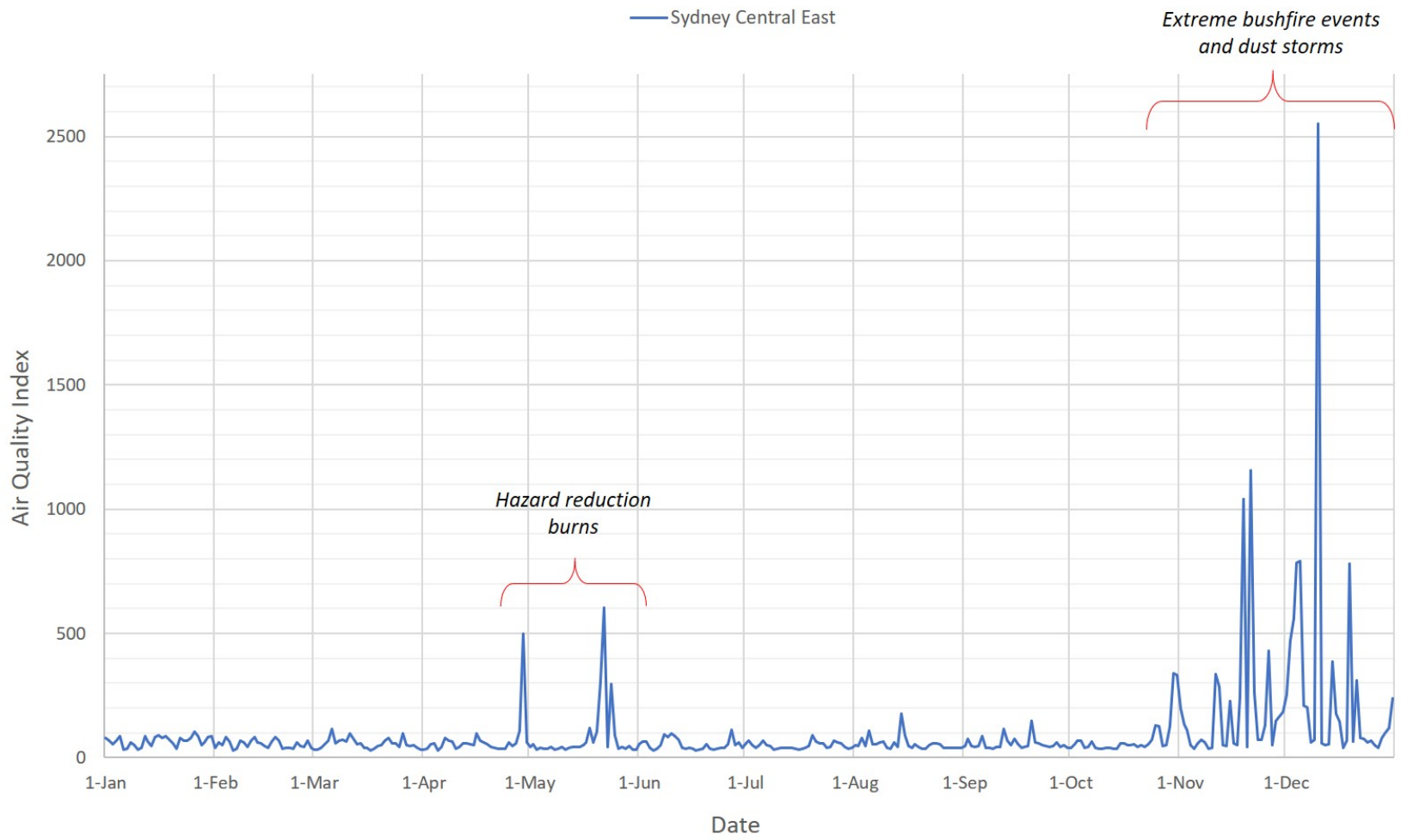


Figure 4: Air Quality Index time series for the Sydney region

Onsite monitoring data

Table 4 shows the monitored concentrations onsite over a six-month period between August 2019 and January 2020. The number of daily or hourly exceedances over the monitoring period have also been presented. The data shown in Table 4 have been calculated as an average across all four AQ Mesh pods present onsite for the reasons described in section 4.1.2. The results show the following.

- Elevated $PM_{2.5}$ concentrations, with **17 exceedances** of the 24-hour $PM_{2.5}$ standard. All exceedances were recorded between the end of October 2019 and January 2020 when smoke from bushfires was impacting the Sydney airshed. The Air Quality Index for Sydney also recorded 'very poor' to 'hazardous' conditions on the days of these recorded exceedances onsite. The average $PM_{2.5}$ concentration across the monitoring period also exceeded the annual $PM_{2.5}$ standards, however this is not directly comparable as a full year of data are not yet available.
- Elevated PM_{10} concentrations, with **six exceedances** of the 24-hour PM_{10} standard. These exceedances also occurred between the end of October 2019 and January 2020. The Air Quality Index for Sydney also recorded 'hazardous' conditions on the days of these recorded exceedances.
- Three exceedances of the 1-hour NO_2 standard. This was limited to three consecutive hours on 19 December 2019. These exceedances are reflected in offsite monitoring data recorded at the Bradfield Highway station. The NSW Air Quality Statement notes that while there was likely some contribution from traffic toward this exceedance, the air quality in Sydney on this day was significantly impacted by bushfire smoke.
- For all other pollutants and averaging periods, monitored concentrations are less than 75% of the Approved Methods impact assessment criteria.

Offsite monitoring station data

Table 5 provides data from the Bradfield Highway, Rozelle and Randwick monitoring stations for the last full calendar year of 2019. While this is not directly comparable with the onsite monitoring period it allows local conditions to be compared against the annual average standards.

Data from the Cook and Phillip monitoring station has not been included in this review as data is only available from September 2019 onwards.

$PM_{2.5}$

- Elevated $PM_{2.5}$ concentrations were recorded with exceedances of the 24-hour $PM_{2.5}$ standard measured on:
  - **23 occasions** at the Bradfield Highway monitor;
  - **21 occasions** at the Rozelle monitor; and

  - **18 occasions** at the Randwick monitor.
- These exceedances were primarily recorded from October 2019 onwards, however occasional exceedances were also recorded in May 2019, which align with hazard reduction burns shown in Figure 4.
- The annual average $PM_{2.5}$ standard was also exceeded at all monitoring stations.

PM_{10}

- Elevated PM_{10} concentrations were recorded with exceedances of the 24-hour PM_{10} standard measured on:
  - **17 occasions** at the Bradfield highway monitor;
  - **16 occasions** at the Rozelle monitor; and
  - **19 occasions** at the Randwick monitor.
- These exceedances were primarily recorded in from October 2019 onwards, however isolated exceedances were also recorded in March and May 2019.
- The annual average PM_{10} standard was met however Randwick and Bradfield Highway were close to exceeding.

NO_2

- The annual average NO_2 standard was met at all monitoring stations. The annual average concentration monitored at Bradfield Highway, while within the standard, was significantly higher than that monitored at other locations due to being influenced by adjacent traffic emissions.
- The 1-hour average NO_2 standard was met at all stations except for the Bradfield Highway.
- Three exceedances of the 1-hour NO_2 standard were recorded at the Bradfield Highway monitor. These exceedances were recorded over three consecutive hours on the 19 December 2019. These exceedances are consistent with the elevated NO_2 concentrations monitored onsite.

No exceedances of the CO or SO_2 standards were measured at any of the offsite monitoring stations during 2019.

A comparison of onsite and offsite monitoring for the same time-period has been carried out below.

Table 4: Monitored concentrations onsite

Pollutant	Standard ($\mu g/m^3$)	Averaging Period	Average monitored pollutant concentration ($\mu g/m^3$)	% of standard	Number of exceedances of the short-term standards for the monitoring period
PM_{10}	50	24-hour (maximum)	**110.3**	**221 %**	**6**
	25	Annual	21.8[1]	87 %	-
$PM_{2.5}$	25	24-hour (maximum)	**93.2**	**373 %**	**17**
	8	Annual	**16.1**[1]	**201 %**	-
CO	100,000	15-minute (maximum)	4525.1	5 %	-
	30,000	1-hour (maximum)	3981.0	13 %	-
	10,000	8-hour (maximum)	2016.2	20 %	-
NO_2	246	1-hour (maximum)	**298.3**	**121 %**	**3**
	62	Annual	38.7[1]	63 %	-
SO_2	570	1-hour (maximum)	75.3	13 %	-
	228	24-hour (maximum)	16.2	7 %	-
	60	Annual	4.3[1]	7 %	-

Note: Exceedances of the standards are shown in bold with blue shading.

1. This is the period mean representative of average data recorded between 1 August 2019 and 31 January 2020. It is not therefore directly comparable with the relevant annual average standards and should be considered indicative.

Onsite monitoring occurs at 15-minute intervals therefore data is not available for comparison with the 10-minute SO_2 standard

Table 5: Monitored concentrations at nearby offsite monitoring locations

Pollutant	Averaging period	Standard	Bradfield Highway		Rozelle		Randwick	
		µg/m^3	µg/m^3	% of the standard	µg/m^3	% of the standard	µg/m^3	% of the standard
PM_{10}	24-hour (maximum)	50	**170.3**	**341 %**	**142.7**	**285 %**	**127.7**	**255 %**
	Annual	25	24.0	96 %	22.6	90 %	24.1	96 %
$PM_{2.5}$	24-hour (maximum)	25	**145.8**	**583 %**	**101.8**	**407 %**	**95.2**	**381 %**
	Annual	8	**13.2**	**165 %**	**10.3**	**129 %**	**10.8**	**135 %**
CO	1-hour (maximum)	30,000	5613.5	19 %	5957.1	20 %	-	-
	8-hour (maximum)	10,000	2520.3	25 %	2291.2	23 %	-	-
NO_2	1-hour (maximum)	246	**287.9**	**117 %**	169.4	69 %	95.9	39 %
	Annual	62	47.9	77 %	18.1	29 %	15.9	26 %
SO_2	1-hour (maximum)	570	60.3	11 %	83.9	15 %	76.0	13 %
	24-hour (maximum)	228	15.7	7 %	13.1	6 %	13.1	6 %
	Annual	60	4.0	7 %	2.1	4 %	2.5	4 %

Note: Exceedances of the standards are shown in bold and shaded blue

Publicly available data is not available for intervals of less than one hour, therefore data is not available for comparison with the 15-minute CO standard or the 10-minute SO_2 standard

Onsite and offsite monitoring comparison

A comparison of monitored data from Rozelle, Randwick, Cook and Phillip and the Bradfield Highway monitoring stations with onsite monitoring is shown in Table 6 for the six-month monitoring period.

This comparison shows that monitored concentrations onsite are comparable with monitored concentrations offsite.

Monitored 24-hour PM_{10} and $PM_{2.5}$ concentrations at all monitoring stations for the six-month monitoring period are shown in Figure 5 and Figure 6, respectively. This shows that onsite concentrations are not materially different to those monitored elsewhere in the local airshed. Elevated concentrations are shown from the end of October 2019 onwards. This correlates with impacts from bushfires and dust storms as shown in Figure 4. At times, monitored concentrations onsite are lower than those monitored offsite during the bushfire season. This is potentially due to more favourable conditions for dispersion onsite given the proposed development's position on top of Observatory Hill.

Monitored average NO_2 concentrations onsite are higher than at Rozelle, Randwick and Cook and Phillip monitoring stations. This is likely due to the proximity of the proposed development to major roads. Monitored NO_2 concentrations onsite are more comparable, but lower than those monitored at the Bradfield Highway station. This is because the Bradfield Highway station is immediately adjacent to the road and closer than the proposed development site.

Figure 7 shows the monitored 1-hour average NO_2 concentrations at all monitoring stations for a shorter time-period around 19 December 2019 when exceedances were recorded onsite and at the Bradfield Highway station. Elevated concentrations of NO_2 were recorded across the local airshed between 11am and 2pm on 19 December 2019. Air quality in Sydney on this day was significantly impacted by smoke therefore it is likely that widespread elevated NO_2 concentrations were related to a bushfire event. In combination with higher background NO_2 concentrations recorded onsite and at the Bradfield Highway station, due to the influence of traffic from the Western Distributor, this caused the exceedance of the 1-hour NO_2 standard.

Onsite monitored SO_2 and CO concentrations are comparable with offsite concentrations and at all locations. They are all less than 50% of the relevant standards.

Summary

Local air quality onsite is not significantly different from conditions monitored elsewhere in the local airshed over the past six months and therefore conditions would be no different to other schools operating within urban areas of Sydney.

Monitored NO_2 data shows the influence of traffic using the Cahill Expressway and Western Distributor at the proposed development site. However, monitored NO_2 concentrations remain less than 75% of relevant standards except for the anomalous three-hour peak in the middle of December 2019. A comparison of onsite and offsite monitored PM_{10} and $PM_{2.5}$ concentrations show that the

proximity of the Cahill Expressway and Western Distributor has little impact on the proposed development site.

Table 6: Comparison of monitored data for the period August 2019 to January 2020

Pollutant	Averaging Period	Onsite (µg/m^3)	Bradfield Highway Monitored pollutant concentration (µg/m^3)	Rozelle Monitored pollutant concentration (µg/m^3)	Cook and Phillip Monitored pollutant concentration (µg/m^3)	Randwick Monitored pollutant concentration (µg/m^3)
PM_{10}	24-hour	**110.3**	**170.3**	**142.7**	**130.8**	**137.3**
	Aug '19 – Jan '20	21.8	30.5	29.3	31.2	31.3
$PM_{2.5}$	24-hour	**93.2**	**145.8**	**101.8**	**112.5**	**114.8**
	Aug '19 – Jan '20	16.1	16.5	14.7	17.8	15.7
CO	1-hour	3981.0	5613.5	5957.1	5040.7	-
	8-hour	2016.2	2520.3	2634.9	2405.8	-
NO_2	1-hour	**298.3**	**287.9**	169.4	207.0	96.0
	Aug '19 – Jan '20	38.7	47.4	16.2	21.4	13.7
SO_2	1-hour	75.3	60.2	44.5	47.1	76.0
	24-hour	16.2	15.7	10.5	7.9	10.5
	Aug '19 – Jan '20	4.3	3.5	1.8	1.8	2.0

Note: Averaging periods have been presented based on available data.

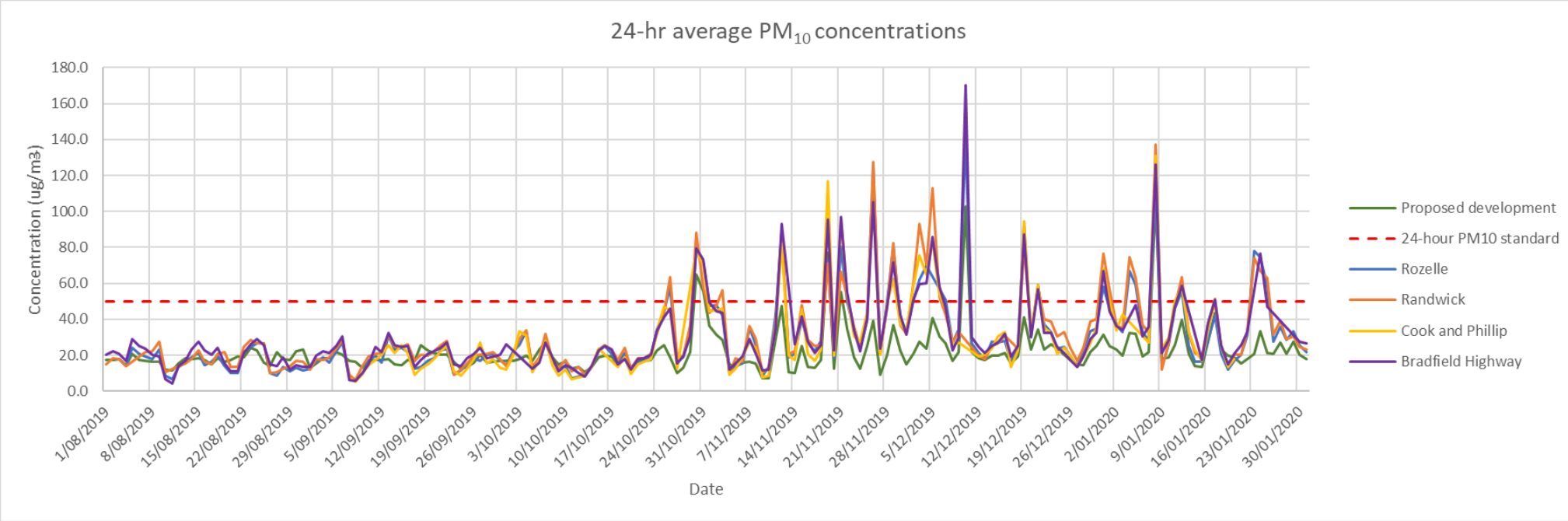


Figure 5: Monitored 24-hour average PM_{10} concentrations at all locations

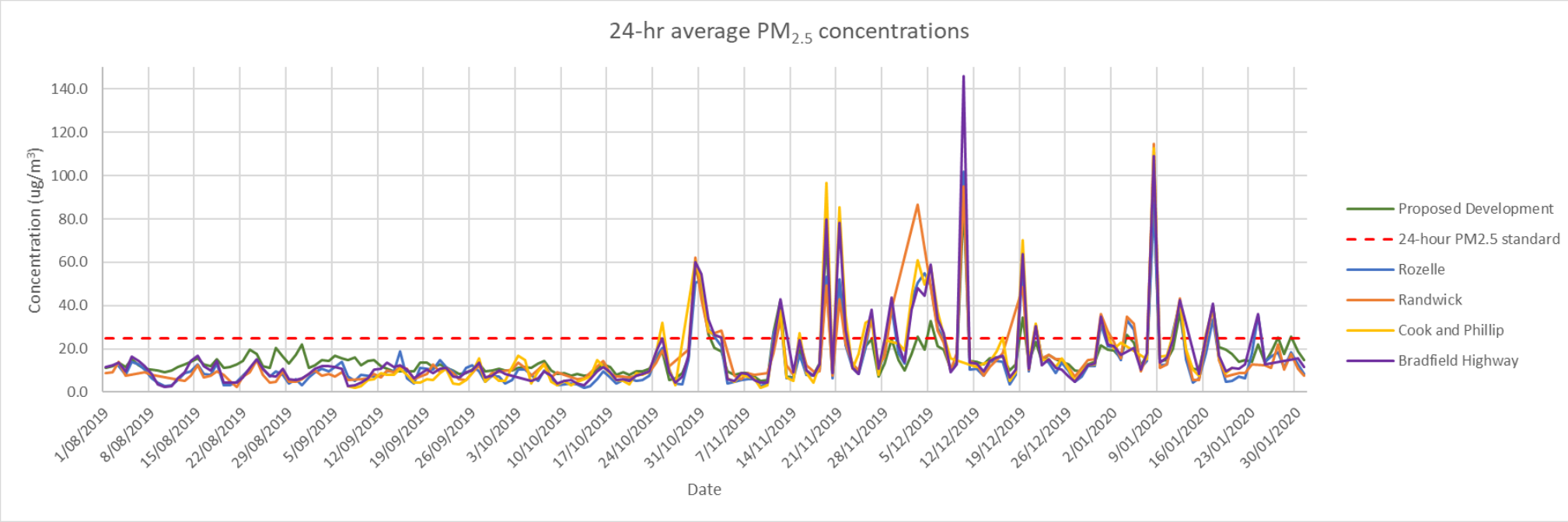


Figure 6: Monitored 24-hour average $PM_{2.5}$ concentrations at all locations

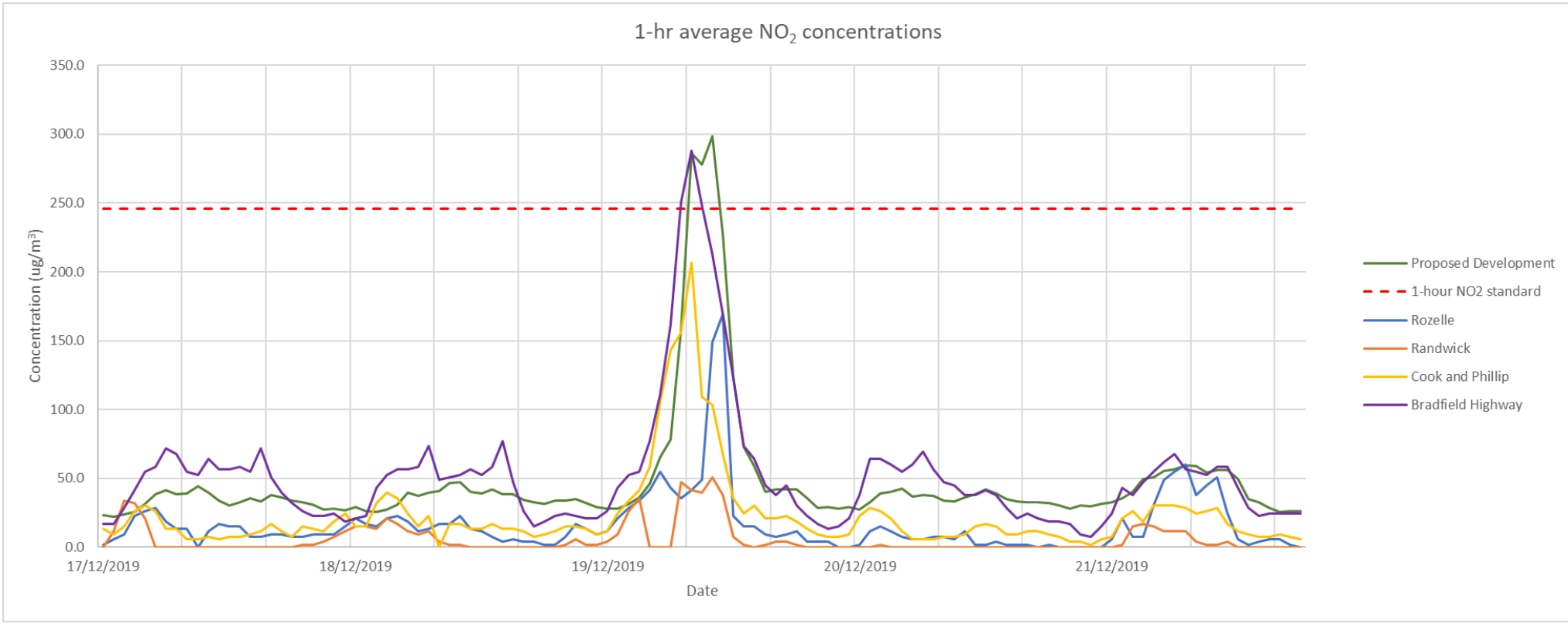
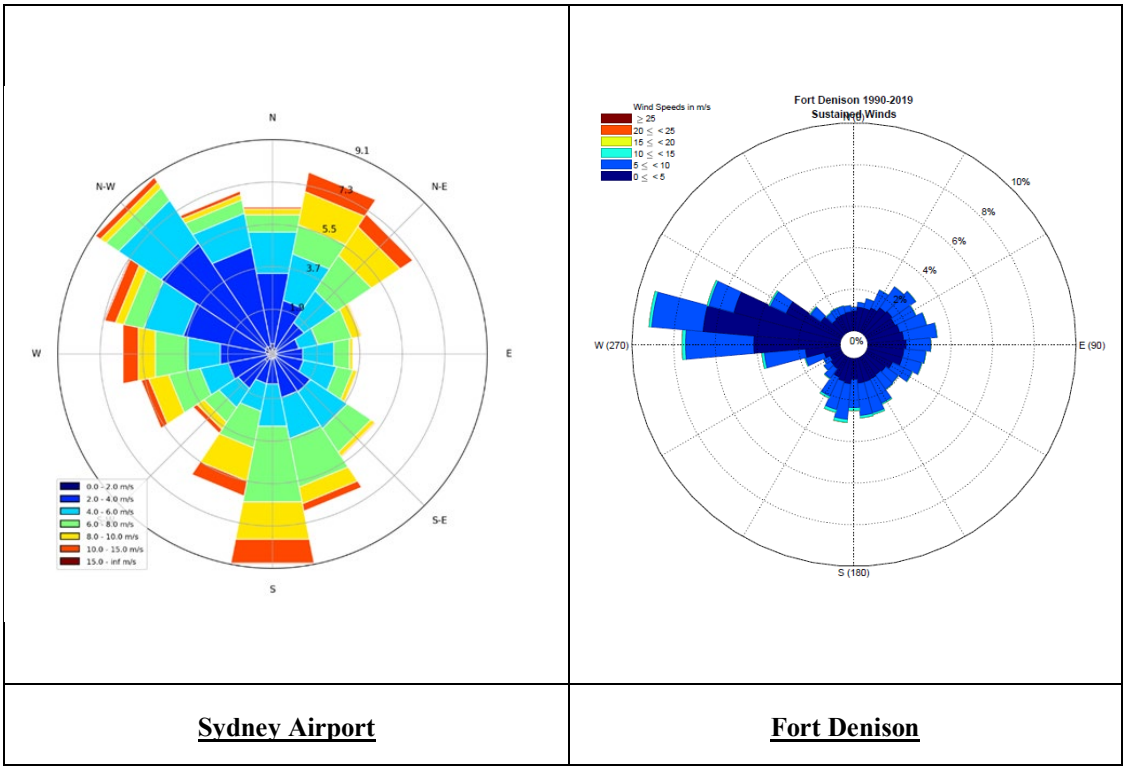


Figure 7: Monitored 1-hour average NO_2 concentrations at all locations

5.2 Local meteorology

The influence of road traffic on local air quality conditions at the proposed development site would be greatest under easterly wind conditions due to the location of the Western Distributor. The Western Distributor is at the same height as the ground level of the proposed development site and therefore pollutants would be effectively dispersed towards the site under easterly wind conditions. While the Cahill Expressway surrounds the proposed development, at the majority of locations the road is in a cutting which contains pollutants and minimises dispersion of pollutants on to the proposed development site.

Figure 8 shows wind roses for typical conditions at Sydney Airport and Fort Denison. Wind direction at Fort Denison is dominated by westerly to north-westerly winds for all wind speeds (0 m/s – 15 m/s). This is likely driven by the land form surrounding its position in Sydney Harbour. At Sydney Airport, wind direction and speed are more widely distributed; however, the predominant wind direction is north-westerly/westerly for light-to-moderate wind speeds (< 6 m/s).



Sydney Airport	Fort Denison

Figure 8: Wind rose from Sydney Airport and Fort Denison

Given the limitations of the Fort Denison meteorological station, it is considered that the wind rose from Sydney Airport is more typical of the conditions at the proposed development site. This suggests that typical meteorological conditions in the area are favourable for minimising the dispersion of pollutants towards the site from the Cahill Expressway and Western Distributor. This correlates with the comparison of onsite and offsite air quality monitoring that shows no prolonged impact on local air quality due to the proximity of the proposed development site to major roads.

6 Assessment of operational impacts

This chapter describes the exposure pathways for students and staff and design measures that have been incorporated to minimise exposure onsite where possible. It also includes a qualitative assessment of local air quality impacts that would be generated during operation of the proposed development.

6.1 Impacts on users

As shown in section 5.1, existing local air quality is generally good; except for PM_{10} and $PM_{2.5}$ concentrations. These occasionally exceed ambient air quality standards and these pollutants have been significantly impacted by bushfires and dust storms in the last quarter of 2019 and the start of 2020.

While local air quality conditions have exceeded standards over the monitoring period, conditions at the proposed development site would be no different to other schools operating within urban areas of Sydney. Potential health effects for users at the proposed development based on monitored data have been reviewed and are included in a memo provided in Appendix A. This notes that there are no health concerns unique to staff and students attending the proposed development compared to other schools operating in Sydney.

The main design aspects of the proposed development that have the potential to impact exposure of staff and students are:

- Moving class rooms, staff rooms and play spaces closer to/further away from pollution sources, either horizontally or in an upwards direction.
- Improving the ventilation system to minimise the movement of polluted air into classrooms and work spaces.

Figure 9 shows the location of proposed buildings and outdoor play spaces.

The only portion of the site where buildings would be built closer to adjacent roads than at present would be the southern area next to the Cahill Expressway. At this location the Cahill Expressway is almost level with the proposed development where it joins the Western Distributor.

The closest building façade would be 10 metres closer to the road. However, there is still a 10 m buffer to the Cahill Expressway and a 20 m buffer to the main carriageway of the Western Distributor. Therefore, this would not present an unsuitable exposure risk for staff and students.

Outdoor play spaces are also not being moved any closer to adjacent roads. The existing ground level play space will remain. Additional outdoor play space included as part of the proposed development is at roof height which also increases the relative distance between traffic using the Cahill Expressway and Western Distributor and receivers using these play spaces.

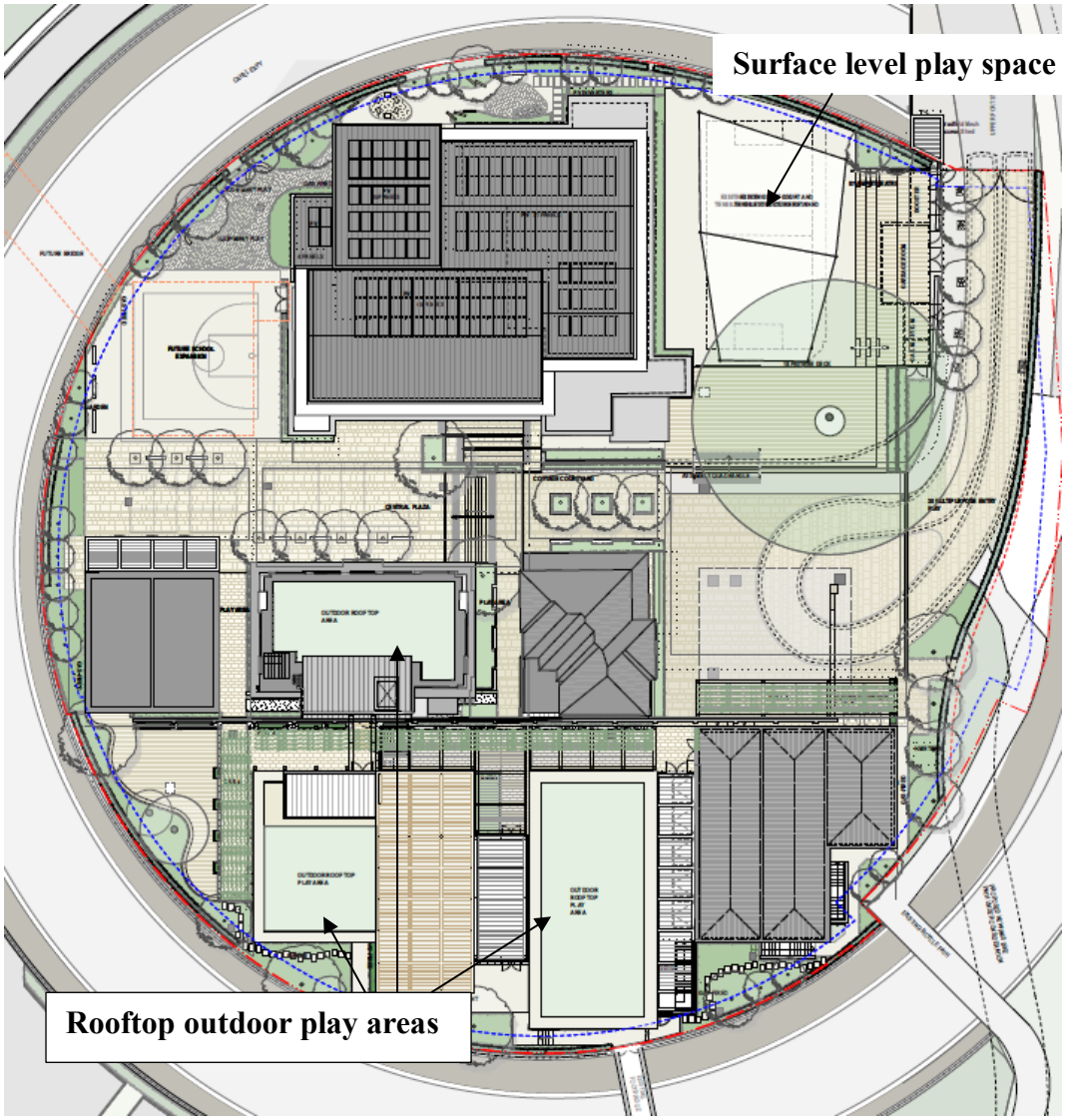


Figure 9: Proposed site plan

The proposed ventilation system has taken account of the exposure of students and staff to air pollutants (primarily PM_{10} and $PM_{2.5}$ concentrations as the key pollutants at risk of exceeding standards). As such, pre-filtered air would be provided to all habitable spaces. This would help improve the indoor air quality.

Filtration systems would require ongoing maintenance to ensure they continue to provide protection and minimise exposure.

Any failure of the ventilation system would be short-term with remedial action carried out as soon as possible. As a result, this would not cause any significant impacts to exposure of staff and students.

With the above design measures included, no further mitigation is considered to be required to minimise exposure of staff and students at the proposed development site.

6.2 Impacts from the proposed development

The proposed development would accommodate 550 students. The potential air quality impacts associated with the proposed development are anticipated to be similar to the current situation, as the site already operates as a school.

With regard to traffic, which is the main source of air quality impacts associated with the operation of a school, all onsite parking would be removed, and a green travel plan would be implemented to encourage students and staff to use sustainable and active transport modes (e.g. cycling and walking). The proposed development is well located to take advantage of active and public transport modes and includes for a pedestrian bridge to better connect the school with pedestrian routes through to Kent Street.

Despite the introduction of a green travel plan, parents would still be allowed to drop-off and pick-up students. Consequently, due to the increased capacity of the school, there is predicted to be up to 89 student-drop offs during the morning peak hour. This number of additional vehicle movements on the local road network would not have a material effect on local air quality.

The proposed development includes for gas-fired condensing boilers, which can generate local emissions to air, in each building as a back-up if the school loses its grid connection. As such, they would not be in operation under normal conditions or on a regular basis. Any installed boilers should be low-emission to minimise the impact on local air quality when in use. Any local air quality impacts associated with the installation and operation of new plant as part of the proposed development would be temporary due to occasional use and where this plant is low-emission it would not materially affect local air quality.

7 Conclusion

The assessment has considered the presence of existing airborne pollutants and their effect on the site's suitability for a proposed school.

Over a six-month period, monitoring data indicated that most pollutants meet the relevant air quality standards onsite and offsite except for PM_{10} and $PM_{2.5}$ and an anomalous peak in 1-hour NO_2 concentration. These exceedances are primarily associated with regional impacts caused across Sydney by the bushfires and dust storms. None of these exceedances have been caused solely by the presence of traffic on the Cahill Expressway or Western Distributor adjacent to the proposed development.

Local air quality onsite is therefore not significantly different from conditions monitored elsewhere in the local airshed and therefore conditions would be no different to other schools operating within urban areas of Sydney.

A key matter for the design was consideration of exposure of students and staff to pollutants. Therefore, the ventilation system for the proposed development includes filtration to help improve indoor air quality.

The potential air quality impacts associated with the proposed development are anticipated to be similar to the current situation, as the site already operates as a school. A small increase in vehicle movements is predicted on the local road network as a result of the increased capacity of the school and green travel plan would be implemented to encourage students and staff to choose sustainable and active transport modes. Proposed gas-fired condensing boilers, which can generate local emission to air, are included for back-up purposes only and therefore would not be in operation on a regular basis.

With the design measures discussed in section 6.1 included, no further mitigation is considered to be required to minimise exposure of staff and students at the proposed development site.

Appendix A

Assessment of Potential Health Effects

28 February 2020

Environmental Risk Sciences Pty Ltd
PO Box 2537
Carlingford Court NSW 2118

Phone: +61 2 9614 0297
Fax: +61 2 8215 0657
Email: jackie@enrisks.com.au
therese@enrisks.com.au
ruth@enrisks.com.au
Website: www.enrisks.com.au

ARUP
Level 5
151 Clarence Street
Sydney NSW 2000

Attn: Lesley-Anne Stone

RE: ADVICE, AIR QUALITY, FORT STREET PUBLIC SCHOOL, SYDNEY, NSW

Environmental Risk Sciences Pty Ltd (enRiskS) has been engaged by ARUP to provide advice regarding air quality data collected at the Fort Street Public School in Sydney and if there is any potential for health effects based on the results.

Results have been provided for consideration in the form of a draft report:

- ARUP (2020), School Infrastructure NSW, Fort Street Public School, Air Quality Assessment (dated 6 February 2020)

1 Background

There are a range of gases and particles that are always present in air, in addition to the normal components of the air we breathe – oxygen and nitrogen. Air quality monitoring targets these chemicals. These include:

- Ozone
- Carbon monoxide (CO)
- Sulfur dioxide (SO_2)
- Nitrogen dioxide (NO_2)
- Particulate matter (or particles) (PM10 and PM2.5)

These chemicals are always present in air due to naturally occurring processes like bushfires, other types of fires, dust blown by wind from uncovered ground and emissions from plants and animals. They are also present in air due to human activities like emissions from vehicles, combustion processes (cooking, power production, home heating (woodfires)), manufacturing emissions or construction (dust from excavations).

Australia has a national approach to managing air quality that provides guidance on how state governments should monitor air quality and also provides guidelines for interpreting the results of such monitoring (NEPC 2016). These guidelines can also be used to help understand monitoring on individual sites although, it is important to remember, they have been designed to apply to regional air quality not local air quality.

There are no guidelines specific to local air quality – these national guidelines are used to identify potential emissions that require detailed investigation.

This letter provides advice about the presence of particles in air at the school – i.e. PM10 and PM2.5.

The other chemicals have been addressed in other reports by ARUP.

The definitions for these two parameters are as follows:

- PM10 – the concentration in air of particulate matter (or particles) that are less than or equal to 10 microns (a micron is 1 millionth of a metre) in diameter (this includes all of the particles smaller than 10 microns such as $PM_{2.5}$ and very fine particles).

- PM2.5 – the concentration in air of particulate matter (or particles) less than or equal to 2.5 microns in diameter (this includes all of the particles smaller than 2.5 microns such as very fine particles and ultrafines).

In addition, the presence of a single occurrence of elevated nitrogen dioxide (NO_2) (and related oxides of nitrogen) has been considered. As noted above, these gases are always present in the air we breathe so understanding the potential for impacts from such gases might have requires understanding how different the concentrations in air at a particular site varies from what is normally present.

Nitrogen oxide gases form when fuel (i.e. petrol, diesel, wood) is burnt so such gases are emitted when vehicles burn fuel or when industry, retail or residential locations burn fuel (e.g. gas heating or cooking). In Sydney, the NSW Government (OEH 2012) estimate that on-road vehicles account for about 62 per cent of emissions of nitrogen oxides in the Sydney airshed, industrial facilities account for 12 per cent, other mobile sources account for about 22 per cent, with the remainder from domestic/commercial sources.

Guidelines

The national guidelines for particles and the other standard chemicals discussed above are provided in the table below – a direct copy of the table in the guidance document (NEPC 2016).

Schedule 2 Standards and Goal

Table 1: Standards for Pollutants

Column 1 Item	Column 2 Pollutant	Column 3 Averaging period	Column 4 Maximum concentration standard	Column 5 Maximum allowable exceedances
1	Carbon monoxide	8 hours	9.0 ppm	1 day a year
2	Nitrogen dioxide	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year None
3	Photochemical oxidants (as ozone)	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year
4	Sulfur dioxide	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year None
5	Lead	1 year	0.50 µg/m^3	None
6	Particles as PM_{10}	1 day 1 year	50 µg/m^3 25 µg/m^3	None None
7	Particles as $PM_{2.5}$	1 day 1 year	25 µg/m^3 8 µg/m^3	None None

Particles

Elevated levels of particulate matter have been linked to adverse health effects after both short term exposure (days to weeks) and long term exposure (months to years). The health effects associated with exposure to particulate matter vary widely. Effects are primarily related to the respiratory and cardiovascular system and include (Morawska et al. 2004; USEPA 2009):

- Aggravation of existing respiratory and cardiovascular disease (as indicated by increased hospital admissions and emergency room visits)
- Changes in cardiovascular risk factors such as blood pressure
- Changes in lung function and increased respiratory symptoms (including asthma)
- Changes to lung tissues and structure
- Altered respiratory defence mechanisms.

Guidelines are available from the NSW EPA and NEPC (NEPC 2003) which indicate acceptable concentrations of particulate matter. These guidelines are listed in the table above and are based on protection from adverse health effects following both short term (acute) and longer term (chronic) exposure for all members of the population including sensitive populations like asthmatics, children and the elderly.

Nitrogen dioxide

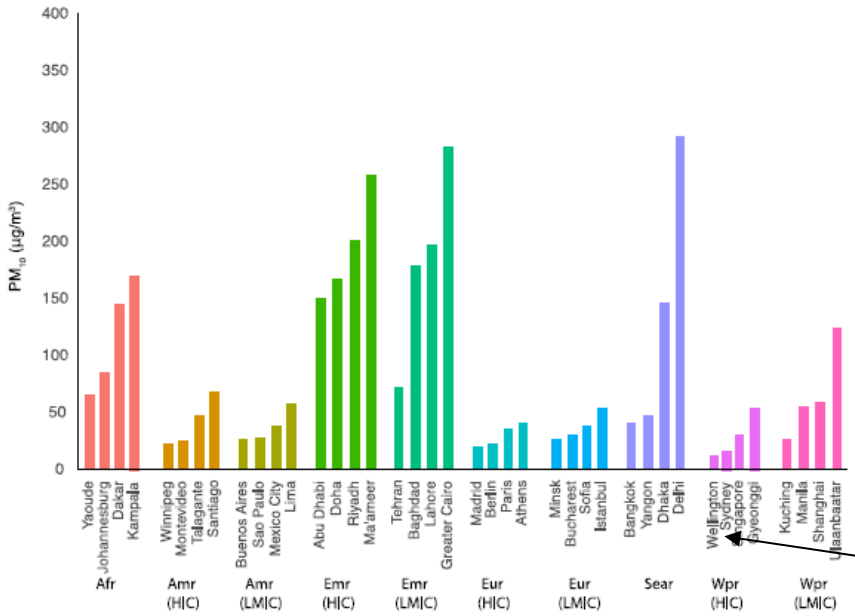
In terms of health effects, nitrogen dioxide is the only oxide of nitrogen that may be of concern (WHO 2000). The health effects associated with exposure to nitrogen dioxide depend on the duration of exposure as well as the concentration.

Guidelines are available from the NSW EPA and NEPC (NEPC 2003) which indicate acceptable concentrations of nitrogen dioxide. These guidelines are listed in the table above and are based on protection from adverse health effects following both short term (acute) and longer term (chronic) exposure for all members of the population including sensitive populations like asthmatics, children and the elderly. These guidelines are for 1 hour and annual average values in air people breathe. They can be converted to the units used in the monitoring undertaken at the school – 0.12 ppm = 240 µg/m^3 and 0.03 ppm = 60 µg/m^3. In addition, consideration has been given to guidelines in NSW that are relevant for even shorter times of exposure to NO_2 for use, for example, when travelling through road tunnels. This guideline is relevant for 15 minute average concentrations and is 0.5 ppm or 1000 µg/m^3 (http://www.chiefscientist.nsw.gov.au/__data/assets/pdf_file/0004/81778/In-Tunnel-Air-Quality-Policy-FINAL.pdf?).

Government Monitoring

The NSW Government has monitoring stations across Sydney to look at these chemicals in Sydney's airshed. There are 20 stations throughout the Sydney Basin from Randwick to Camden/Campbelltown. The national guidance requires that the NSW EPA monitor these chemicals and demonstrate that regional air quality in NSW is in compliance with NEPM guidelines.

Australia is recognised internationally as having good air quality most of the time. The World Health Organisation has reviewed government monitoring data from countries around the world. The most recent summary document includes the following graph showing how particle levels in Sydney compare to other major cities (*https://www.who.int/airpollution/data/AAP_database_summary_results_2018_final2.pdf?ua=1*).



PM_{10}: Particulate matter of 10 microns or less: Afr: Africa; Amr: Americas; Emr: Eastern Mediterranean; Eur: Europe; Sear: South-East Asia; Wpr: Western Pacific; LMIC: low and middle-income countries; HIC: high-income countries. [1] Selection criteria: For the latest year of measurement for each city included in the database, the largest for each country within a region was selected. City size ranges from 192'900 to 26 million habitants

(*sourced from https://www.who.int/airpollution/data/AAP_database_summary_results_2018_final2.pdf?ua=1*)

It can be seen that the value listed for Sydney is one of the lowest for any of the cities listed – only Wellington in New Zealand was lower. Obviously, during bushfires (such as the situation that occurred in late 2019 and early 2020) Sydney's air quality is not as good as these long term averages.

2 Monitoring at the School

As part of preparation for construction and refurbishment of buildings at the School, air quality monitors were deployed to get baseline information about air quality at the site. The monitors were installed and began operation in August 2019. They are designed to collect a measurement every 15 minutes all day every day for CO, NO_2, SO_2, PM10 and PM2.5. As with all such monitors there will be occasions where a measurement cannot be collected due to problems with the equipment.

Monitors have been located across the school site as shown in the following figure.

The monitors that have been installed are AQMesh monitors. Information about these monitors has been sourced from the manufacturer's website (https://www.aqmesh.com/product/).

These monitors are primarily passive which means they do not pull air at a constant rate across the sensors rather they depend on air movement (i.e. due to wind, movement of people or movement of vehicles) around the monitor to bring the air being monitored toward the sensors. Gaseous pollutants are passively monitored using an electrochemical sensor (relevant for NO_2). However, particulate matter is monitored using an optical particle counter which actively pulls air through the device to obtain a sample.

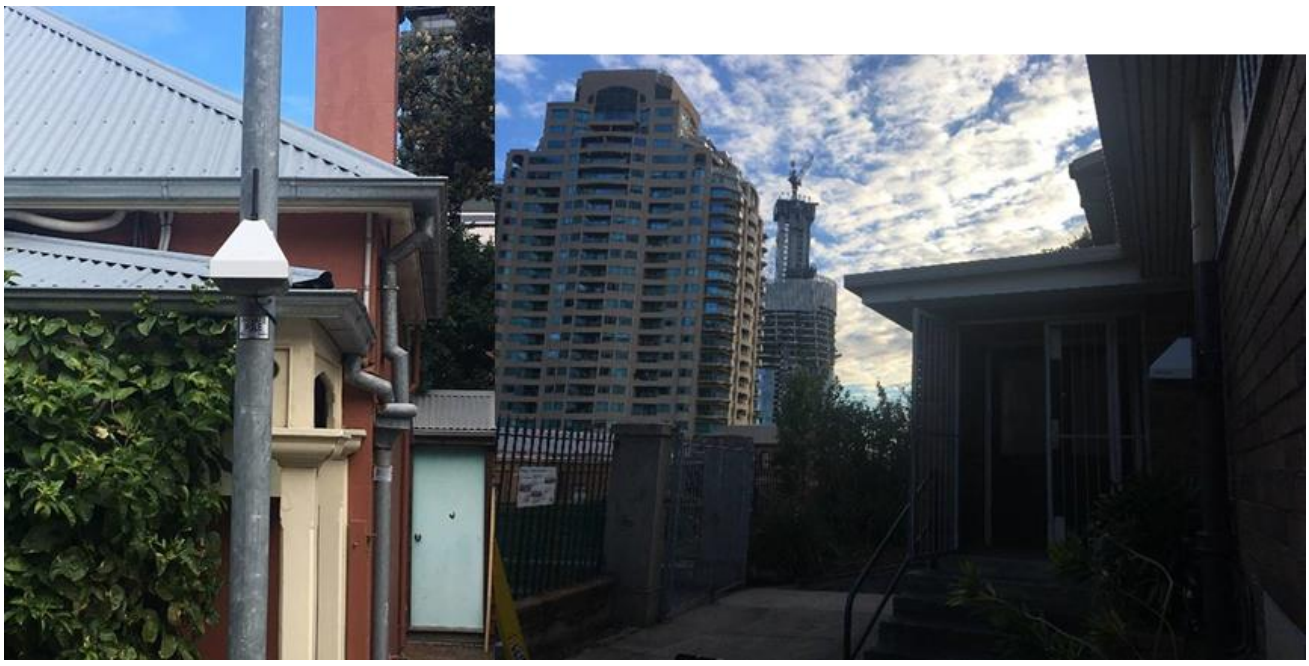
The monitors have been attached at varying heights above the ground in each location with some quite close to buildings (see photos below). This means results may be impacted by wake effects from the buildings as the wind blows around close to the monitor.

The national guidance and Australian Standard (AS/NZS 3580.1.1 (2016)) provide information to governments (and others legally required to undertake such monitoring) about what types of monitors may be used and how they should be installed (how close to buildings, height above the ground etc) to ensure data are robust. These AQ Mesh monitors are not recommended for more permanent monitoring stations as active monitors that draw the air being assessed across the sensors at a constant rate are preferred. The monitors being used at the school may be suitable for short term monitoring programs as they provide indicative/trend information.

Prior to installation of these monitors at the school, they were installed near a reference monitoring station near Concord Oval to ensure they were giving similar readings as the reference station for the same air. This is a standard approach when using these types of monitors – they are essentially validated with a monitoring station that does comply with the Australian Standard.

In addition, 4 monitors were installed at the site instead of only 1 to ensure appropriate data were collected.

For the purposes of this assessment, it has been assumed the data as provided are reliable, however, no independent review of the quality or accuracy of the data has been undertaken.



3 Results

There are 4 monitors that have been placed around the school – 3 in areas close to play areas used by the children and 1 near the roadway that runs down between buildings in the middle of the school.

The site occupies an area of about 0.5 ha which is not a large area. Given the size of the area, it is appropriate to average the results for all 4 monitors to assess the air quality at the school.

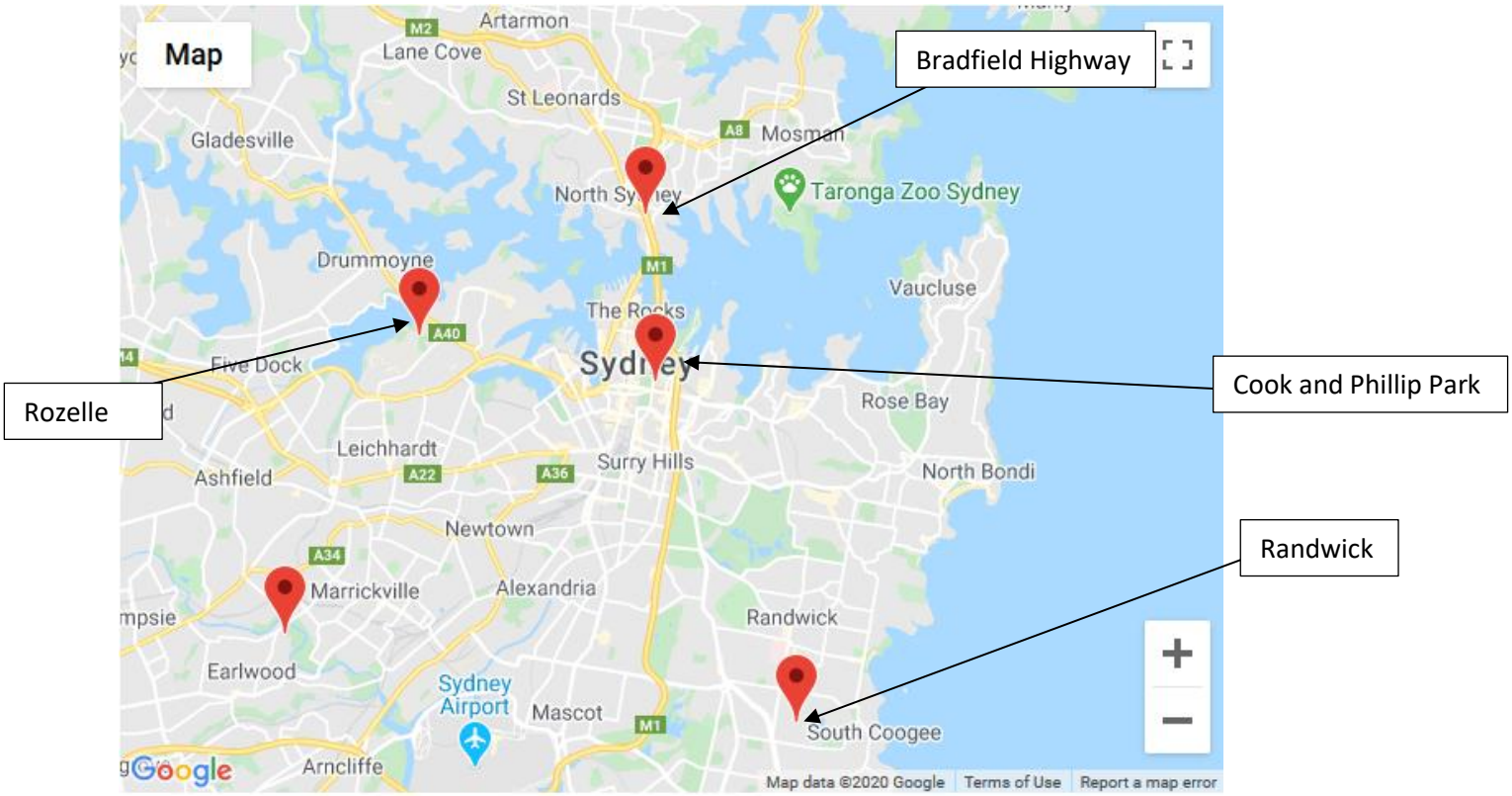
It is also important to note that children are at the school on weekdays between approximately 9 am to 3 pm. Also, while they are there, they will be inside the buildings most of the time. Teachers may be present at the school for longer hours but again much of their time will be spent indoors. The levels of particles indoors will be lower than in outdoor air. This is the basis of NSW Health recommendations to spend time indoors when bushfire smoke is present in the Sydney basin. When outside teachers and children will spend the majority of their time in the play areas around the outside of the school buildings. This means monitors 1, 2 and 4 are located in the areas most likely to be where people spend time outside.

The results for the 4 monitors have been averaged to get an appropriate estimate of the air quality for the school.

The average for the school can be compared to the results in Sydney at all the relevant government monitoring stations (i.e. those around the central business district of Sydney) and to the annual average guideline provided by national authorities to determine if the air quality at the school is in compliance with national guidelines and/or is the same as the quality of air over the whole Sydney region.

The results for the government monitoring stations have been obtained from the online database at https://www.environment.nsw.gov.au/AQMS/search.htm . Data have been sourced for the monitoring stations at the Bradfield Highway (near the northern entry to the Harbour Bridge), Rozelle, Randwick and Cook and Phillip Park.

A map showing the locations of these stations is provided below.



Particulate matter

Table 1 shows this comparison for particulate matter.

Table 1 Comparison of Average Results for Particulate Matter with Relevant Government Monitoring Stations and National Guidelines

Monitoring Location	PM2.5 (maximum 24 hr average) (µg/m³)	PM2.5 (annual average) (µg/m³)	PM10 (maximum 24 hr average) (µg/m³)	PM10 (annual average) (µg/m³)
School Average	93	16 (6 month average)	110	22 (6 month average)
National Guideline	**25**	**8**	**50**	**25**
Government Monitoring Stations				
Bradfield Highway	146	13	170	24
Rozelle	102	10	143	23
Randwick	95	11	128	24
Cook and Phillip Park	113	18 (6 month average)	131	31 (6 month average)

Graphs showing these results in more detail are provided below.

The school results are shown by the green line.

For the graph showing the PM10 results, it can be seen that often the school results were below the results for all the government monitoring stations.

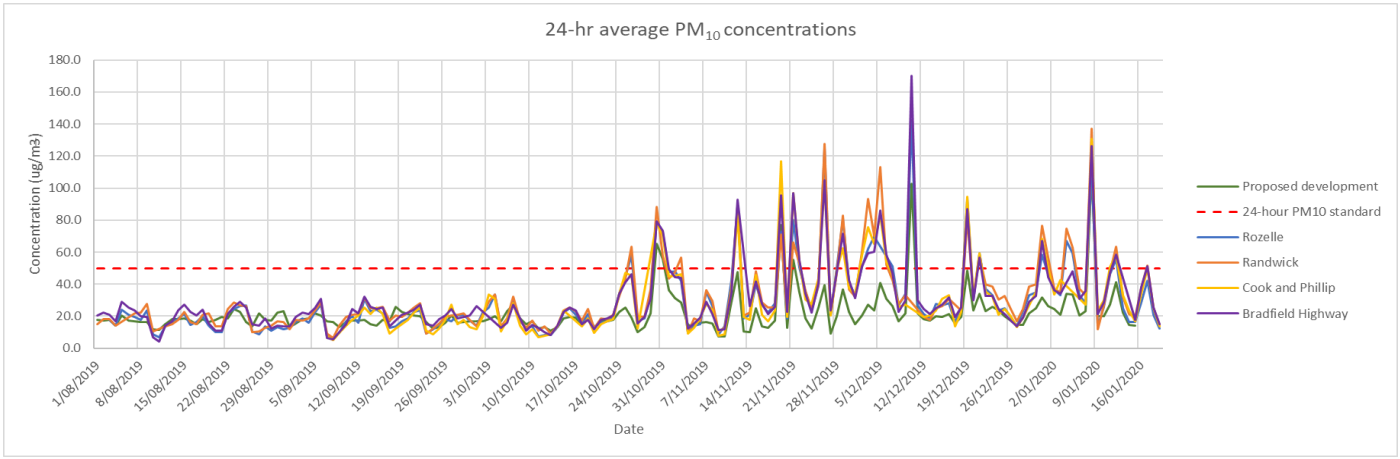
For the graph showing the PM2.5 results, the green line can hardly be identified until the very end of the monitoring period which is because it is essentially the same as the results for the government monitoring stations. At the end of the monitoring period there were some higher levels at the school site but all remained below the guideline and are still essentially the same as the government monitoring sites given the errors in measurement and sampling.

From the comparison in **Table 1**, it can be seen that:

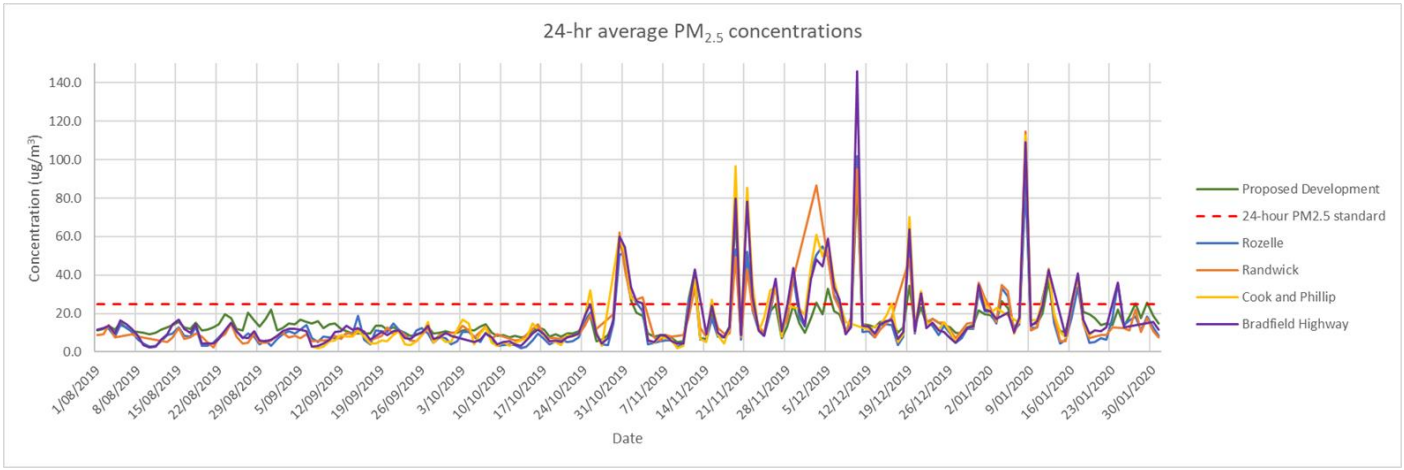
- the results for the school were not different to the government monitoring stations over this time period – i.e. the air quality at the school is the same as the quality of air across the whole region
- the averages for August to January for PM2.5 for the school and Cook and Phillip Park as well as the annual averages at all other locations were above the annual guideline for all locations listed
- the averages for August to January for PM10 for the school and Cook and Phillip Park as well as the annual averages at all other locations were generally around the national long term guideline (i.e. annual average) – one government station was higher than the annual guideline while the school monitoring reported the lowest average for this parameter over these months
- the maximum 24 hour averages for August to January for PM2.5 and PM10 for all locations were above the relevant guidelines with the school showing the lowest average overall

The elevated results for PM2.5 and PM10 across Sydney over these months are due to the impact of smoke from the extensive bushfires and related dust storms occurring around NSW at the time on Sydney's air quality which resulted in many days with elevated levels of particles across the entire Sydney Basin.

These results show there was little difference in the air quality in relation to particulate matter at the school compared to the rest of Sydney, so there are no health concerns that are unique to children attending the school due to air quality at the school – it was essentially the same as the rest of Sydney.



Monitored 24-hour average PM_{10} concentrations at all locations



Monitored 24-hour average $PM_{2.5}$ concentrations at all locations

Nitrogen dioxide

Table 2 shows this comparison for nitrogen dioxide.

Table 2 Comparison of Average Results for Nitrogen Dioxide with Relevant Government Monitoring Stations and National Guidelines

Monitoring Location	Nitrogen dioxide (maximum 1 hour average) (mg/m^3)	Nitrogen dioxide (annual average) (mg/m^3)
School Average	298	39 (6 month average)
National Guideline	**246**	**62**
Government Monitoring Stations		
Bradfield Highway	288	48
Rozelle	169	18
Randwick	96	16
Cook and Phillip Park	207	21 (6 month average)

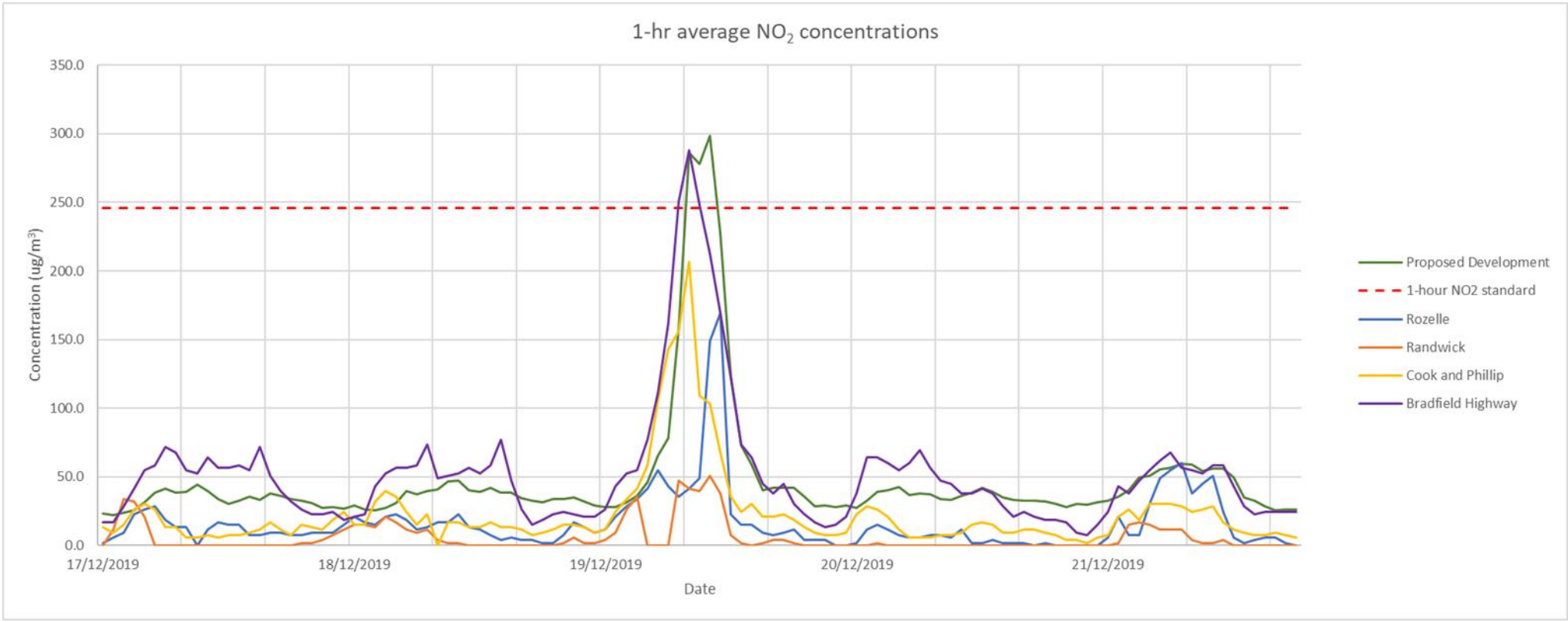
From this comparison, it can be seen that:

- the results for the school were not greatly different to the government monitoring stations over this time period, in particular, the results for the Bradfield Highway site were essentially the same – i.e. the air quality at the school was the same as the quality of air across the whole region
- the averages for August to January for NO_2 for the school and Cook and Phillip Park as well as the annual averages at all other locations were compliant with the relevant guideline
- the maximum 1 hour averages for August to January for NO_2 around this part of Sydney were elevated and some were above the guideline including the school

The maximum concentration measured as a 1 hour average at the school occurred on 19 December 2019 – a day which was not part of the school year. This elevated level occurred over a few hours and, based on the data at the government monitoring stations, was widespread across the region. A graph showing the results for nitrogen dioxide on the days surrounding the day on which this peak occurred is provided below.

It can be seen in this graph that generally the levels at all monitoring stations and at the school were well below the guideline value for 1 hour averages except for this single peak event. It is not clear what may have caused this peak event. It is possible that it was related to some unusual chemistry occurring in the atmosphere due to the high levels of bushfire related pollutants. The Air Quality Index for the day was in the hazardous range (780 for this part of Sydney). Ozone levels were also elevated for these stations on this day.

These results show there was little difference in the air quality in relation to NO_2 at the school compared to the rest of Sydney, so there are no health concerns that are unique to children attending the school due to air quality at the school – it was essentially the same as the rest of Sydney.



Monitored 1-hour average NO_2 concentrations at all locations

4 References

Morawska, L, Moore, MR & Ristovski, ZD 2004, *Health Impacts of Ultrafine Particles, Desktop Literature Review and Analysis*, Australian Government, Department of the Environment and Heritage.

NEPC 2003, *National Environment Protection (Ambient Air Quality) Measure*, National Environment Protection Council.

NEPC 2016, *National Environment Protection (Ambient Air Quality) Measure*, Federal Register of Legislative Instruments F2016C00215.

USEPA 2009, *Integrated Science Assessment for Particulate Matter*, United States Environmental Protection Agency. <http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=216546#Download>.

WHO 2000, *WHO air quality guidelines for Europe, 2nd edition, 2000 (CD ROM version)*, World Health Organisation.

5 Limitations

Environmental Risk Sciences Pty Ltd has prepared this report for the use of ARUP Pty Ltd in accordance with the usual care and thoroughness of the consulting profession. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report.

It is prepared in accordance with the scope of work and for the purpose outlined in this report.

The methodology adopted and sources of information used are outlined in this report. Environmental Risk Sciences Pty Ltd has made no independent verification of this information beyond the agreed scope of works and assumes no responsibility for any inaccuracies or omissions. No indications were found that information contained in the reports provided for use in this assessment was false.

This report was prepared in November 2019 and updated in February 2020 with additional data and is based on the information provided and reviewed at that time. Environmental Risk Sciences Pty Ltd disclaims responsibility for any changes that may have occurred after this time.

This report should be read in full. No responsibility is accepted for use of any part of this report in any other context or for any other purpose or by third parties. This report does not purport to give legal advice. Legal advice can only be given by qualified legal practitioners.

6 Closure

If you require any additional information, please do not hesitate to contact Therese on (02) 9614 0297 or 0487 622 551.

Yours sincerely,

Jackie Wright (Fellow ACTRA)
Director/Principal
Environmental Risk Sciences Pty Ltd