



TODOROSKI
AIR SCIENCES

NORTHCONNEX
AMBIENT AIR QUALITY MONITORING
INDEPENDENT AUDIT
MAY 2021 – OCTOBER 2021

Transurban

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NorthConnex

Ambient Air Quality Monitoring

Independent Audit

May 2021 – October 2021

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1 INTRODUCTION

Todoroski Air Sciences have conducted an independent audit of the ambient air quality monitoring data collected for the NorthConnex Motorway (hereafter referred to as the Project).

This independent audit reviews the available ambient air quality and meteorological data collected for the Project during 1 May 2021 to 31 October 2021. A brief examination of a full year of data, including the previous six months, is also provided.

The auditor has previously conducted an independent review of the NorthConnex Project Air Quality Impact Assessment report for the NSW Department of Planning and Environment and independently reviewed the suitability of various monitoring locations for placement of the ambient monitoring equipment and presented the findings to the Air Quality Community Consultative Committee (AQCCC) for this Project. The auditor is also conducting the 6-monthly NorthConnex audits for the in-tunnel monitoring data, ventilation outlet monitoring data and air quality monitoring operating procedures and equipment.

Condition E7 of Infrastructure Approval SSI-6136 requires an audit of the monitoring data collected for the Project. The relevant part of the condition reads as follows:

The Ambient Air Quality - Monitoring

E7 ...

Monitoring results shall be made publicly available and shall be subject to an independent audit at six-monthly intervals (or at a longer interval, if approved by the Secretary). The auditor shall be approved by the Secretary in consultation with the EPA and the AQCCC, and the auditor's report shall be directly provided to the Proponent and the AQCCC.

1.1 Project Requirements

Under Condition E7 of Infrastructure Approval SSI-6136, the Project is required to monitor the following ambient air quality pollutants and parameters set out in **Table 1-1** below, following the specified sampling method, units of measure, and sampling frequency.

Monitoring is required to be conducted at a minimum at;

- ✦ two ground level receptors near the northern ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;
- ✦ two ground level receptors near the southern ventilation outlet, at locations suitable for detecting any impact on air quality from the outlet;
- ✦ one location along Pennant Hills Road, at a location suitable for detecting any impact on air quality along Pennant Hills Road; and,
- ✦ one location away from any of the locations set out above suitable for providing background ambient air quality reference data for the project area.

The quality of the monitoring results shall be assured through a NATA accredited process and results should comply with the ambient air quality goals set out for the Project under condition E8.

20071149_NorthConnex_Ambient_AQ_Audit_May21_Oct21_220512.docx

Under condition E9, should the monitoring results exceed any of the air quality goals for any given event, excluding extraordinary events such as bushfires and dust storms, the Project will immediately notify the Secretary, EPA and Ministry of Health.

The monitoring results shall be made publicly available and shall be subject to an independent audit at six-monthly intervals, which is the purpose of this report.

Table 1-1: Ambient air quality monitoring methodologies required under Condition E7

Pollutant/Parameter	Unit of measurement	Averaging Period	Frequency	Method
NO	pphm	1-hour	Continuous	AM-12 (AS/NZS 3580.5.1 –1993)
NO ₂	pphm	1-hour	Continuous	AM-12 (AS/NZS 3580.5.1 –1993)
NO _x	pphm	1-hour	Continuous	AM-12 (AS/NZS 3580.5.1 –1993)
PM ₁₀	µg/m ³	24-hour	Continuous	AS 3580.9.8-2008
PM _{2.5}	µg/m ³	24-hour	Continuous	AS 3580.9.13-2013
CO	ppm	1-hour, 8-hour	Continuous	AM-2 (AS/NZS 2923-1987) & AM-6 (AS 3580.7.1-1992)
Wind speed at 10m	m/s	1-hour	Continuous	AM-2 (AS/NZS 2923-1987) & AM-4 (USEPA (2000) EPA 454/R-99-005)
Wind direction at 10m	degrees	1-hour	Continuous	AM-2 (AS/NZS 2923-1987) & AM-4 (USEPA (2000) EPA 454/R-99-005)
Sigma theta	degrees	1-hour	Continuous	AM-2 (AS/NZS 2923-1987) & AM-4 (USEPA (2000) EPA 454/R-99-005)
Temperature at 2m	K	1-hour	Continuous	AM-4 (USEPA (2000) EPA 454/R-99-005)
Temperature at 10m	K	1-hour	Continuous	AM-4 (USEPA (2000) EPA 454/R-99-005)
Siting	-	-	-	AM-1 (AS 2922-1987) & AM-4 (USEPA (2000) EPA 454/R-99-005)

ppm = parts per hundred million

ppm = parts per million

µg/m³ = micrograms per cubic metre

2 AIR QUALITY MONITORING SITES

Ambient air quality monitoring, data collection and reporting was conducted by Ecotech Pty Ltd (Ecotech), a NATA accredited organisation. Monthly ambient air quality and weather monitoring validation reports are prepared by Ecotech (**ACOEM Ecotech, 2021a-f**).

Figure 2-1 presents the location of the ambient air quality monitoring sites for the Project.

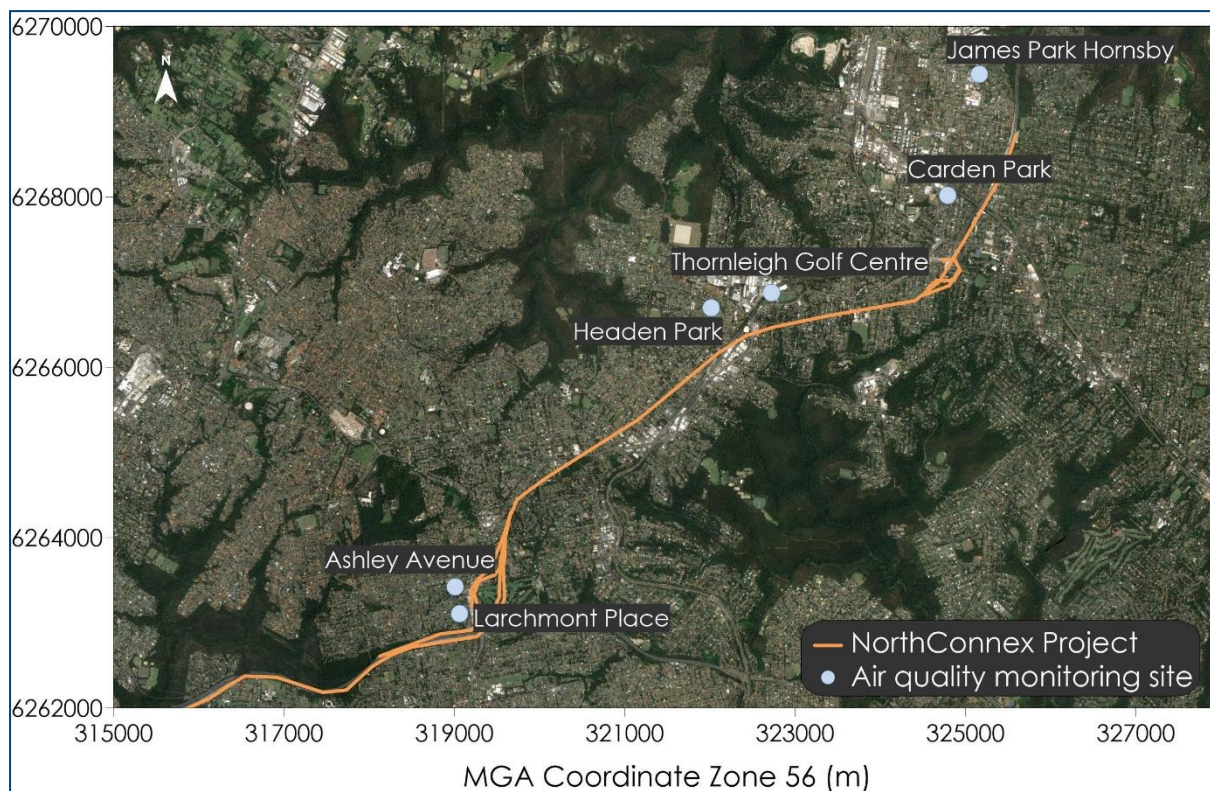


Figure 2-1: Monitoring site locations

3 AIR QUALITY GOALS

3.1 Particulate matter

Particulate matter consists of dust particles of varying size and composition. Two classes of particulate matter include PM₁₀, particulate matter with equivalent aerodynamic diameters of 10µm or less, and PM_{2.5}, particulate matter with equivalent aerodynamic diameters of 2.5µm or less.

PM₁₀ particles are generated through various sources, which include but are not limited to, the abrasion or crushing of rock, the general disturbance of dusty material and from pollen generated by trees. Finer particulates, such as PM_{2.5}, are more often generated through combustion processes such as wood burning and vehicle exhaust or chemical processes in the atmosphere.

3.2 Nitrogen dioxide

Nitrogen dioxide (NO₂) is reddish-brown in colour (at high concentrations) with a characteristic odour and can irritate the lungs and lower resistance to respiratory infections such as influenza. NO₂ belongs to a family of reactive gases called oxides of nitrogen (NO_x). These gases form when fuel is burned at high temperatures, mainly from motor vehicles, power generators and industrial boilers (**US EPA, 2011**). It is important to note that when formed, NO₂ is generally a small fraction of the total NO_x generated in a combustion process.

3.3 Carbon monoxide

Carbon monoxide (CO) is an odourless, colourless gas. CO can be produced during incomplete combustion of carbon based materials such as fuel, coal or wood etc. It can inhibit the capacity of blood to transport oxygen in humans resulting in symptoms of headache, nausea and fatigue.

3.4 NorthConnex ambient air quality goals

Table 3-1 summarises the ambient air quality goals set out for the Project per Condition E8.

Table 3-1: NorthConnex ambient air quality goals

Pollutant	Averaging Period	Air quality goal
PM ₁₀	24-hour	50 µg/m ³
PM _{2.5}	24-hour	25 µg/m ³
NO ₂	1-hour	0.12 ppm
CO	8-hour rolling	9 ppm

ppm = parts per million

µg/m³ = micrograms per cubic metre

4 METEOROLOGICAL MONITORING DATA

Representative wind speed and direction data have been obtained from the Project's ambient monitoring stations. The data are presented as a series of windroses. For an example of how to read a windrose, refer to **Figure A-1** in **Appendix A**.

Figure 4-1 presents the windroses for the Project's monitoring stations during the review period. Detailed windroses are provided in **Appendix B**.

It is noted that most of the monitoring stations are positioned in sheltered locations which generally results in lower wind speeds, and broader wind distributions.

The Ashley Avenue monitoring station predominantly recorded winds from the southwestern quadrant.

The Carden Park monitoring station recorded a high proportion of winds ranging from the southwestern quadrant.

The predominate wind directions recorded at the Headen Park monitoring station were from the south-southwest to north-northwest.

The James Park Hornsby monitoring station predominantly recorded winds from the west-southwest, southwest and west sectors. Wind speeds at the James Park Hornsby monitoring station were typically higher than at the other ambient monitoring stations. This would be expected given the low grassy ground cover nearby that is less sheltered from the prevailing winds relative to the other monitoring locations.

The Larchmont Place monitoring station predominantly experienced winds from the west-southwest and southwest.

Thornleigh Golf Centre monitoring station experiences varied winds, predominantly from the south to north-northwest.

Figure 4-1 shows the differences between the distributions of winds at each of the ambient monitoring stations. The variation in localised winds is clear to see, however the locations also display a similar underlying trend in the wind distribution patterns, with the winds tending to originate more from the south to western quadrant during the review period.

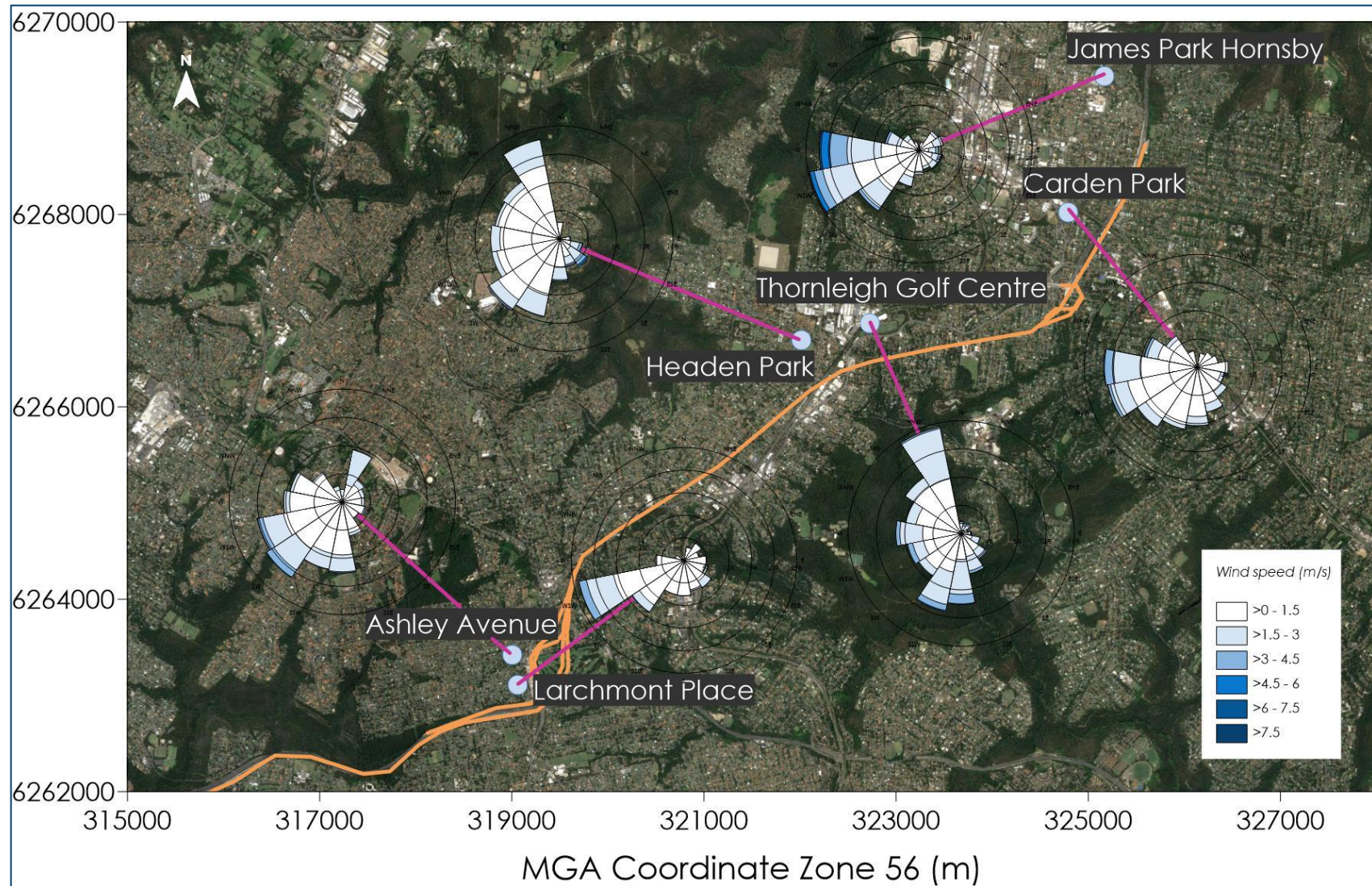


Figure 4-1: Windroses – 1 May 2021 to 31 October 2021

5 AMBIENT AIR QUALITY MONITORING DATA

The monitoring data in this report are presented as provided to Todoroski Air Sciences.

All of the monitoring data provided to Todoroski Air Sciences are presented in graphical format in **Appendix C**.

It is noted that small negative concentration readings are due to the instrument noise at low/zero concentration levels and are a normal part of the operation of gas and particulate analysers and are thus considered to be valid data for reporting purposes. This is especially the case for short term readings (e.g., 5-minutes) and generally does not arise often for averaging periods of longer than an hour. When hourly particulate matter data shows negative readings they often coincide with high moisture or rainfall conditions.

Table 5-1 presents a summary of the measured pollutant levels occurring during the review period from 1 May 2021 to 31 October 2021.

The data in **Table 5-1** indicates:

- The recorded NO₂ and CO levels were below the relevant air quality goal during the review period.
- There was one 24-hour average PM_{2.5} level recorded at Carden Park which was above the respective daily air quality goal of 50µg/m³ during the review period.
- All monitors recorded one or more 24-hour average PM_{2.5} levels above the respective daily air quality goal of 25µg/m³ during the review period.

All stations recorded maximum 24-hour average PM_{2.5} levels which were higher than the maximum 24-hour average PM₁₀ levels during the review period. Note that the maximum PM_{2.5} and PM₁₀ levels occur on the same day for each monitor, and these days appear to be associated with hazard reduction burns as discussed in **Sections 5.1** and **5.2**.

Tapered Element Oscillating Microbalance (TEOM) monitors are used for measuring PM₁₀ while Beta Attenuation Monitors (BAMs) are used for measuring PM_{2.5}. Ecotech notes in the monthly monitoring reports that TEOM monitors can under report concentrations compared to the BAMs, especially when the air contains a large proportion of semi-volatile particulate matter, such as those associated with smoke from hazard reduction burns. As a result, it is normal to see occasional periods where PM₁₀ is less than PM_{2.5} and this situation does not necessarily indicate a fault with either instrument.

Table 5-2 presents the percentage of data capture available over the review period. There was greater than 90% capture rate for all pollutants at all monitors over the review period with the exception of NO₂ at the Thornleigh Golf Centre which over the six-month review period only recorded approximately 76.7%. **Figure C-6** in the Appendix C indicates that there were significant periods of missing NO₂ data during August, September and October 2021. The relevant monthly reports indicate some intermittent unrealistic negative NO₂ data and that instrument faults occurred during these months.

Table 5-1: Summary of measured pollutant levels for review period

Site	PM _{2.5} (µg/m ³)	PM ₁₀ (µg/m ³)	NO ₂ (ppm)	CO (ppm)
	24-hour average	24-hour average	1-hour average	8-hour rolling average
	NorthConnex Ambient Air Quality Goal			
	25	50	0.12	9
Maximum pollutant level				
Ashley Avenue	40.5	36.4	0.05	0.7
Carden Park	76.4	58.1	0.04	1.1
Headen Park	48.5	45.2	0.04	0.8
James Park Hornsby	59.8	48.6	0.04	1.4
Larchmont Place	38.1	35.1	0.04	0.6
Thornleigh Golf Centre	46.5	46.1	0.04	0.8
Minimum pollutant level				
Ashley Avenue	0.4	1.2	0.001	0.1
Carden Park	2.5	0.3	0.000	0.02
Headen Park	-0.7	0.9	0.000	0.01
James Park Hornsby	-0.4	0.8	0.000	0.02
Larchmont Place	-0.6	1.3	0.000	0.02
Thornleigh Golf Centre	2.3	2.2	0.000	0.02
Number of times recorded above criterion				
Ashley Avenue	2	0	0	0
Carden Park	5	1	0	0
Headen Park	1	0	0	0
James Park Hornsby	4	0	0	0
Larchmont Place	2	0	0	0
Thornleigh Golf Centre	4	0	0	0
6 Month average pollutant level				
Ashley Avenue	6.0	11.7	0.01	0.2
Carden Park	7.9	12.8	0.01	0.2
Headen Park	4.5	12.2	0.01	0.2
James Park Hornsby	6.0	12.7	0.01	0.2
Larchmont Place	4.9	11.8	0.01	0.2
Thornleigh Golf Centre	7.8	14.0	0.01	0.2
Rolling Annual Average				
Ashley Avenue	6.5	13.7	0.01	0.2
Carden Park	6.7	14.6	0.01	0.2
Headen Park	6.3	14.0	0.01	0.2
James Park Hornsby	4.9	14.6	0.01	0.2
Larchmont Place	5.1	13.8	0.01	0.2
Thornleigh Golf Centre	7.9	15.7	0.01	0.2

Table 5-2: Percentage of data capture available for the review period

Site	Data Capture %			
	PM _{2.5}	PM ₁₀	NO ₂	CO
Ashley Avenue	99.5	98.9	94.2	98.0
Carden Park	99.5	96.2	92.0	95.3
Headen Park	98.9	98.9	93.7	97.9
James Park Hornsby	97.8	99.5	94.1	97.5
Larchmont Place	99.5	98.9	95.0	97.0
Thornleigh Golf Centre	98.4	93.5	76.7	97.8

5.1 PM_{2.5} monitoring data

Figure 5-1 presents the 24-hour average PM_{2.5} monitoring data recorded during the review period. The data indicate that 24-hour average PM_{2.5} levels were above the respective air quality goal of 25µg/m³ on occasion during the review period. The elevated results occurred on:

- ✦ 4 May 2021 at Ashley Avenue, Carden Park, Larchmont Place and Thornleigh Golf Centre;
- ✦ 21 August 2021 at Carden Park, James Park and Thornleigh Golf Centre;
- ✦ 22 August 2022 at Ashley Avenue, Carden Park, Headen Park, James Park, Larchmont Place and Thornleigh Golf Centre;
- ✦ 11 September 2021 at Carden Park and James Park; and
- ✦ 20 September 2021 at Carden Park, James Park and Thornleigh Golf Centre.

The 24-hour average level exceedances have been reported in their respective Above-Goal Reading (AGR) notification reports (**Transurban, 2021a-d**). The AGR notification reports indicate that suburbs near the NorthConnex Motorway were impacted by smoke associated with hazard reduction burns during these times.

It is noted that an AGR notification report was also prepared for a potential 24-hour average PM_{2.5} exceedance at Carden Park on 31 July 2021. The July monthly report and monitoring data provided to Todoroski Air Sciences do not show this exceedance, however comment on this date stating “static multiplier of 0.001 applied to correct unrealistic PM_{2.5} reading cause due to logger error”.

5.2 PM₁₀ monitoring data

Figure 5-2 presents the 24-hour average PM₁₀ monitoring results recorded during the review period. The data indicate that 24-hour average PM₁₀ levels were above the respective air quality goal of 50µg/m³ on one occasion during the review period at the Carden Park monitor location.

The elevated 24-hour average result at Carden Park occurred on 22 August 2021.

The 24-hour average level exceedance has been reported in its respective AGR notification report (**Transurban, 2021b**). The AGR notification report indicates that suburbs near the NorthConnex Motorway were impacted by smoke associated with hazard reduction burns during this time.

5.3 NO₂ monitoring data

Figure 5-3 presents the 1-hour average NO₂ monitoring data recorded for the Project during the review period. The data indicate the NO₂ levels were below the relevant air quality goal of 0.12ppm during the review period.

5.4 CO monitoring data

Figure 5-4 presents the 8-hour rolling average CO monitoring data recorded for the Project during the review period. The data indicate the CO levels were well below the relevant air quality goal of 9ppm during the review period.

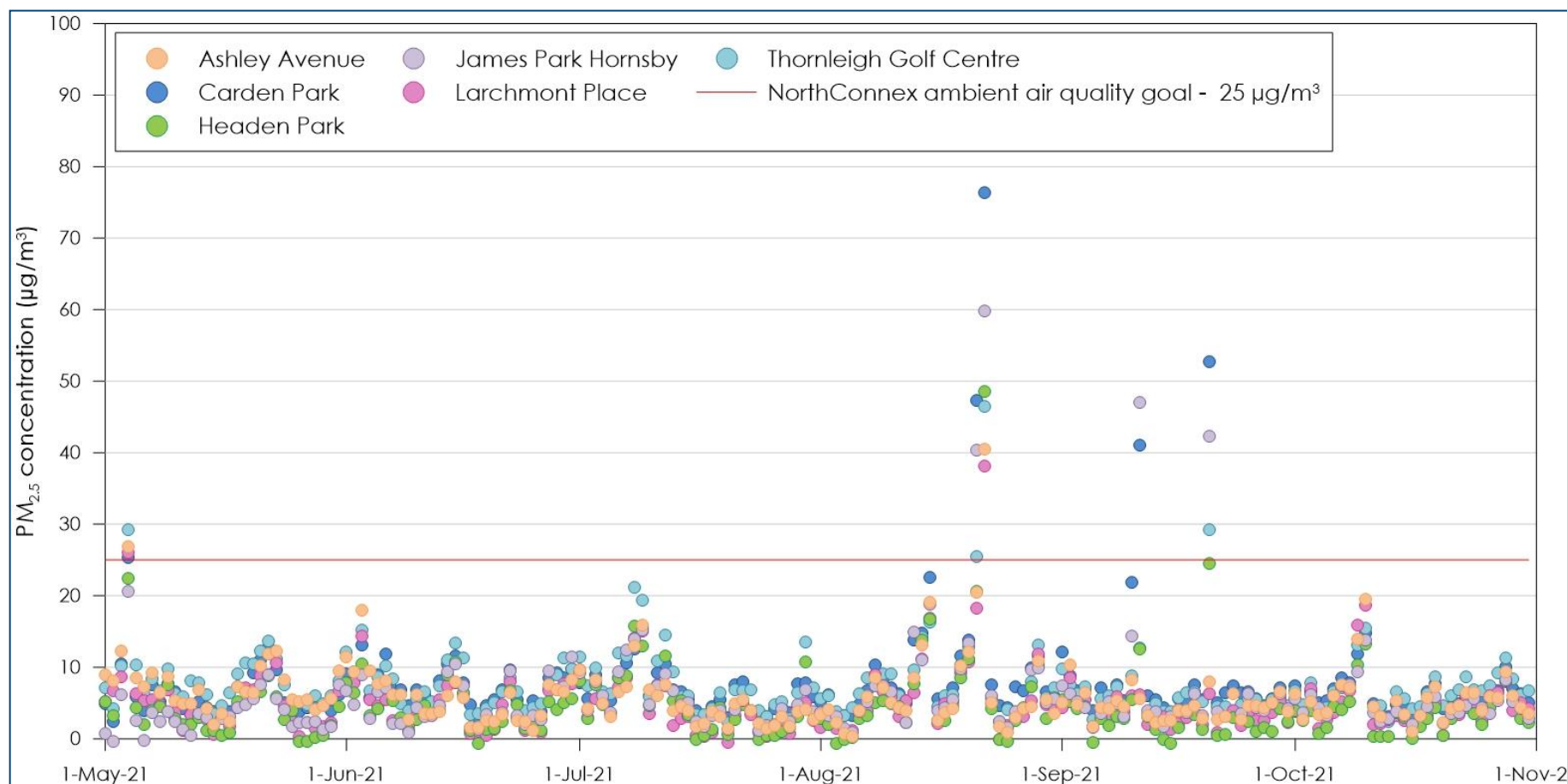


Figure 5-1: 24-hour average PM_{2.5} levels

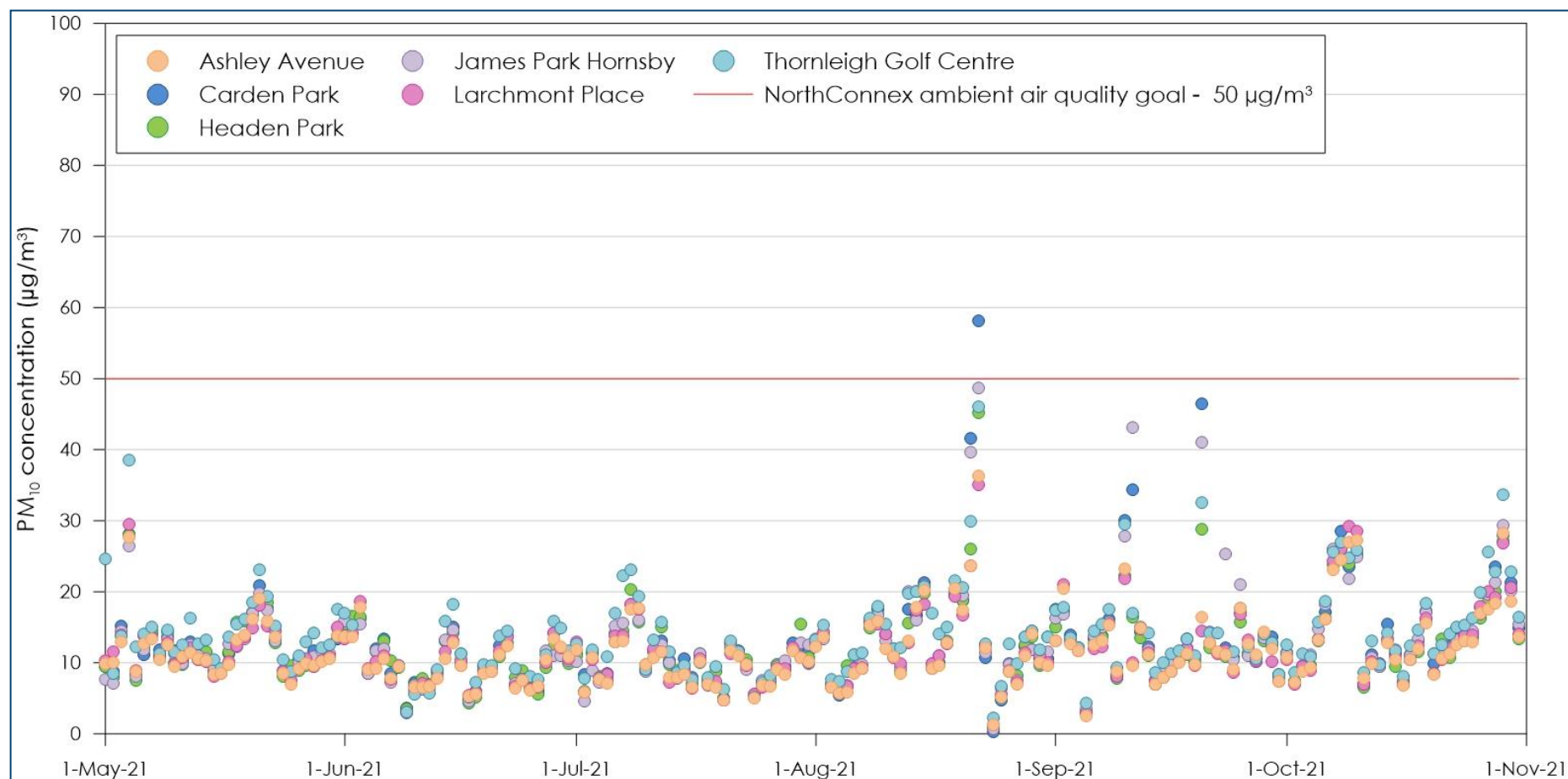


Figure 5-2: 24-hour average PM₁₀ levels

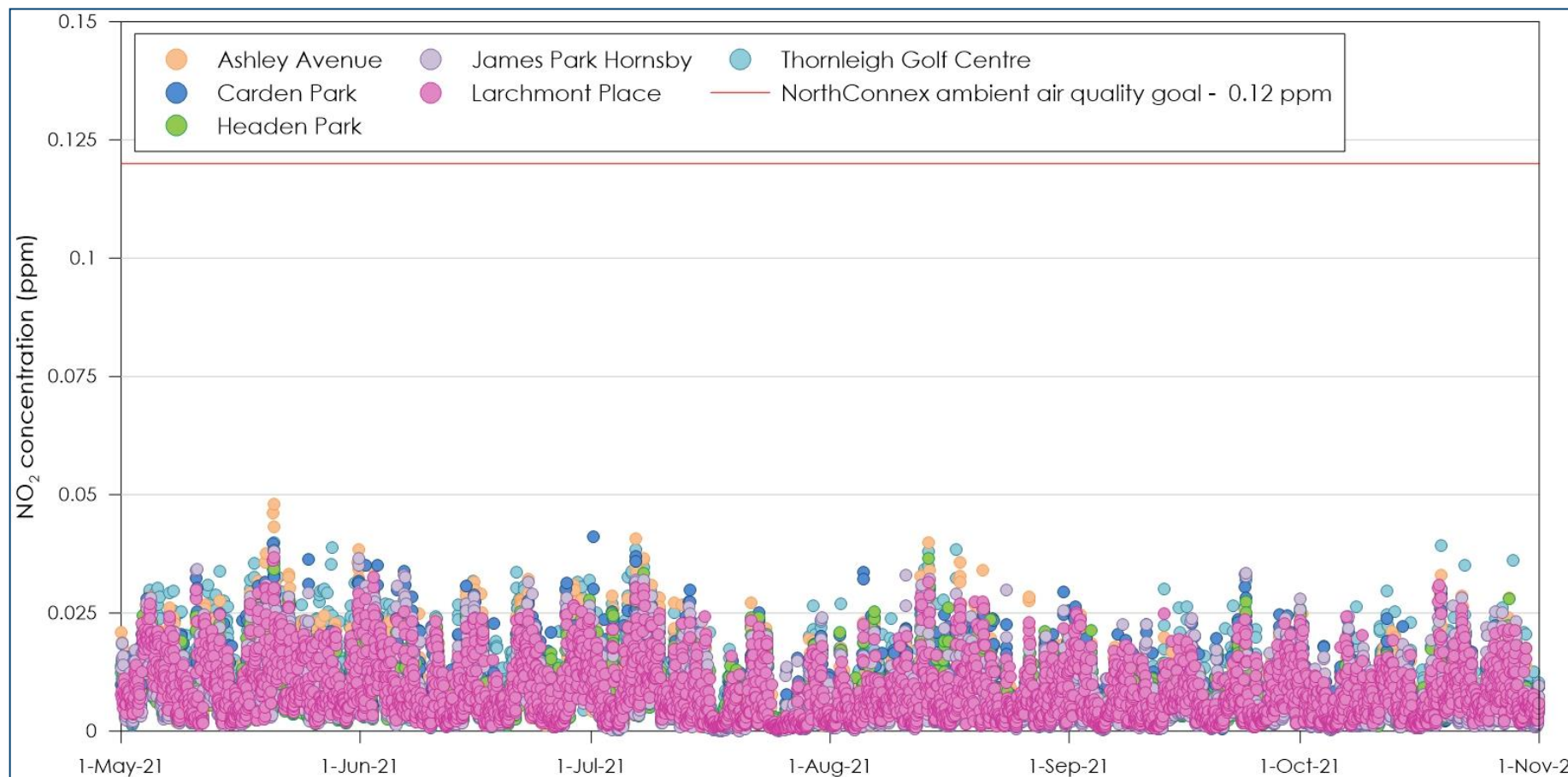


Figure 5-3: 1-hour average NO₂ levels



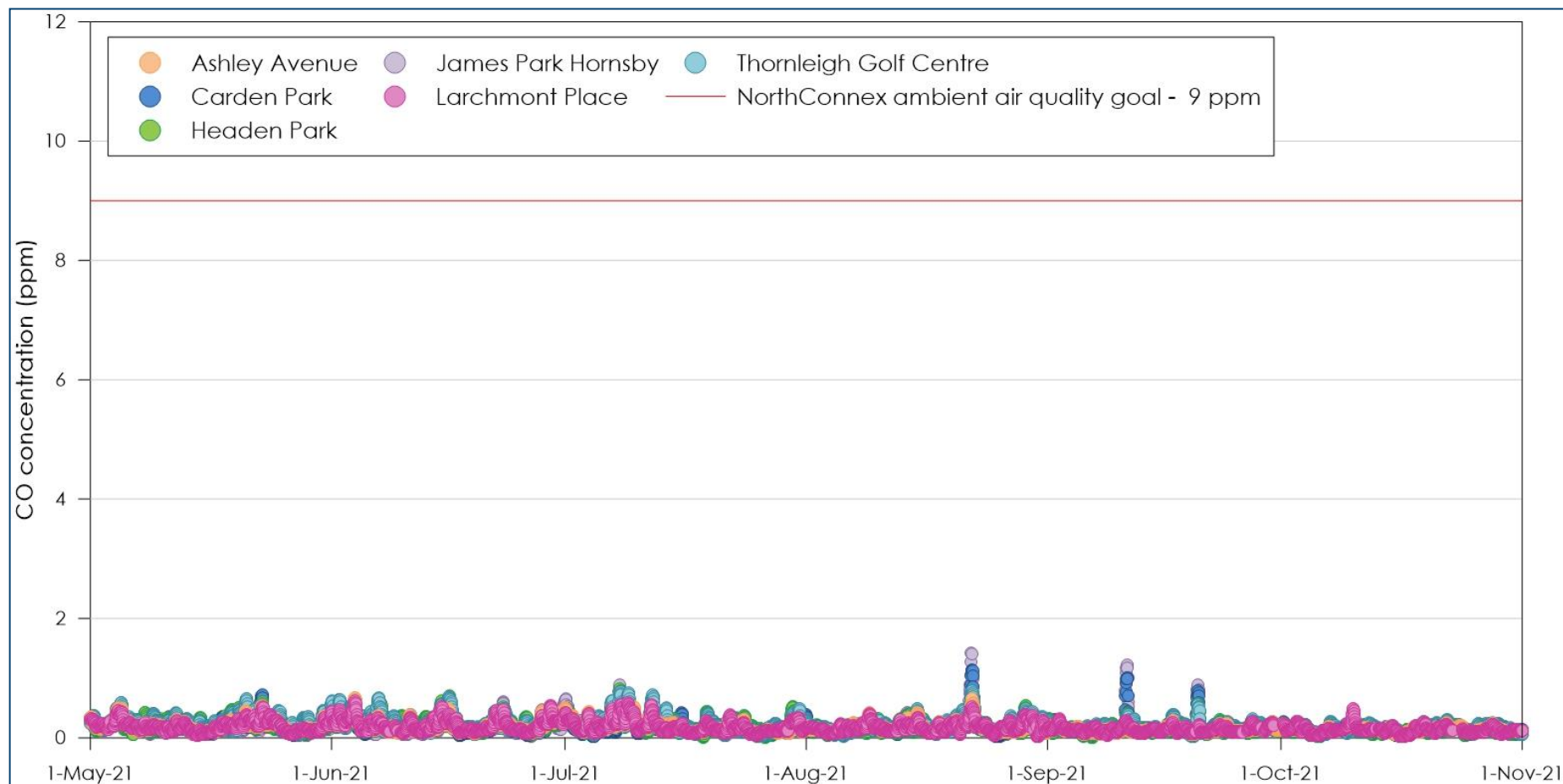


Figure 5-4: 8-hour rolling average CO levels



6 DISCUSSION AND RECOMMENDATIONS

Todoroski Air Sciences have conducted an independent audit of the ambient air quality monitoring data collected for the NorthConnex Project.

The recorded ambient air quality monitoring data between 1 May 2021 and 31 October 2021 were generally below their respective ambient air quality goals as outlined in **Table 3-1**.

Exceedances for the 24-hour average PM₁₀ and PM_{2.5} goals have been reported in their respective AGR notifications. Elevated 24-hour average PM₁₀ and PM_{2.5} levels recorded during the review period appear to be impacted by smoke from hazard reduction burns.

1-hour average NO₂ levels and 8-hour rolling CO levels during the review period were below their respective air quality goals.



7 REFERENCES

ACOEM Ecotech (2021a)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st May to 31st May 2021", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, September 2021

ACOEM Ecotech (2021b)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st June to 30th June 2021", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, September 2021

ACOEM Ecotech (2021c)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st July to 31st July 2021", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, August 2021

ACOEM Ecotech (2021d)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st August to 31st August 2021", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, September 2021

ACOEM Ecotech (2021e)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st September to 30th September 2021", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, October 2021

ACOEM Ecotech (2021f)

"NorthConnex Ambient Air Quality and Weather Monitoring Validated Report 1st October to 31st October 2021", prepared by Ecotech Pty Ltd (Ecotech) for Lendlease Bouygues Joint Venture, November 2021

Transurban (2021a)

"NorthConnex Ambient Above-Goal Reading (AGR) Notification – 4 May 2021", prepared by Transurban, May 2021

Transurban (2021b)

"NorthConnex Ambient Above-Goal Reading (AGR) Notification – 21 and 22 August 2021", prepared by Transurban, August 2021

Transurban (2021c)

"NorthConnex Ambient Above-Goal Reading (AGR) Notification – 11 September 2021", prepared by Transurban, September 2021



Transurban (2021d)

"NorthConnex Ambient Above-Goal Reading (AGR) Notification – 20 September 2021",
prepared by Transurban, September 2021

US EPA (2011)

"Health Effects of Pollution", United States Environmental Protection Agency website
<http://www.epa.gov/region07/air/quality/health.htm>, 2011



Appendix A

How to Read a Windrose



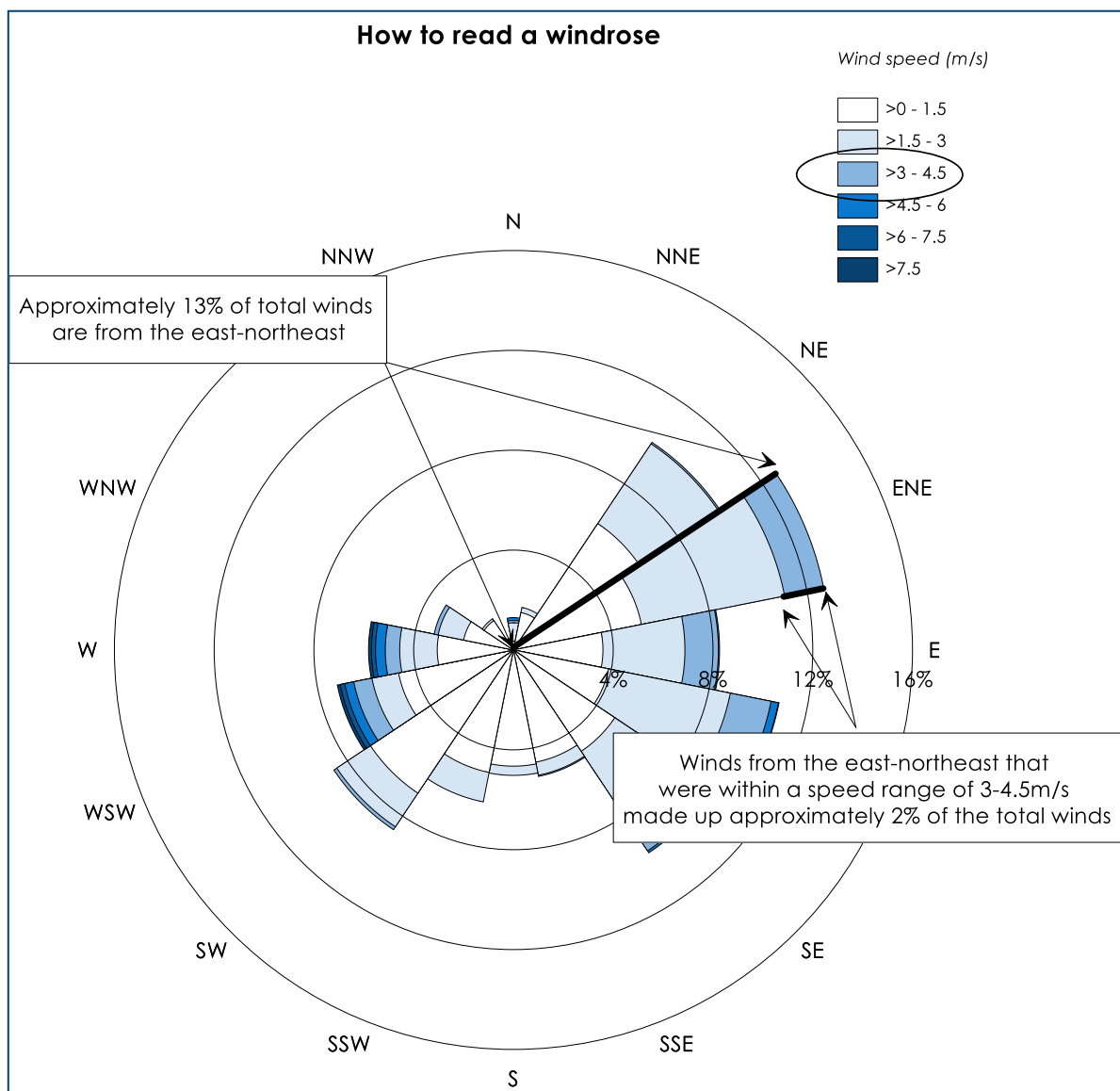


Figure A-1: How to read a windrose

Appendix B

Windroses



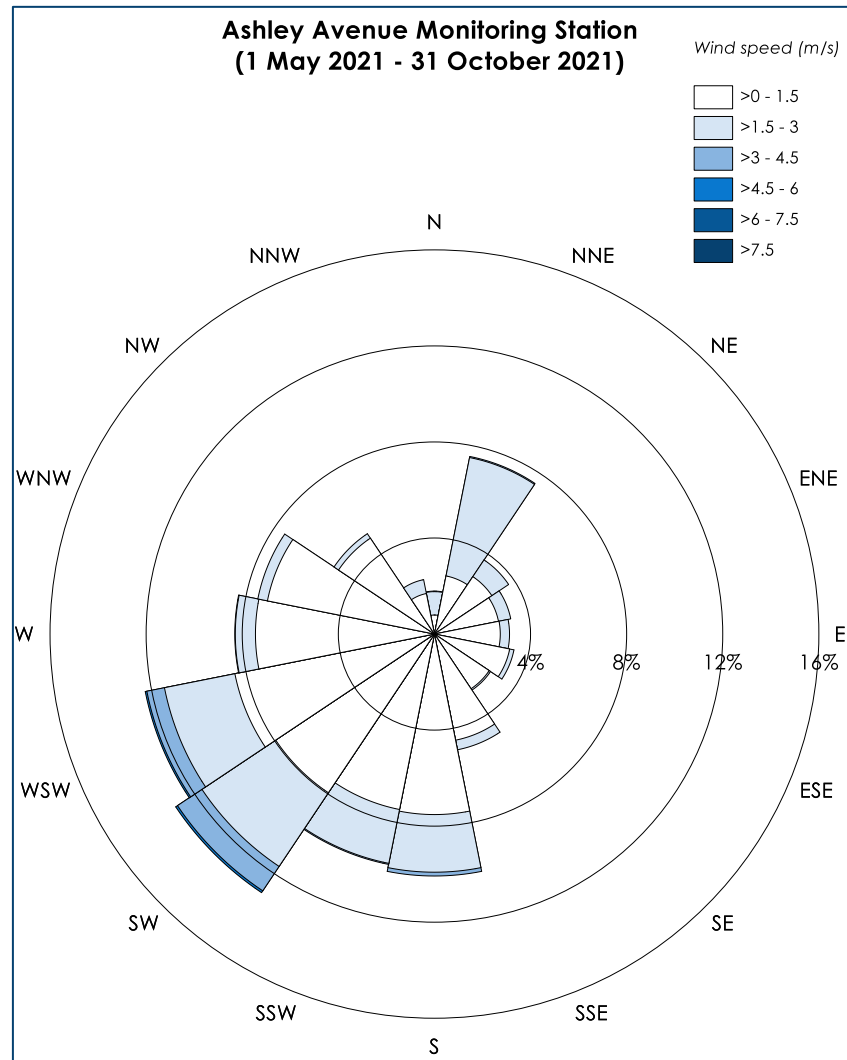


Figure B-1: Ashley Avenue windrose – 1 May 2021 to 31 October 2021

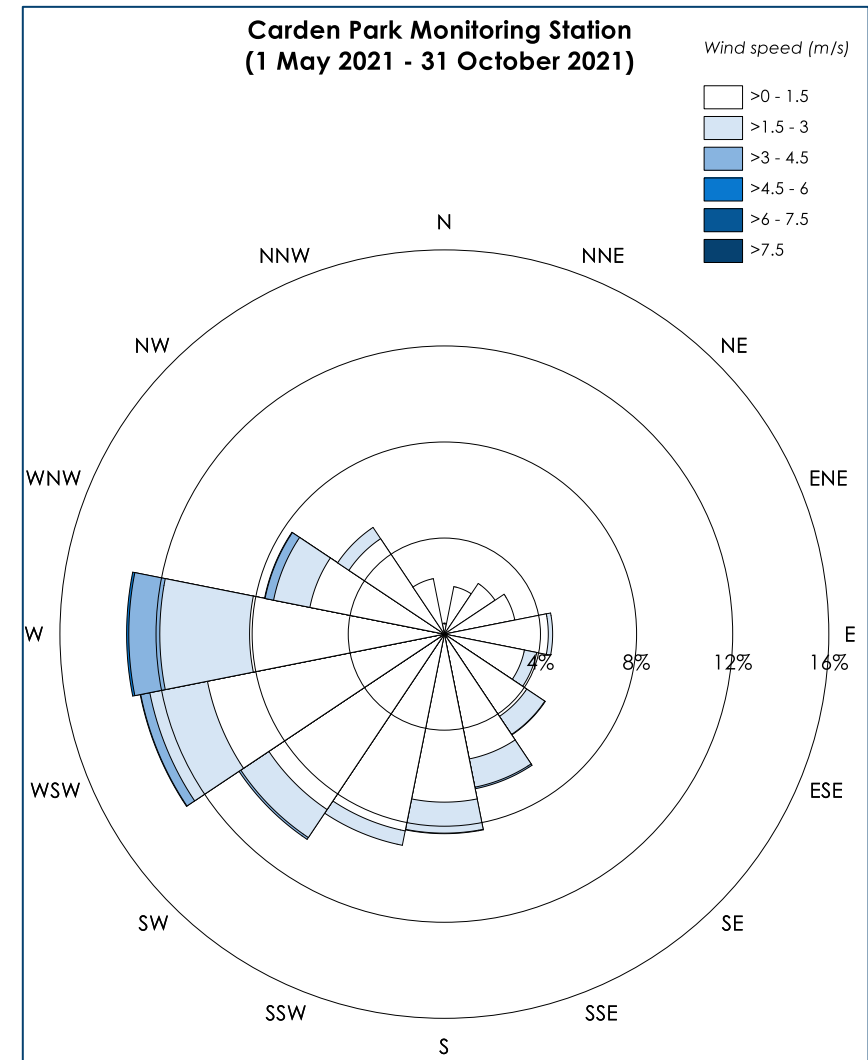


Figure B-2: Carden Park windrose – 1 May 2021 to 31 October 2021



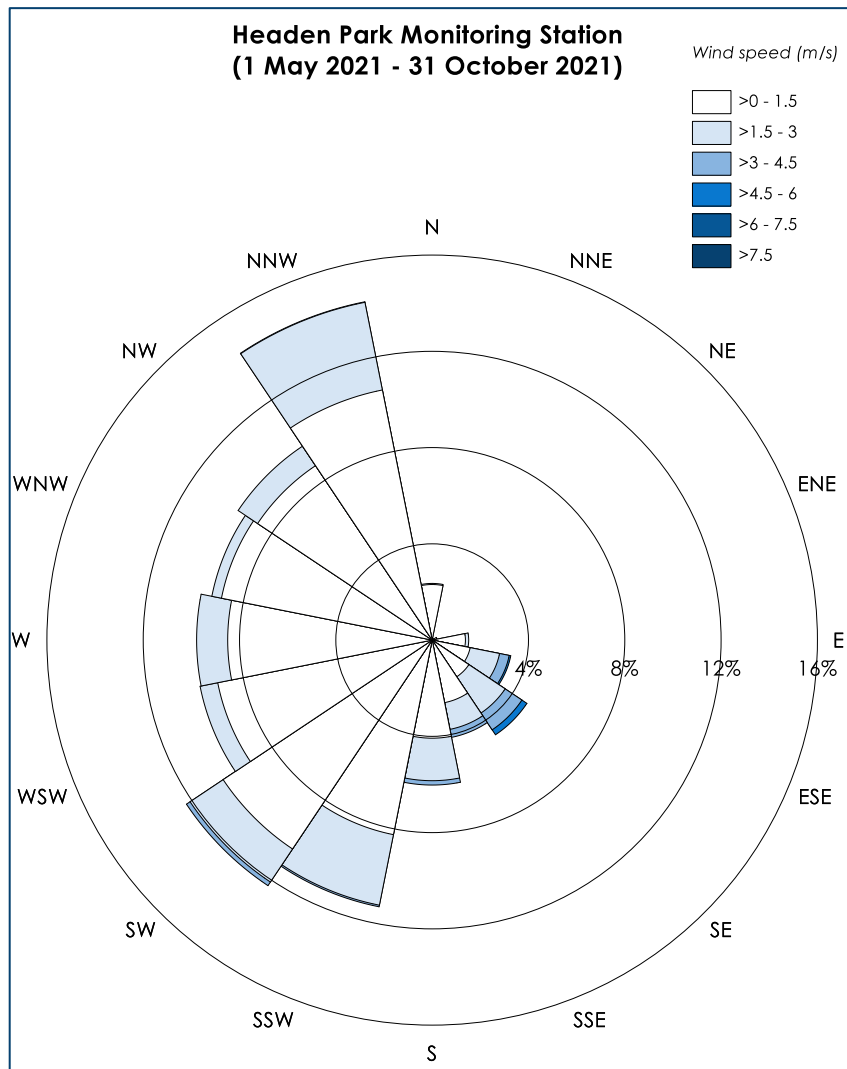


Figure B-3: Headen Park windrose – 1 May 2021 to 31 October 2021

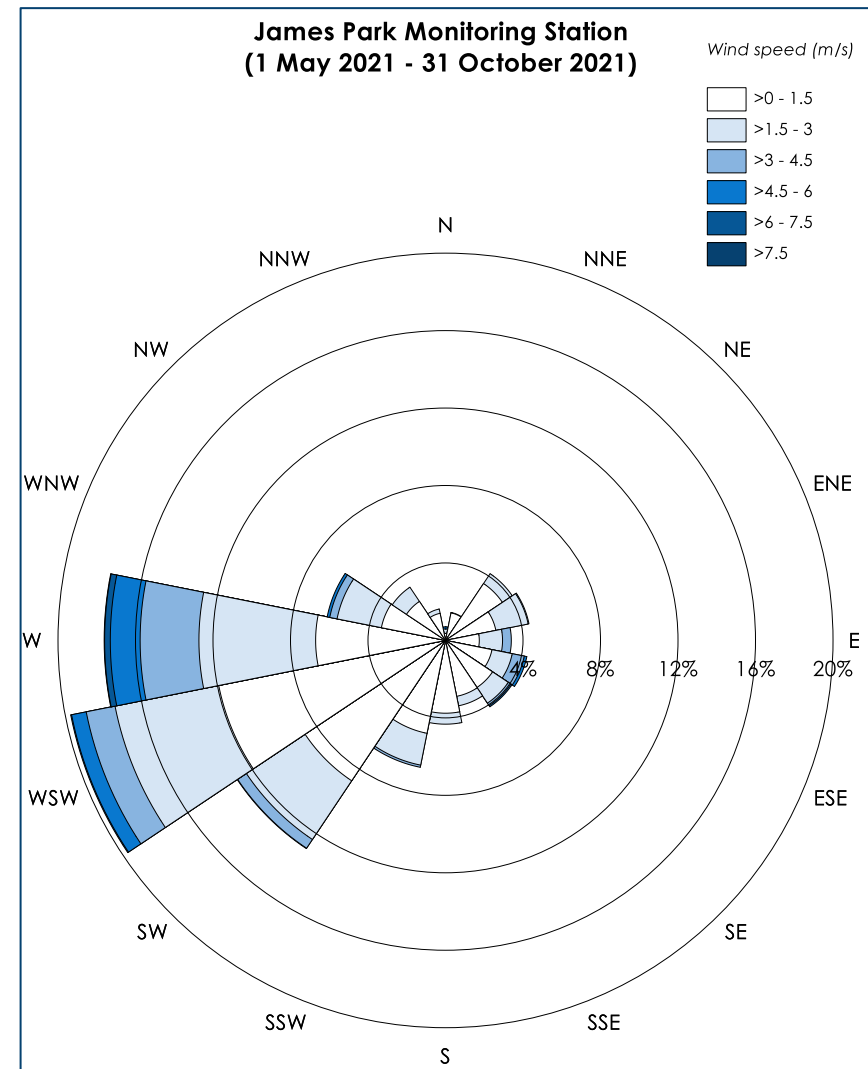


Figure B-4: James Park Hornsby windrose – 1 May 2021 to 31 October 2021

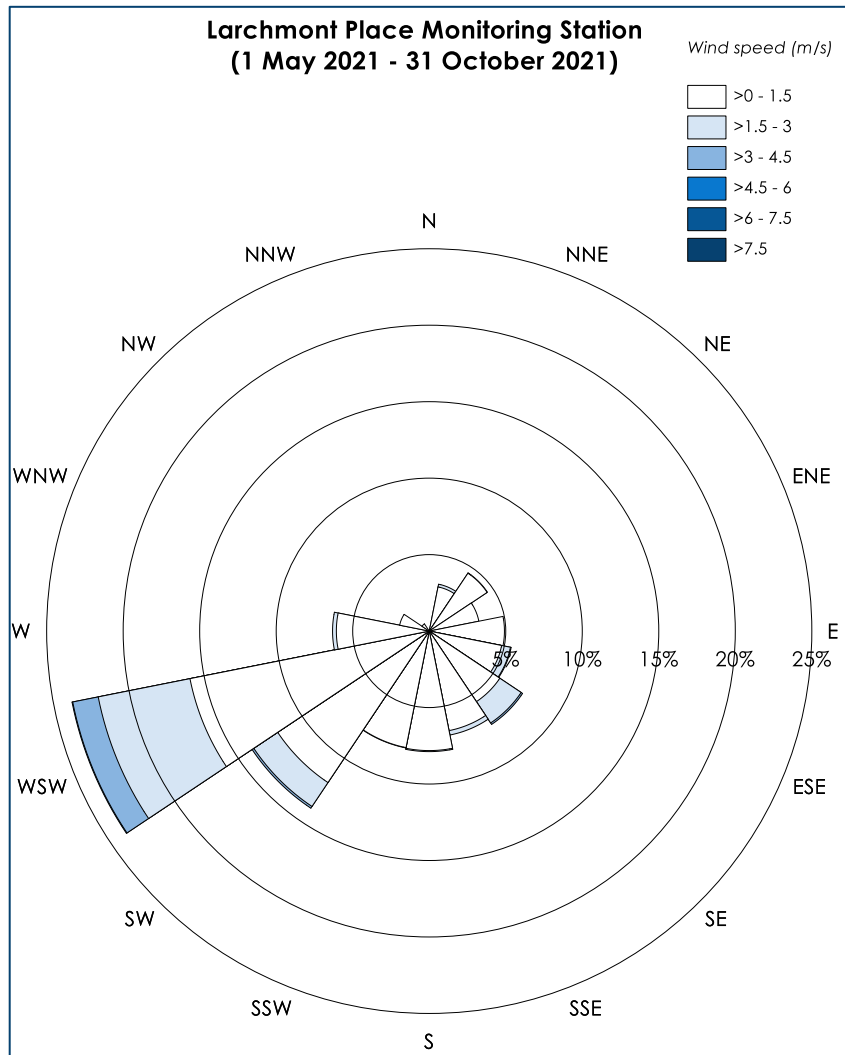


Figure B-5: Larchmont Place windrose – 1 May 2021 to 31 October 2021

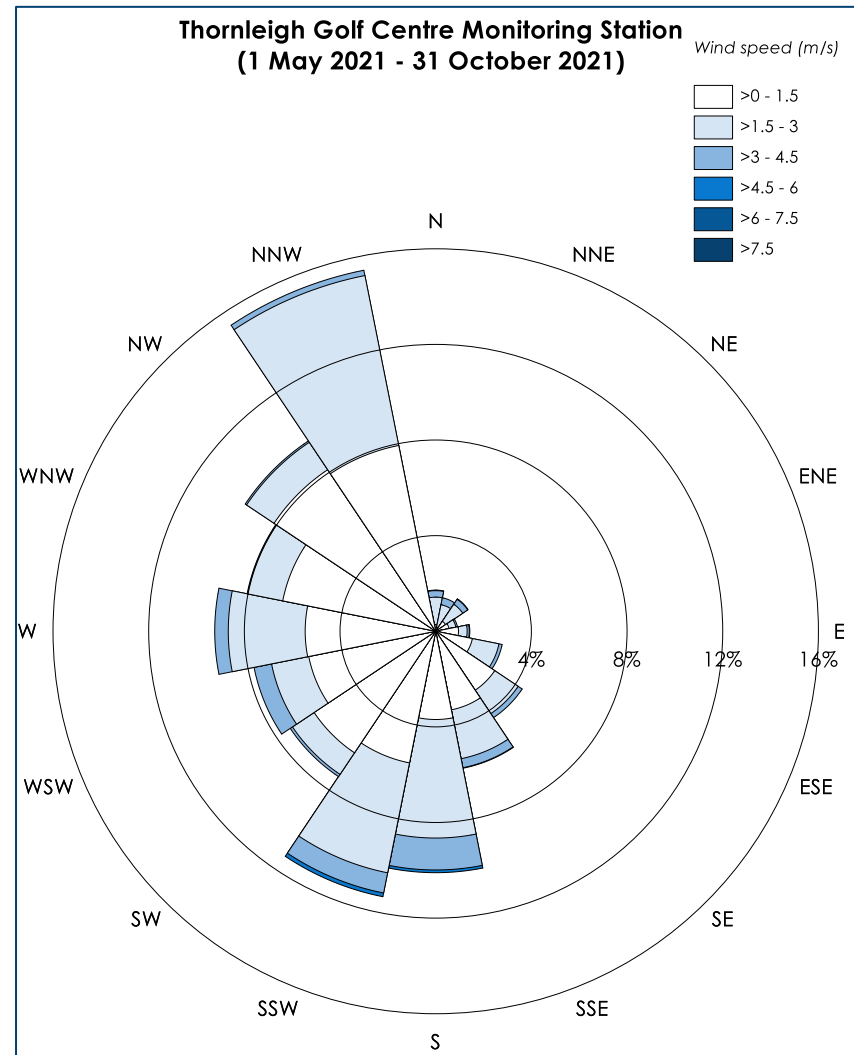


Figure B-6: Thornleigh Golf Centre windrose – 1 May 2021 to 31 October 2021

Appendix C

Monitoring Data (Graphical)



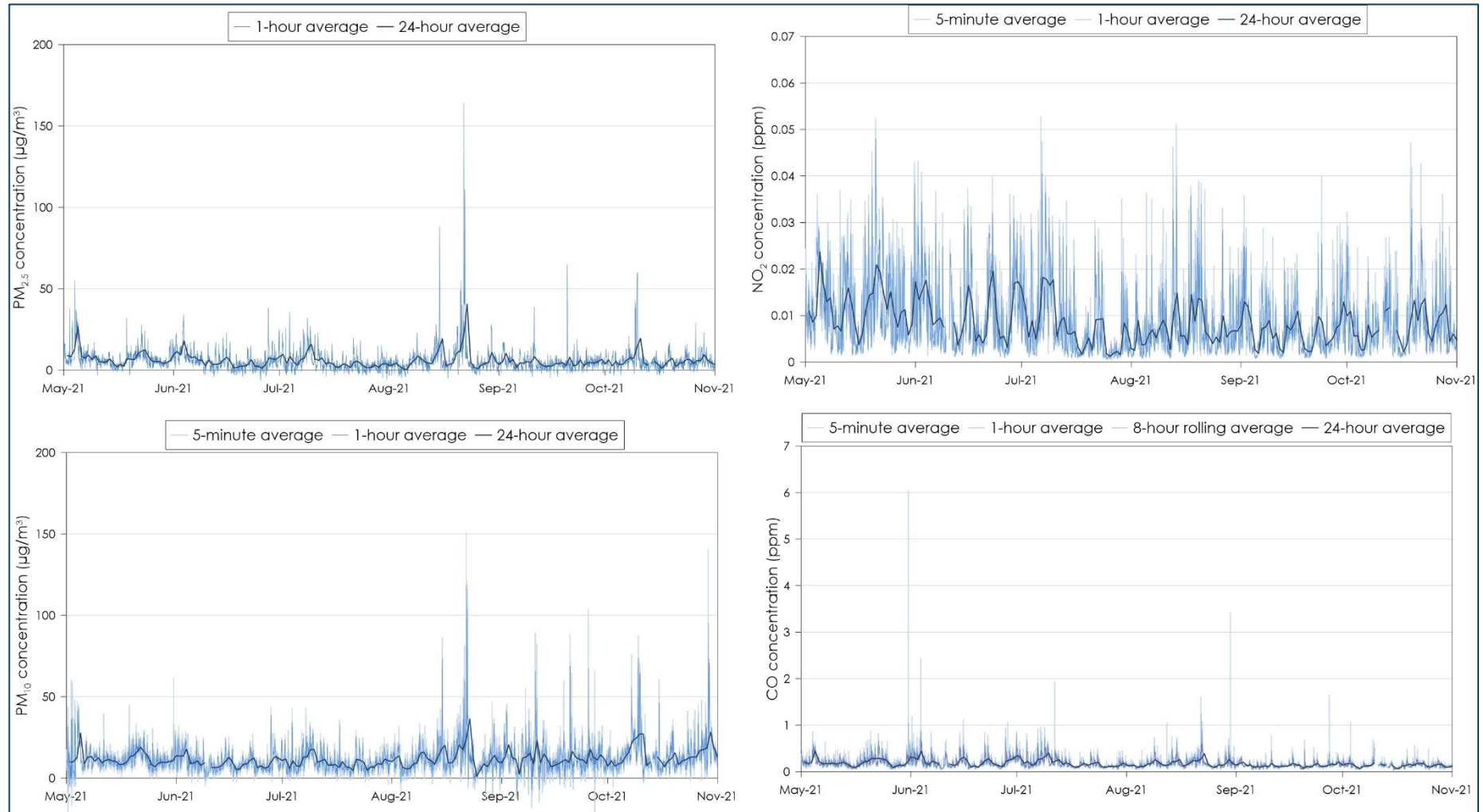


Figure C-1: Ashley Avenue monitoring data



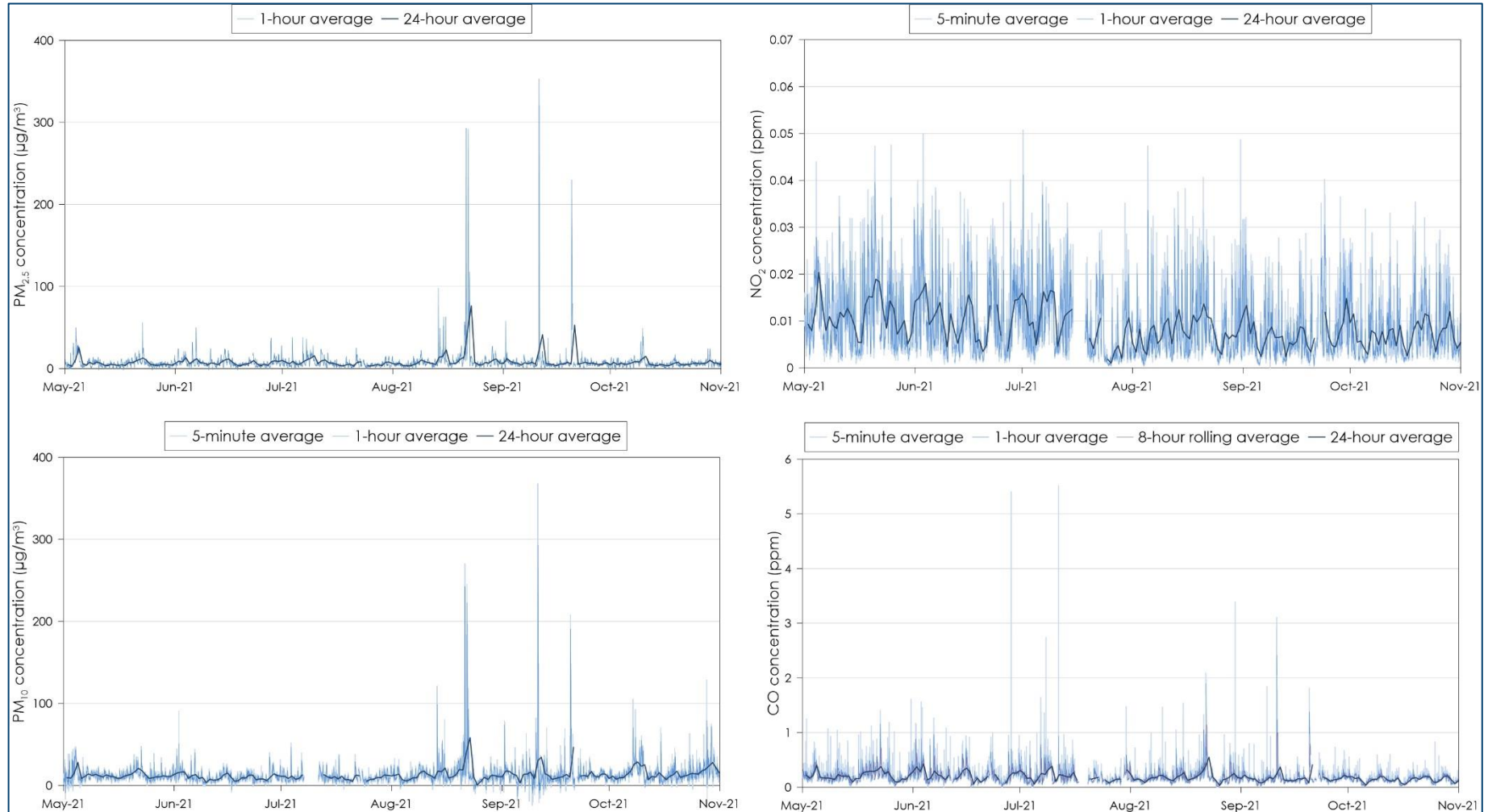


Figure C-2: Carden Park monitoring data



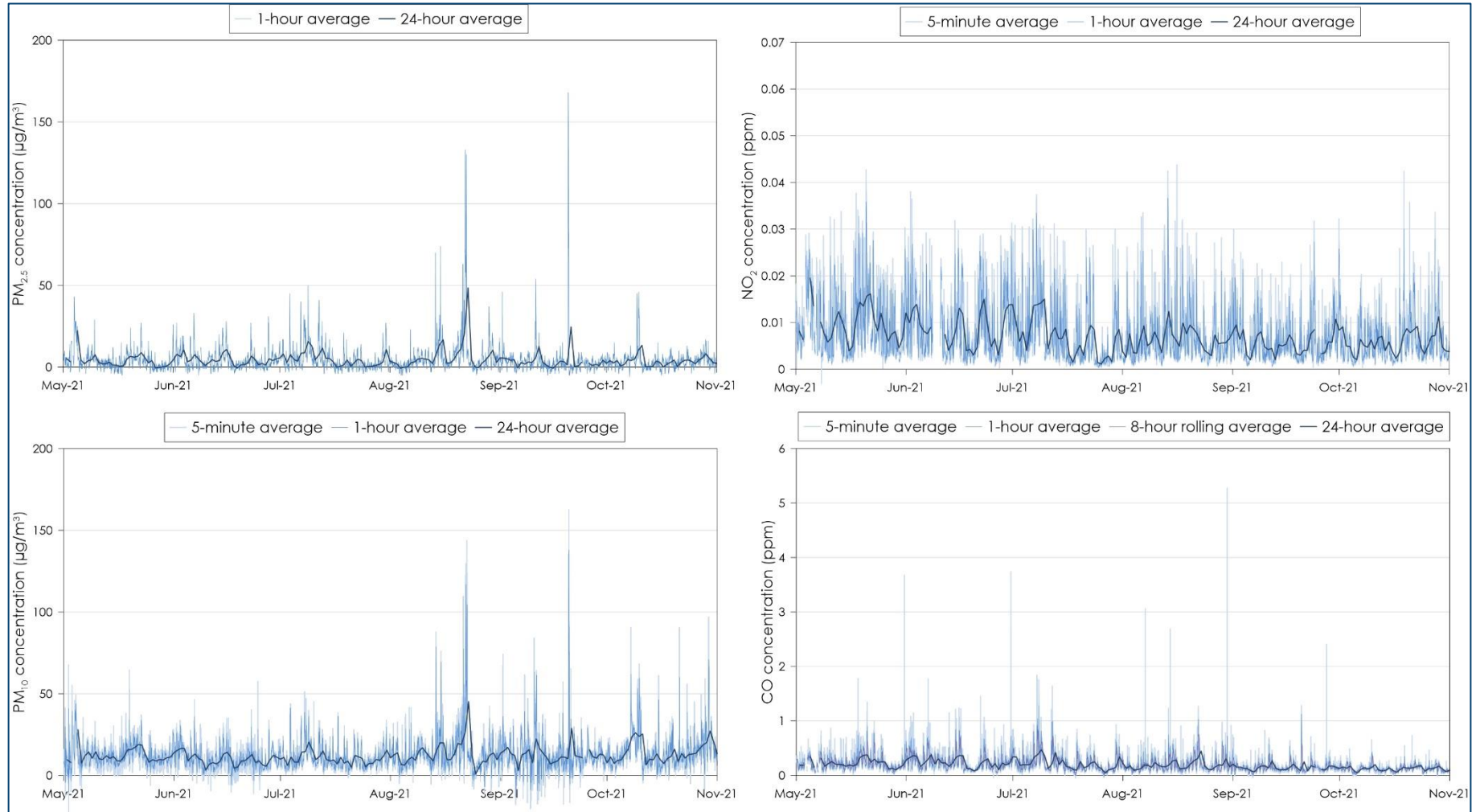


Figure C-3: Headen Park monitoring data



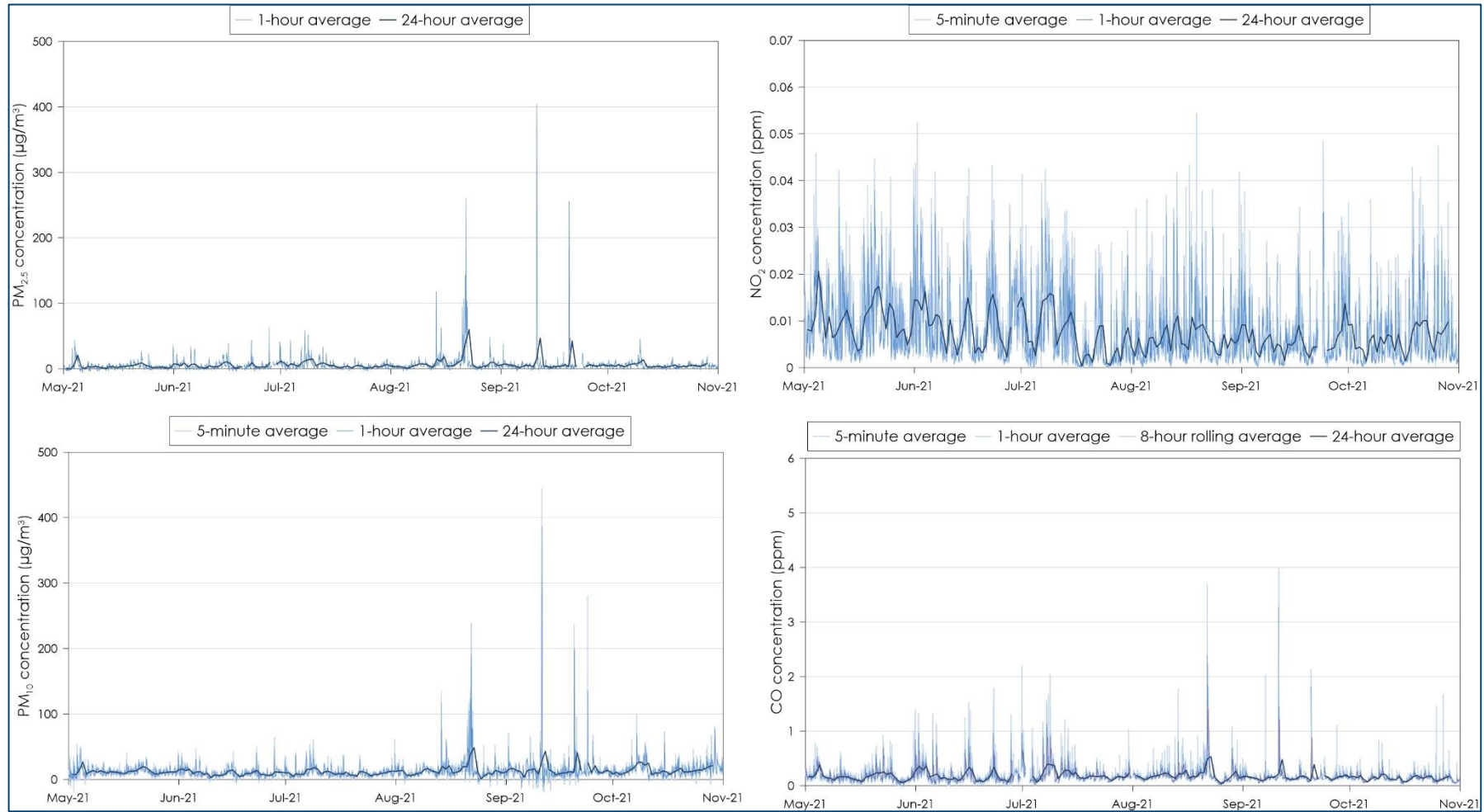


Figure C-4: James Park Hornsby monitoring data



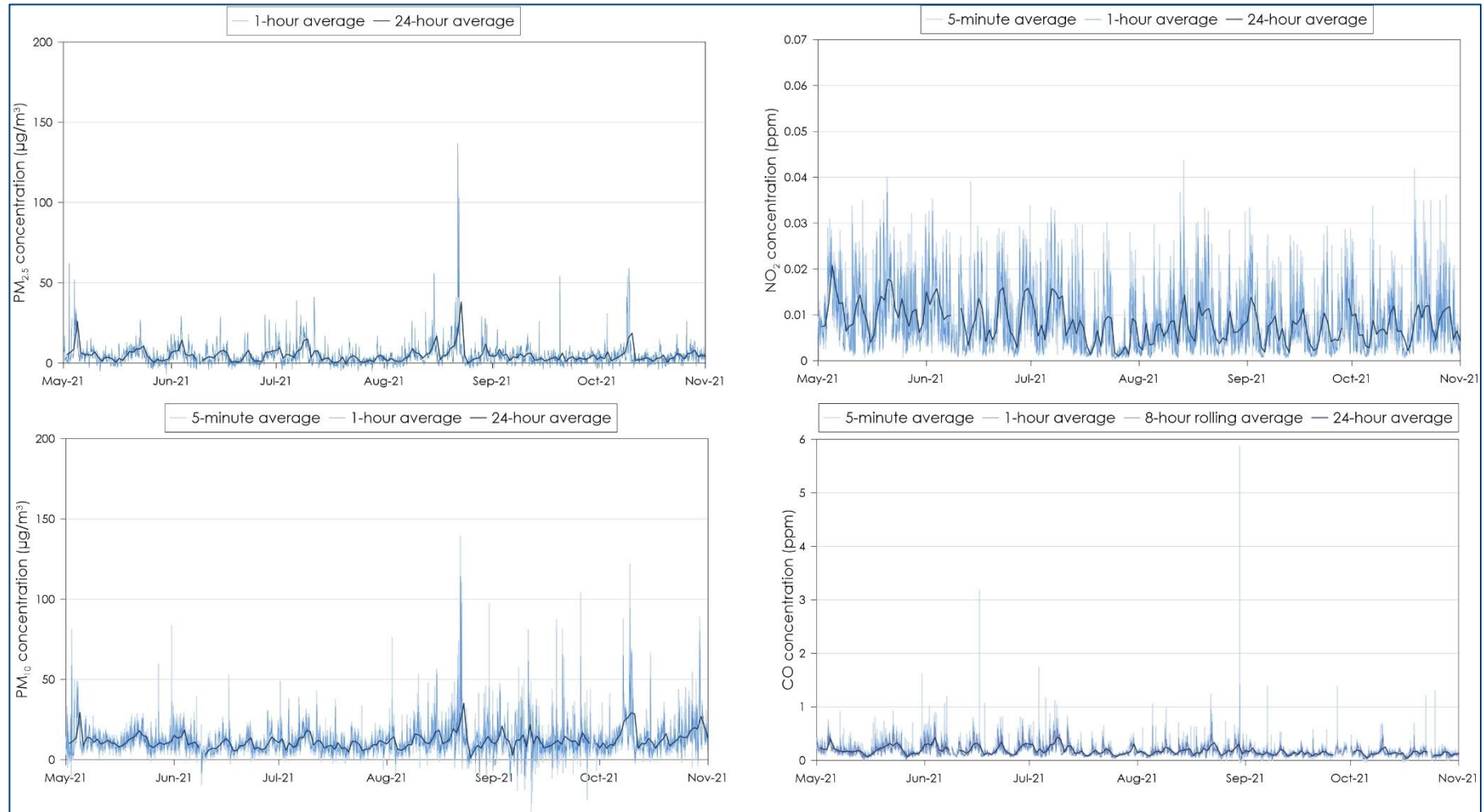


Figure C-5: Larchmont Place monitoring data



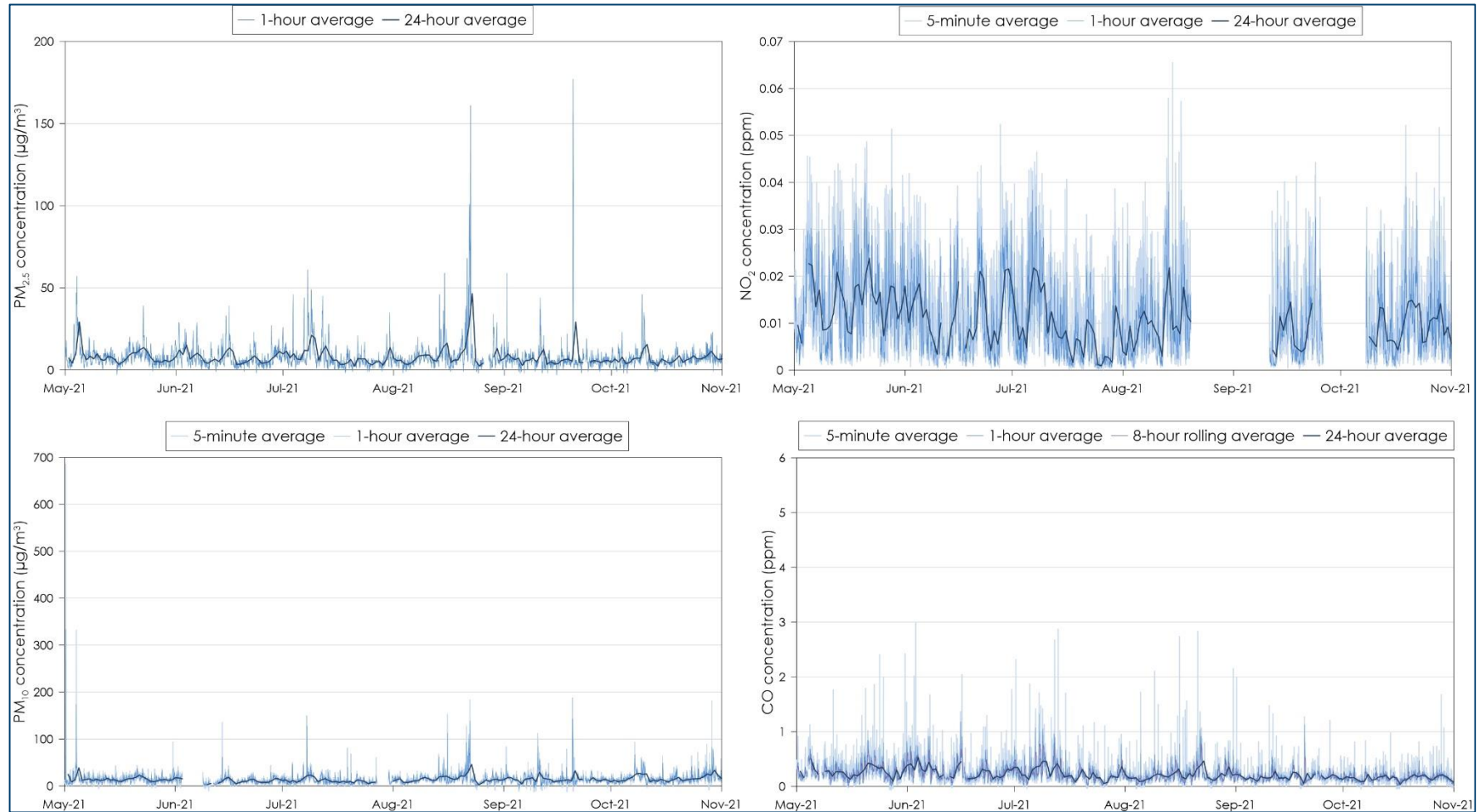


Figure C-6: Thornleigh Golf Centre monitoring data