



REPORT

Ambient Air Quality Monitoring (AAQM) Report December 2018

West Gate Tunnel Project

Submitted to:

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Executive Summary

Air quality monitoring for the West Gate Tunnel Project has been specifically established to develop a “baseline” of data from current local conditions. This baseline will be used to measure any changes once the tunnel opens in 2022. When the project opens, air quality monitoring will continue for up to 5 years.

The results of the West Gate Tunnel Project Ambient Air Quality Monitoring (AAQM) program for the period of 1 December 2018 to 31 December 2018 are presented below.

The following tables present the maximum measured concentration for each parameter at Stations 1, 2, 3, 4, 5 and 6 during the reporting period. The maximum concentration for each parameter is compared with the respective criteria.

Station 1 Summary December 2018

Parameter	Units	Averaging period	Maximum concentration	Air quality objective ^A	Exceedances
PM _{2.5}	ug/m ³	24 hour	13	25	Nil
PM ₁₀	ug/m ³	24 hour	41	50	Nil

Note:

A - SEPP(AAQ) objective

Station 2, Station 3, Station 5 and Station 6 Summary December 2018

Parameter	Units	Averaging period	Maximum concentration				Air quality objective ^A	Exceedances
			Station 2	Station 3	Station 5	Station 6		
PM _{2.5}	ug/m ³	24 hour	15	12	13	14	36	Nil
PM ₁₀	ug/m ³	24 hour	32	37	40	57	60	Nil

Note:

A - SEPP(AQM) Intervention level

Station 4 Summary December 2018

Parameter	Units	Averaging period	Maximum concentration	Air quality objective	Exceedances
PM _{2.5}	ug/m ³	24 hour	17	36 ^A	Nil
PM ₁₀	ug/m ³	24 hour	123	60 ^A	5
NO ₂	ppb	1 hour	50	140 ^A	Nil
CO	ppm	1 hour	0.8	29 ^A	Nil
Benzene	ppb	24 hour	<0.5	3.0 ^B	Nil
Toluene	ppb	24 hour	6.1	1000 ^B	Nil
Total xylene isomers	ppb	24 hour	1.5	250 ^B	Nil

Note:

A - SEPP(AQM) Intervention level

B - Air NEPM Monitoring investigation level

The December ambient air quality monitoring programme results were less than the respective air quality objectives for all parameters measured at stations 1, 2, 3, 5 and 6. Station 4 (Primula Avenue) exceeded the PM₁₀ air quality objective on five days (6/12/2018, 7/12/2018, 8/12/2018, 11/12/2018 and 12/12/2018), all other parameters monitored at station 4 were less than the respective air quality objectives.

Station 4 is now located in a construction area (Millers Road exit ramp and noise wall relocation) and the measured PM₁₀ concentrations may not be representative of impacts at the closest residential receptor.

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1.0 INTRODUCTION

Air quality monitoring for the West Gate Tunnel Project has been specifically established to develop a “baseline” of data from current local conditions. This baseline will be used to measure any changes once the tunnel opens in 2022. When the project opens, air quality monitoring will continue for up to 5 years.

The results of the West Gate Tunnel Project West Gate Tunnel Project Ambient Air Quality Monitoring (AAQM) program for the period of 1 December 2018 to 31 December 2018 are contained in the following report.

The AAQM program was conducted in accordance with the Environmental Performance Requirement (EPR) AQP4 for the Project and consists of six AAQM stations (AAQMS) monitoring the following ambient air quality indicators:

- continuous measurement of particulate matter with an equivalent aerodynamic diameter less than 10 microns (PM₁₀)
- continuous measurement of particulate matter with an equivalent aerodynamic diameter less than 2.5 microns (PM_{2.5})
- continuous measurement of ambient temperature and relative humidity
- continuous measurement of wind speed and wind direction (Stations 1 to 5).

Additionally, one of the specified AAQMS (Primula Avenue) monitors the following additional air quality indicators in combination with PM₁₀ and PM_{2.5}:

- continuous monitoring of oxides of nitrogen ([NO_x] comprising of nitrogen dioxide (NO₂) and nitric oxide [NO])
- continuous monitoring of carbon monoxide (CO)
- one in six day monitoring of benzene, toluene, ethylbenzene and xylene isomers (BTEX)
- continuous measurement of atmospheric pressure.

AAQMS Station 1 to Station 6 were installed and commissioned during the period 22/08/2018 to 12/10/2018. Specific installation dates can be found below in Section 2.1.

Details of the air quality indicators monitored at each AAQMS are provided in Table 1.

Table 1: AAQMS monitoring details

Site name	Location	Coordinates	Monitoring parameters
Station 1	Barbara Beyer Reserve, 2 Harris Street, Yarraville	-37.812730°S 144.900017°E	PM ₁₀ and PM _{2.5} Ambient temperature, relative humidity, wind speed and wind direction
Station 2	51-53 Francis Street	-37.821800°S 144.894383°E	PM ₁₀ and PM _{2.5} Ambient temperature, relative humidity, wind speed and wind direction
Station 3	Railway Lot 64, (part) 15 Goulburn Street, Yarraville	-37.814063°S 144.891320°E	PM ₁₀ and PM _{2.5} Ambient temperature, relative humidity, wind speed and wind direction

Site name	Location	Coordinates	Monitoring parameters
Station 4	44 Primula Avenue, Brooklyn	-37.824284°S 144.846425°E	PM ₁₀ and PM _{2.5} NO, NO ₂ , NO _x and CO BTEX – one in six day sampling (24 hour average) Ambient temperature, relative humidity, atmospheric pressure, wind speed and wind direction
Station 5	Donald McLean Reserve, Spotswood	-37.826442°S 144.882133°E	PM ₁₀ and PM _{2.5} Ambient temperature, relative humidity, wind speed and wind direction
Station 6	44 Millers Road Brooklyn	-37.821252°S 144.848878°E	PM ₁₀ and PM _{2.5} Ambient temperature and relative humidity

2.0 AAQMS DETAILS

2.1 Site locations

AAQMS Station 1 to Station 5 were installed and commissioned during the period 22/08/2018 to 31/08/2018. AAQMS Station 6 (Millers Road) was commissioned on 12/10/2018. Wind sensors (wind speed and direction) were installed later due to delays in calibration from the instrument supplier. The wind sensor at Station 6 does not meet the siting criteria specified in AS 3580.14 due to the proximity of buildings, large trees and power lines, therefore, the data has not been reported. AAQMS commissioning dates are provided in Table 2. Figure 1 presents the locations of the AAQMS.

Table 2: AAQMS commissioning dates

Parameter	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
AAQMS	23/08/2018	22/08/2018	22/08/2018	22/08/2018	31/08/2018	12/10/2018
Wind speed & direction	07/09/2018	20/09/2018	14/09/2018	10/09/2018	17/09/2018	23/11/2018 ^A

A - wind sensor is not compliant with siting criteria specified in AS 3580.14

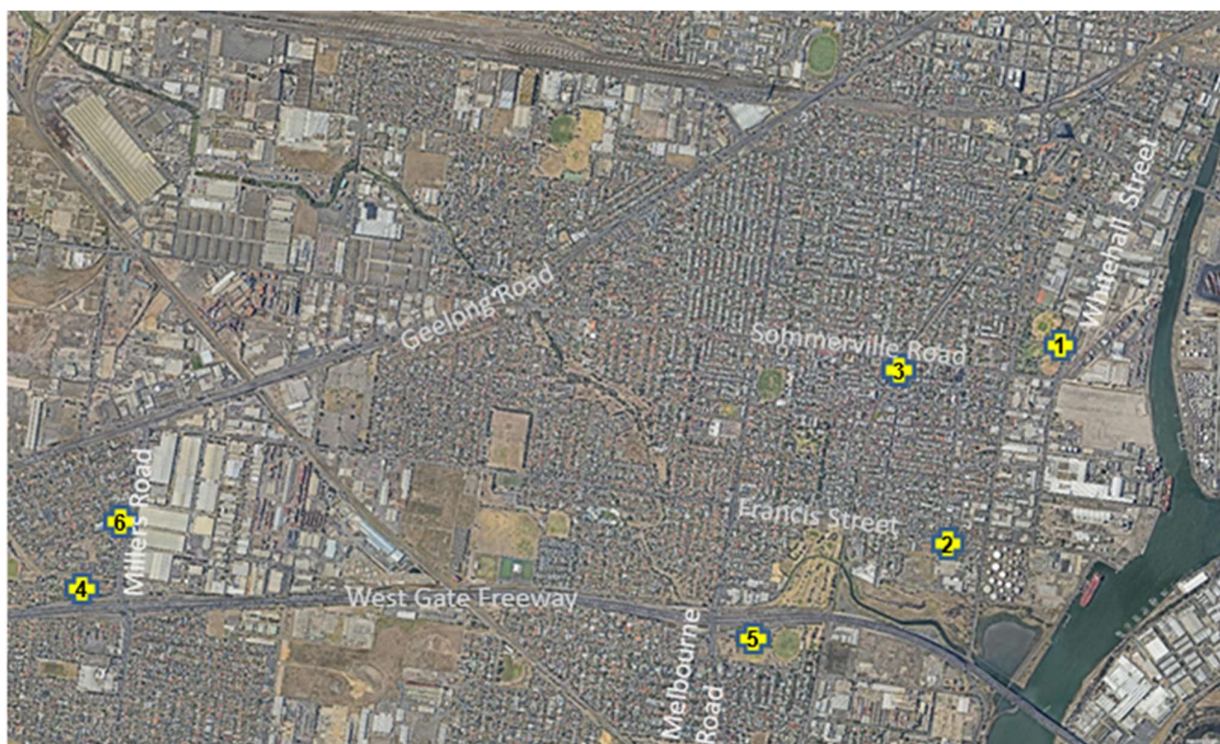


Figure 1: West Gate Tunnel AAQMS site locations

2.2 Siting assessment

Australian Standard AS/NZS 3580.1.1 “Methods for Sampling and Analysis of Ambient Air – Part 1.1. Guide to Siting Air Monitoring Equipment” provides general guidance for the siting of ambient air monitoring equipment and specific siting parameters for individual air pollutants. Table 3 provides a comparison between recommended criteria contained in the Standard for the parameters monitored at neighbourhood and peak monitoring stations with actual conditions at each AAQMS.

Table 3: Australian standard AAQMS siting criteria compliance

Station	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Station type	Neighbourhood	Peak	Peak	Peak	Peak	Peak
Inlet height above ground level 1.0 m – 15 m	✓	✓	✓	✓	✓	✓
Clear sky angle 120° (Neighbourhood)	✓	-	-	-	-	-
Unrestricted 270° airflow around inlet (Neighbourhood)	✓	-	-	-	-	-
Unrestricted 180° airflow around inlet (Peak)	-	✓	✓	✓	✓	✓
Distance to supporting structure ≥ 1 m	✓	✓	✓	✓	✓	✓

Station	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6
Station type	Neighbourhood	Peak	Peak	Peak	Peak	Peak
10 m from drip line of trees	✓	✓	✓	✓	✓	✗ ^A
No extraneous sources nearby	✓	✓	✓	✗ ^B	✓	✗ ^C
Greater than 50 m from road ($\leq 10,000$ vehicles/day)	✓	-	-	-	-	-
Greater than 2 m from road (Peak station)	-	✓	✓	✓	✓	✓

Note:

- A Tree drip line is <3 m from sampler inlets and meteorological monitoring equipment
 B Temporary construction area for Millers Road noise wall and exit ramp relocation works
 C Residential chimney is <5 m from the sampler inlet.

2.3 Equipment specifications

Table 4 provides a list of the monitoring equipment installed at the AAQMS.

Table 4: AAQMS instrumentation

Parameter	Equipment item	Manufacturer	Model
PM _{2.5}	Beta Attenuation Monitor (BAM)	Thermo Fisher Scientific Inc.	5014i
PM ₁₀	Beta Attenuation Monitor (BAM)	Thermo Fisher Scientific Inc.	5014i
Oxides of Nitrogen	Chemiluminescence	Thermo Fisher Scientific Inc.	42i
Carbon Monoxide	Infra-red gas filter correlation	Thermo Fisher Scientific Inc.	48i
Temperature	Pt100 resistive platinum sensor	Thermo Fisher Scientific Inc.	5014i
BTEX	Summa canister	Restek	6 litre
Relative humidity	Capacitive thin film sensor	Thermo Fisher Scientific Inc.	5014i
Atmospheric Pressure	Beta Attenuation Monitor (BAM)	Thermo Fisher Scientific Inc.	5014i
Wind speed and wind direction	Ultrasonic anemometer	RM Young	Model 86000

3.0 AIR QUALITY CRITERIA

The ambient air quality criteria applicable to the West Gate Tunnel Project are derived from the following legislation:

- State Environment Protection Policy (Ambient Air Quality) [SEPP(AAQ)]
- State Environment Protection Policy (Air Quality Management) [SEPP(AQM)].
- National Environment Protection (Air Toxics) Measure Monitoring Investigation Levels (MILs)

SEPP(AAQ)

The SEPP(AAQ) adopts the requirements of the National Environment Protection (Ambient Air Quality) Measure (Air NEPM) and its environmental quality objectives (EQOs) for CO, NO₂, and particles (as PM₁₀ and PM_{2.5}). The SEPP(AAQ) EQOs apply to air quality within a region or sub-region considered to be representative of exposure of the general population in Victoria. These objectives have been adopted for the purposes of comparison with results from background/ neighbourhood monitoring stations for the West Gate Tunnel Project and are relevant to Station 1 (Yarraville Gardens).

SEPP(AQM)

The SEPP(AQM) sets out legislative requirements for managing and assessing air emissions in Victoria. The aim of the SEPP(AQM) is to ensure that prescribed air quality objectives are met and protect the beneficial uses of the air environment. Schedule B lists intervention levels which are used in the assessment of local or neighbourhood air monitoring data. Consistent with assessment of impacts described in the Environment Effects Statement for the West Gate Tunnel Project, the intervention levels have been adopted for purposes of comparison with results from peak monitoring stations for the West Gate Tunnel Project and are applicable to Station 2 (Francis Street), Station 3 (Railway Reserve), Station 4 (Primula Avenue), Station 5 (Donald McLean Reserve) and Station 6 (Millers Road).

NEPM (Air Toxics)

The aim of the Air Toxics NEPM is to gain a greater understanding of the levels of air toxics at specific locations where elevated concentrations are likely to occur and where the potential for significant human exposure exists. The Air Toxics NEPM established monitoring investigation levels (MILs) relevant for the West Gate Tunnel Project for benzene, toluene and xylene isomers. The MILs are used purposes of comparison with results from the air toxics monitored at Station 4 (Primula Avenue).

Table 5 presents the air quality indicators and objectives for each AAQMS for the West Gate Tunnel Project.

Table 5: Air quality indicators and objectives

Location	Pollutant	Units	Air Quality Objective	Averaging period
Station 1	PM ₁₀	µg/m³	50	24 hour
			20	Annual
	PM _{2.5}		25	24 hour
			8	Annual
Station 2 Station 3	PM ₁₀	µg/m³	60	24 hour

Location	Pollutant	Units	Air Quality Objective	Averaging period
Station 4 Station 5 Station 6	PM _{2.5}		36	
Station 4	CO	ppm	29	1 hour
	NO ₂	ppb	140	1 hour
	Benzene	ppb	3	Annual
	Toluene	ppb	1000	24 hour
			100	Annual
	Ethylbenzene	ppb	NA	24 hour
	Xylene isomers	ppb	250	24 hour
			200	Annual

4.0 TEST METHODS

4.1 Particulate matter (PM_{2.5})

PM_{2.5} concentrations are determined using a Beta Attenuation Monitor (BAM).

Suspended particulate matter in ambient air is measured using the attenuation of beta rays as a surrogate for continuous mass determination. Beta rays are high energy electrons generated from the radioactive decay of the radon isotope Rn-222. When contacting particulate matter beta rays are either absorbed or their energy level is diminished. The relationship between the attenuation of beta rays between the source and detector is used to determine the mass density.

The BAM is equipped with a flow control and measurement system. The flow control system volumetrically controls the flowrate to 16.7 l/min. The flowrate is used with the mass density to calculate the particulate matter concentration.

The sampler is fitted with a size selective inlet, which separates particles with an equivalent aerodynamic diameter greater than 10 microns from the sample stream. An in-line PM_{2.5} particle size separator is also fitted to further separate particles; only those with an equivalent aerodynamic diameter less than 2.5 microns can pass through the particle size separator to the filter for mass determination.

The PM_{2.5} monitoring method is based on the requirements contained within Australian Standard AS/NZS 3580.9.12 “*Methods for Sampling and Analysis of Ambient Air – Method 9.12: Determination of Suspended Particulate Matter – PM_{2.5} Beta Attenuation Monitors*” (NATA Laboratory Accreditation No. 1910).

4.2 Particulate matter (PM₁₀)

PM₁₀ concentrations are determined using a continuous BAM without an in-line PM_{2.5} particle size separator. All other measurement processes remain the same as for the PM_{2.5} test method.

The PM₁₀ monitoring method is based on the requirements contained within Australian Standard AS/NZS 3580.9.11:2016 “*Methods for Sampling and Analysis of Ambient Air – Method 9.11: Determination of Suspended Particulate Matter – PM₁₀ Beta Attenuation Monitors*” (NATA Laboratory Accreditation No. 1910).

4.3 Nitrogen dioxide (NO₂)

Oxides of nitrogen concentrations were determined using a 42i Thermo Scientific chemiluminescence gas analyser.

Automatic calibrations are carried out daily against a NATA certified reference gas mixture. Manual calibrations are conducted at one month intervals.

The oxides of nitrogen (NO, NO₂ and NO_x) monitoring method is based on the requirements of Australian Standard AS 3580.5.1, *"Determination of Oxides of Nitrogen – Chemiluminescence Method"*.

4.4 Carbon monoxide (CO)

Carbon monoxide concentrations are determined using a 48i Thermo Scientific infra-red gas filter correlation analyser.

Automatic calibrations are carried out daily against a NATA certified reference gas mixture. Manual calibrations are conducted at one month intervals.

The carbon monoxide monitoring method is based on the requirements of Australian Standard AS 3580.7.1, *"Determination of Carbon Monoxide – Direct Reading Instrumental Method"*.

4.5 Volatile organic compounds (BTEX)

A sample is collected in an evacuated electro-polished and passivated stainless steel canister. Analysis involves separation by gas chromatography (GC) and measurement by mass selective (MS) detector.

The procedure for sampling Volatile Organic Compounds (VOCs) using evacuated canisters, and for the subsequent analysis, is described in USEPA Method TO-15 "Determination of Volatile Organic Compounds (VOCs) in air collected in specially-prepared canisters and analysed by Gas Chromatography/Mass Spectrometry (GC/MS)".

Samples were analysed by Queensland Health (NATA Laboratory Accreditation No. 41) based on USEPA method TO-15. The test method used was in accordance with Golder Source Test Method C9, "Canister (Evacuated) Sampling for VOC: In Ambient Air and Source Emissions".

4.6 Meteorological parameters

Monitoring of meteorological parameters; wind speed/direction, temperature, relative humidity and atmospheric pressure was conducted in accordance with Australian Standard AS 3580.14 *"Methods for Sampling and Analysis of Ambient Air – Part 14: Meteorological Monitoring for Ambient Air Quality Monitoring Applications"* (NATA Laboratory Accreditation No. 1910).

5.0 MEASUREMENT UNCERTAINTY

5.1 PM_{2.5}

The measurement uncertainty for PM_{2.5} by BAM is published by Thermo-Fisher as $\pm 2 \mu\text{g}/\text{m}^3$ (24 hour average).

5.2 PM₁₀

The measurement uncertainty for PM_{2.5} by BAM is published by Thermo-Fisher as $\pm 2 \mu\text{g}/\text{m}^3$ (24 hour average).

5.3 NO₂

The measurement uncertainty for NO, NO₂ and NO_x by Chemiluminescence is published in AS3580.5.1 as $\pm 10\%$ (24 hour average).

5.4 CO

The measurement uncertainty for CO by Infra-red gas filter correlation is published in AS3580.7.1 as $\pm 10\%$ (24 hour average).

5.5 Benzene

USEPA Method TO-15 cites the accuracy and precision for two ambient air quality studies conducted in the United States of America. The average replicate precision for a range of 16 compounds in both studies was 15%. Replicate precision was defined as the ratio of the average difference between replicates to the average value of replicates.

The reported accuracies for both studies ranged between $\pm 4\%$ and $\pm 31\%$. The average accuracy for both studies for the range of 16 compounds was $\pm 11\%$. Accuracy is defined as the ratio of the difference between expected and observed audit results to the expected audit result.

5.6 Meteorological parameters

The estimated measurement uncertainty for each of the parameters is presented in Table 6.

Table 6: Meteorological parameters measurement uncertainty

Parameter	Measurement uncertainty ^A
Wind speed	Greater of ± 0.6 m/s or 5%
Wind direction	$\pm 5^\circ$
Atmospheric pressure	± 3 hPa
Temperature	$\pm 6\%$
Relative humidity	$\pm 5 - 7\%$ RH

Note:

A Measurement uncertainty estimates are as published in AS3580.14 "Methods for Sampling and Analysis of Ambient Air – Part 14 Meteorological Monitoring for Ambient Air Quality Monitoring Applications".

5.7 Calibration and maintenance

Sample flow rate calibration was conducted on a monthly basis using a NATA calibrated primary standard flowmeter. Calibration details for the reporting period are presented in Table 7.

Table 7: Calibrations

Location	Parameter	Last Calibration Date	Calibration Type
Station 1	PM ₁₀	17/12/2018	3 Monthly
	PM _{2.5}	17/12/2018	3 Monthly
	Wind speed and direction	9/08/2018	Two yearly
Station 2	PM ₁₀	17/12/2018	3 Monthly
	PM _{2.5}	17/12/2018	3 Monthly
	Wind speed and direction	7/08/2018	Two yearly
Station 3	PM ₁₀	17/12/2018	3 Monthly
	PM _{2.5}	17/12/2018	3 Monthly
	Wind speed and direction	10/08/2018	Two yearly
Station 4	PM ₁₀	18/12/2018	3 Monthly
	PM _{2.5}	18/12/2018	3 Monthly
	NO/ NO ₂ / NO _x	18/12/2018	3 Monthly
	CO	18/12/2018	3 Monthly
	BTEX	NA	Flow-controllers and canisters certified by lab
	Wind speed and direction	7/08/2018	Two yearly
Station 5	PM ₁₀	17/12/2018	3 Monthly
	PM _{2.5}	17/12/2018	3 Monthly
	Wind speed and direction	10/08/2018	Two yearly
Station 6	PM ₁₀	18/12/2018	3 Monthly
	PM _{2.5}	18/12/2018	3 Monthly

6.0 RESULTS

The monitoring results for 1 December 2018 to 31 December 2018 are presented in the following sections.

6.1 Particulate matter (BAM PM_{2.5} & PM₁₀)

PM_{2.5} and PM₁₀ were continuously monitored and 5-minute averages logged. The 5-minute average data was transformed to 24 hour averages for reporting.

PM_{2.5} and PM₁₀ concentration statistics from the reporting period for Station 1 to Station 6 are presented in Table 8 to Table 13. The 24 hour average plots for Station 1 to Station 6 are presented in Figure 2 to Figure 7.

6.1.1 Station 1 – Yarraville Gardens

Table 8: Station 1 (Yarraville Gardens AAQMS) PM_{2.5} and PM₁₀ percentiles (24 hour average)

Parameter	Concentration (µg/m ³) ^A							Air quality objective ^B (µg/m ³)
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th	
PM _{2.5}	13	13	13	13	13	9.6	7.7	25
PM ₁₀	41	41	40	37	31	23	17	50

Note:

A Micrograms per cubic metre at 0°C and 101.3 kPa

B SEPP(AAQ) Objective

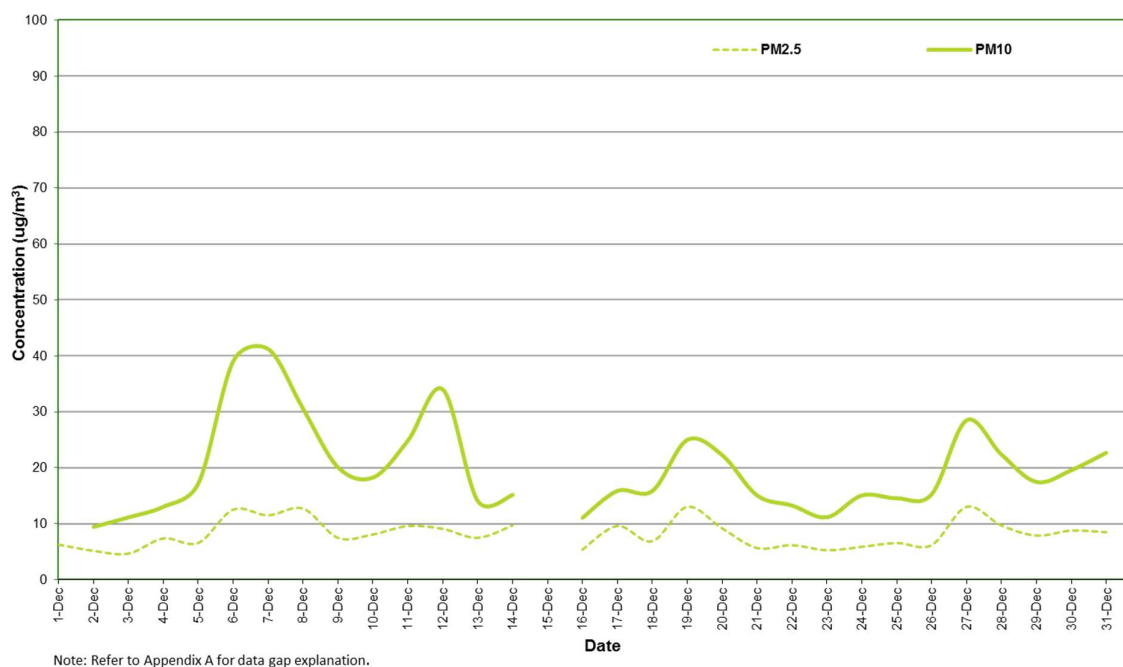


Figure 2: Station 1 PM_{2.5} and PM₁₀ concentration (24 hour average) – December 2018

6.1.2 Station 2 – Francis Street

Table 9: Station 2 (Francis Street AAQMS) PM_{2.5} and PM₁₀ percentiles (24 hour average)

Parameter	Concentration (µg/m ³) ^A							Air quality objective ^B (µg/m ³)
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th	
PM _{2.5}	15	14	14	13	12	11	7.9	36
PM ₁₀	32	32	32	32	30	25	19	60

Note:

A Micrograms per cubic metre at 0°C and 101.3 kPa

B SEPP(AQM) Intervention level

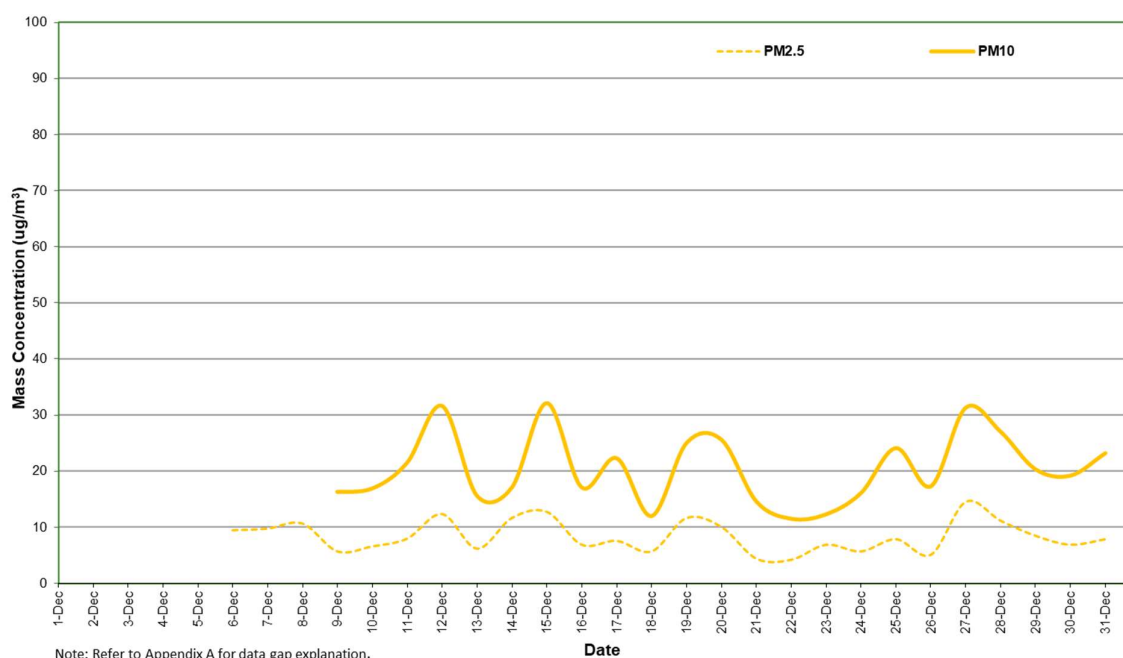


Figure 3: Station 2 PM_{2.5} and PM₁₀ concentration (24 Hour Average) – December 2018

6.1.3 Station 3 – Railway Reserve

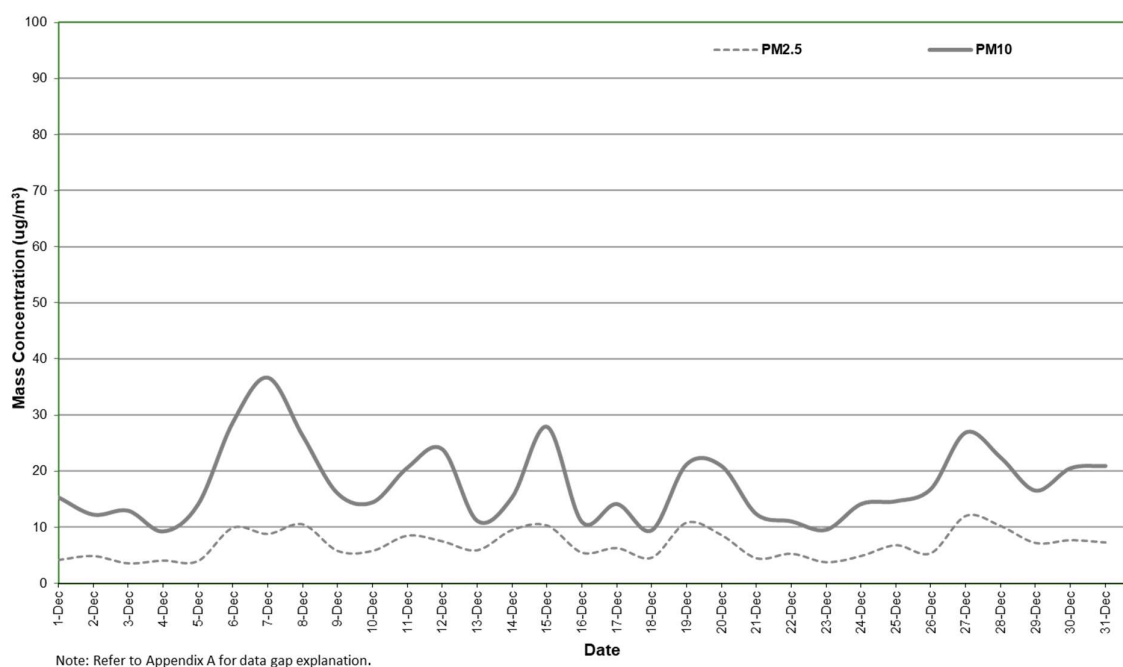
Table 10: Station 3 (Railway Reserve AAQMS) PM_{2.5} and PM₁₀ percentiles (24 hour average)

Parameter	Concentration (µg/m ³) ^A							Air quality objective ^B (µg/m ³)
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th	
PM _{2.5}	12	12	11	11	10	8.7	6.3	36
PM ₁₀	37	34	32	28	27	21	15	60

Note:

A Micrograms per cubic metre at 0°C and 101.3 kPa

B SEPP(AQM) Intervention level



Note: Refer to Appendix A for data gap explanation.

Figure 4: Station 3 PM_{2.5} and PM₁₀ concentration (24 hour average) – December 2018

6.1.4 Station 4 – Primula Avenue

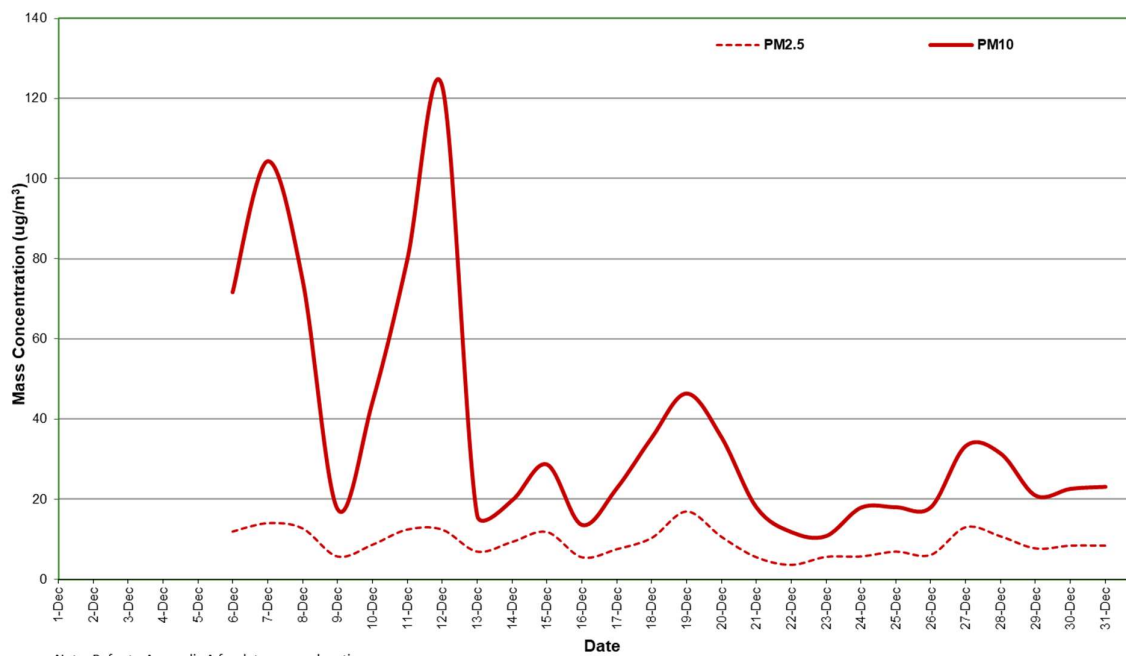
Table 11: Station 4 (Primula Avenue AAQMS) PM_{2.5} and PM₁₀ percentiles (24 hour average)

Parameter	Concentration (µg/m ³) ^A							Air quality objective ^B (µg/m ³)
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th	
PM _{2.5}	17	16	15	14	13	12	8.5	36
PM ₁₀	123	119	114	98	77	42	23	60

Note:

A Micrograms per cubic metre at 0°C and 101.3 kPa

B SEPP(AQM) Intervention level



Note: Refer to Appendix A for data gap explanation.

Figure 5: Station 4 PM_{2.5} and PM₁₀ concentration (24 hour average) – December 2018

6.1.5 Station 5 – Donald McLean Reserve

Table 12: Station 5 (Donald McLean Reserve AAQMS) PM_{2.5} and PM₁₀ percentiles (24 hour average)

Parameter	Concentration (µg/m ³) ^A							Air quality objective ^B (µg/m ³)
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th	
PM _{2.5}	13	13	12	12	11	10	6.5	36
PM ₁₀	40	38	37	33	30	22	16	60

Note:

A Micrograms per cubic metre at 0°C and 101.3 kPa

B SEPP(AQM) Intervention level

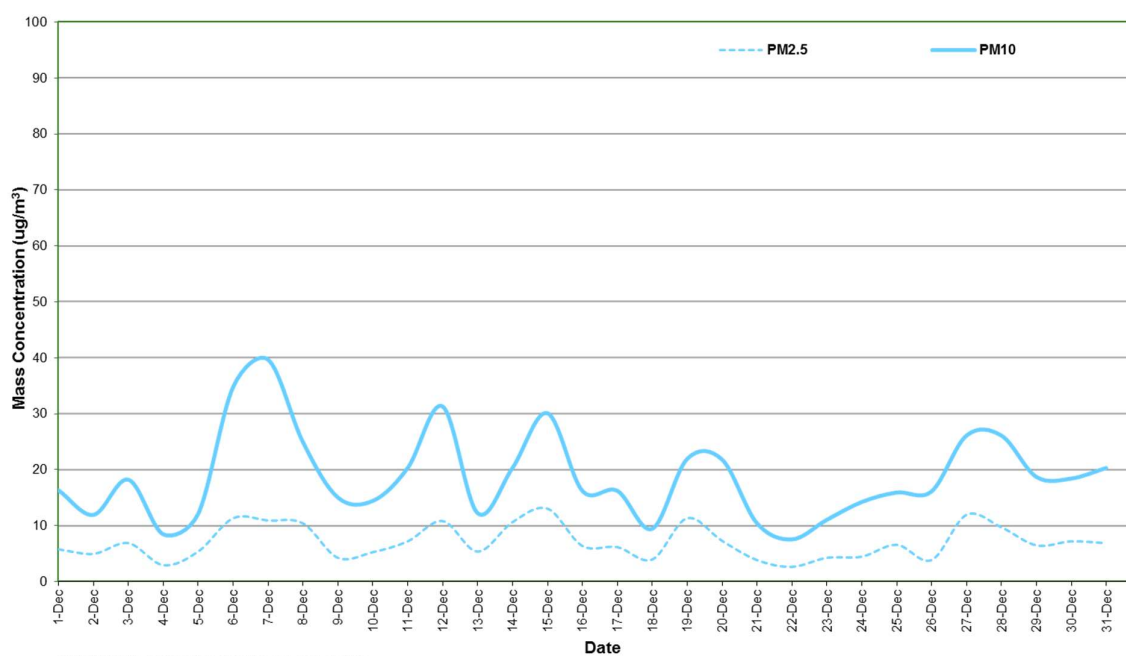


Figure 6: Station 5 PM_{2.5} and PM₁₀ concentration (24 hour average) – December 2018

6.1.6 Station 6 – Millers Road

Table 13: Station 6 (Millers Road AAQMS) PM_{2.5} and PM₁₀ percentiles (24 hour average)

Parameter	Concentration (µg/m ³) ^A							Air quality objective ^B (µg/m ³)
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th	
PM _{2.5}	14	14	13	12	12	10	7.4	36
PM ₁₀	57	55	53	47	42	30	19	60

Note:

A Micrograms per cubic metre at 0°C and 101.3 kPa

B SEPP(AQM) Intervention level

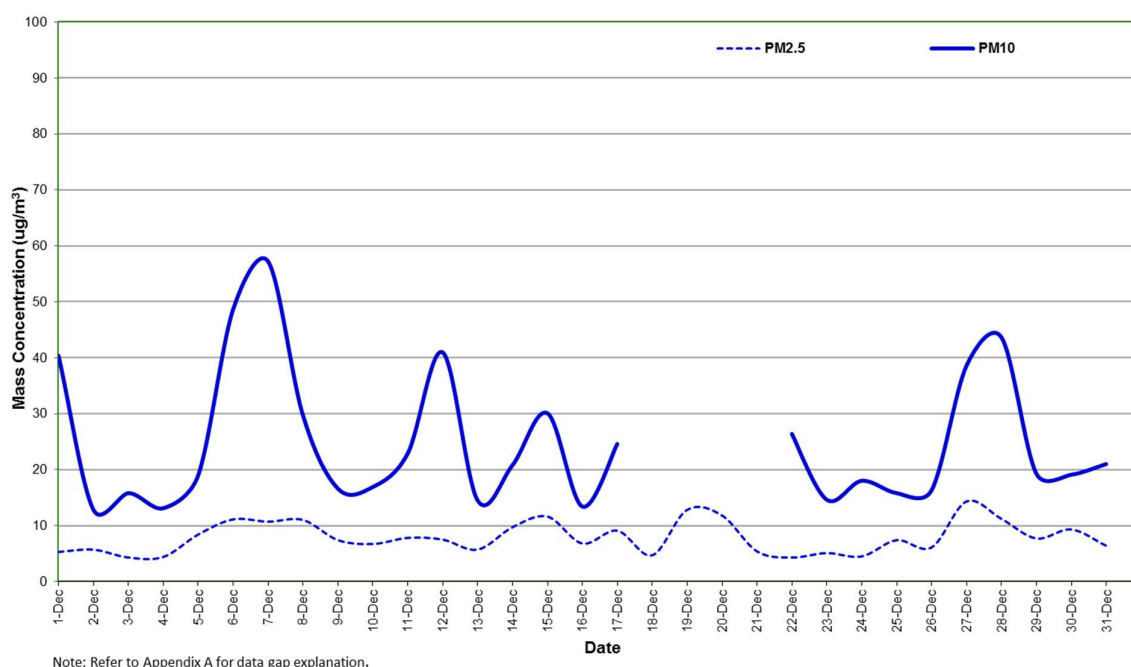


Figure 7: Station 6 PM_{2.5} and PM₁₀ concentration (24 hour average) – December 2018

6.1.7 Combined PM_{2.5} mass concentrations

Combined plots of the AAQMS PM_{2.5} and PM₁₀ are presented in Figure 8 and Figure 9 respectively.

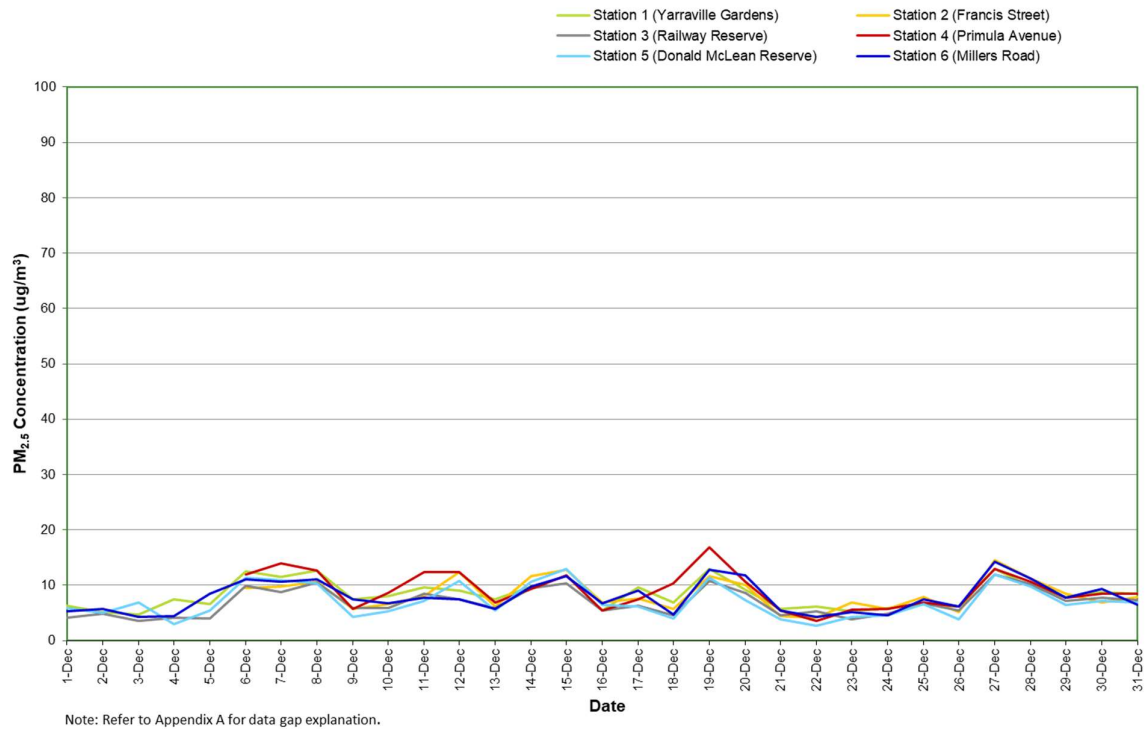


Figure 8: Combined PM_{2.5} concentration (24 hour average) – December 2018

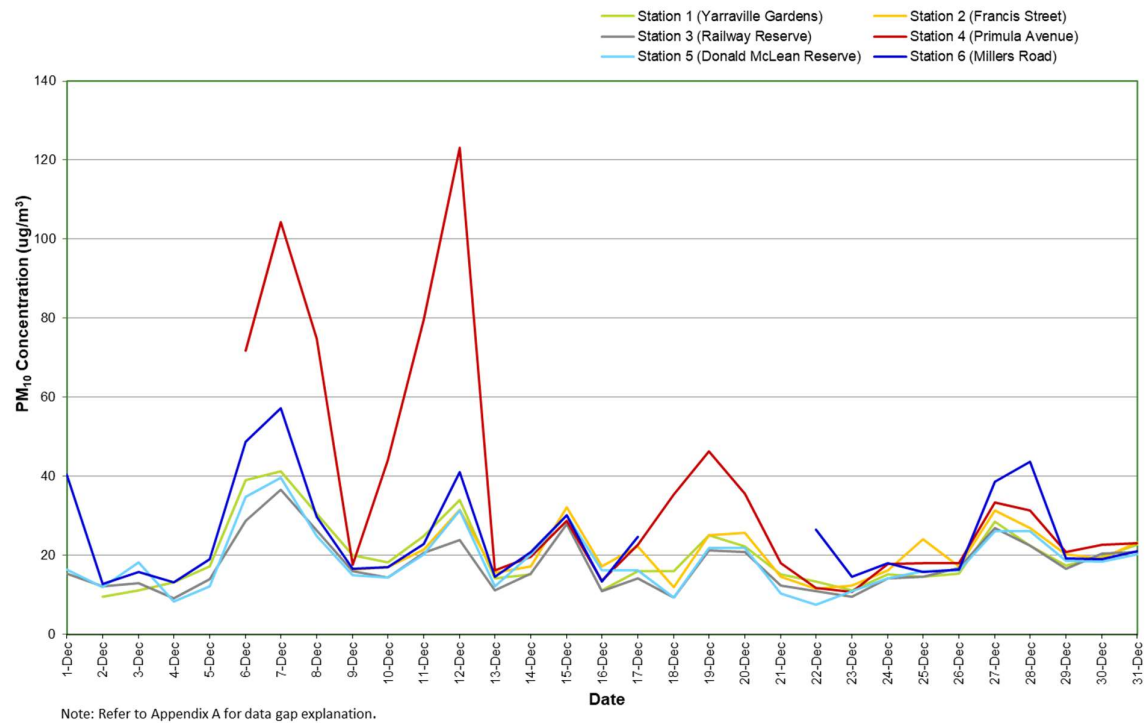


Figure 9: Combined PM₁₀ concentration (24 hour average) – December 2018

6.2 Nitrogen dioxide (NO₂)

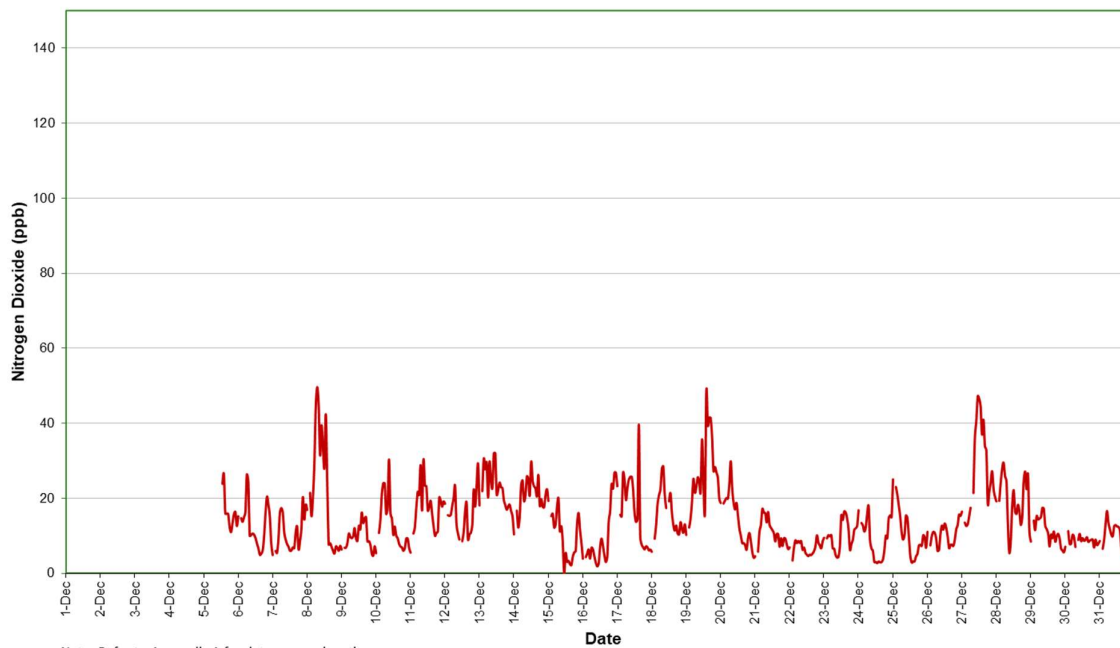
NO₂ (1 hour average) mass concentration statistics for the reporting period are given in Table 14. A plot of NO₂ (1 hour average) mass concentration for the reporting period is presented in Figure 10.

Table 14: Station 4 (Primula Avenue AAQMS) NO₂ percentiles (1 hour average)

Parameter	Concentration (ppb) ^A							SEPP (AQM) intervention level
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th	(ppb)
NO ₂	50	44	40	30	25	19	12	140

Note:

A Parts per billion



Note: Refer to Appendix A for data gap explanation.

Figure 10: Station 4 NO₂ concentration (1 hour average) – December 2018

6.3 Carbon monoxide (CO)

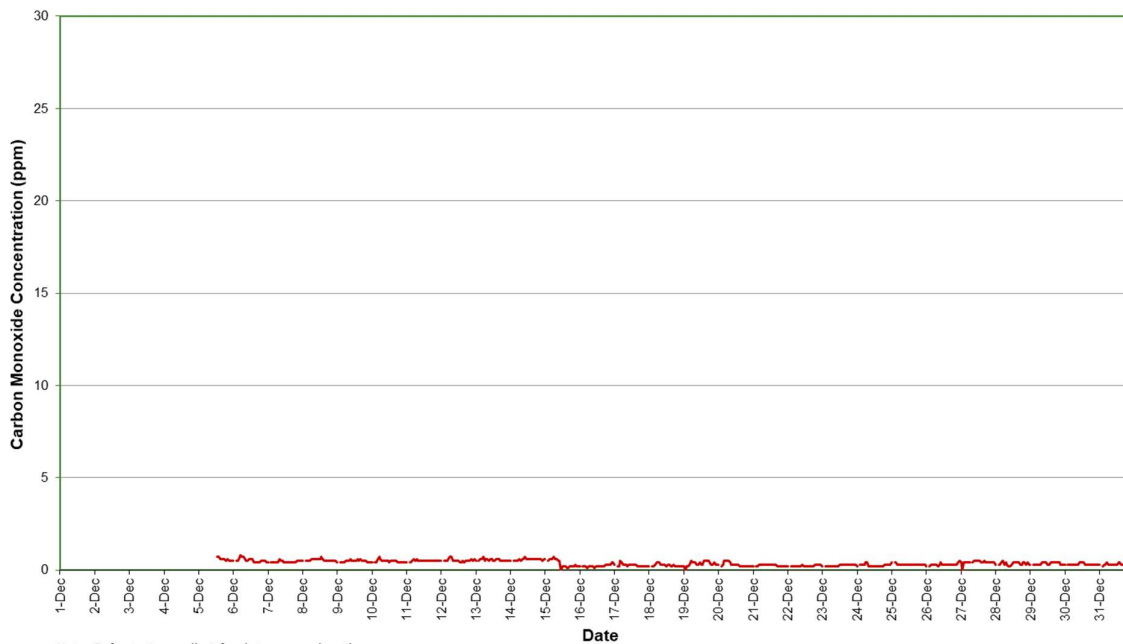
CO (1 hour average) mass concentration statistics for the reporting period are given in Table 15. A plot of CO (1 hour average) concentration for the reporting period is presented with the SEPP(AQM) Schedule B CO Intervention Level of 29 ppm (1 hour average) in Figure 11.

Table 15: Station 4 (Primula Avenue AAQMS) CO percentiles (1 hour average)

Parameter	Concentration (ppm) ^A							SEPP (AQMS) intervention level
	Maximum	99 th	98 th	95 th	90 th	75 th	50 th	(ppm)
CO	0.8	0.7	0.6	0.6	0.6	0.5	0.4	29

Note:

A Parts per million



Note: Refer to Appendix A for data gap explanation.

Figure 11: Station 4 CO concentration (1 hour average) – December 2018

6.4 Volatile organic compounds (BTEX)

VOC samples were collected from Station 4 (Primula Avenue), in an evacuated electro-polished and passivated stainless steel canister. Analysis involves separation by gas chromatography (GC) and measurement by mass selective (MS) detector.

The procedure for sampling Volatile Organic Compounds (VOCs) using evacuated canisters, and for the subsequent analysis, is described in USEPA Method TO-15 "Determination of Volatile Organic Compounds (VOCs) in air collected in specially-prepared canisters and analysed by Gas Chromatography/Mass Spectrometry (GC/MS)".

Samples were analysed by Queensland Health (NATA Laboratory Accreditation No. 41) based on USEPA method TO-15 (Laboratory Report Nos. SSP62195 and SSP62474).

The test method used was in accordance with Golder Source Test Method C9, "Canister (Evacuated) Sampling for VOC: In Ambient Air and Source Emissions".

BTEX (24 hour average) concentration statistics for the reporting period are given in Table 16. Laboratory certificates are presented in Appendix B.

Table 16: Station 4 - Primula Avenue AAQMS BTEX concentrations (24 hour average)

Date	Benzene (ppb)	Toluene (ppb)	Ethylbenzene (ppb)	Total xylene isomers (ppb)
4/12/2018	<0.5	1.9	<0.5	<1
10/12/2018	<0.5	6.1	1.2	1.5
16/12/2018	<0.5	0.9	<0.5	<1
22/12/2018	<0.5	0.5	<0.5	<1
28/12/2018	<0.5	1.1	<0.5	<1
NEPM MIL ^A	3.0 ^B	1000	NA	250

Note:

A National Environment Protection Measure (Air Toxics) Monitoring Investigation Level

B Annual average

Sample analysis conducted by Queensland Health, NATA Accreditation No. 41

6.5 Meteorological parameters

6.5.1 Temperature

Ambient Temperature data for all AAQMS sites are presented in Figure 12 for the reporting period.

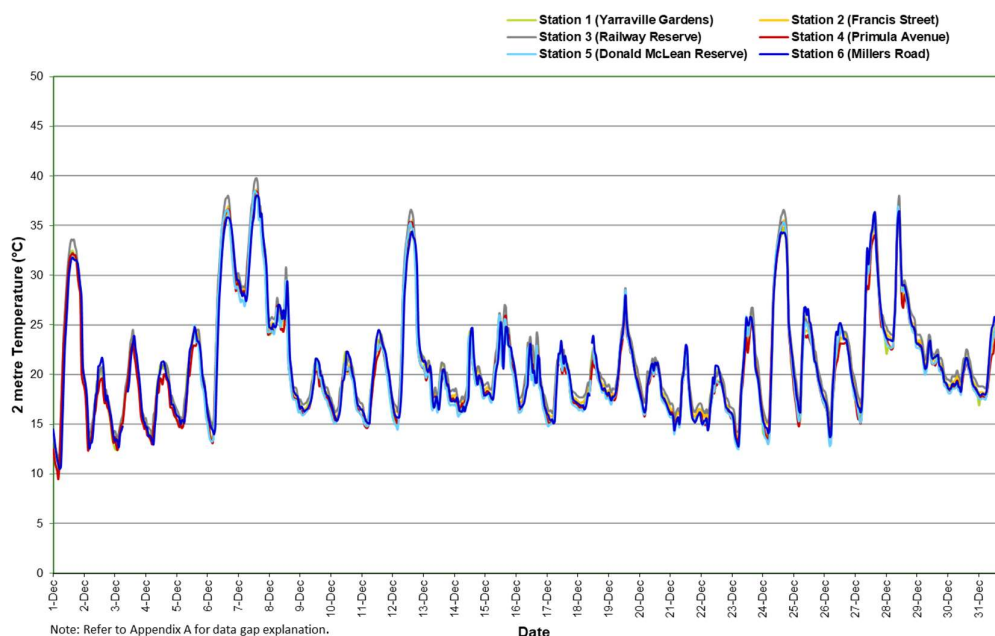


Figure 12: Ambient temperature (1 hour average) All AAQMS – December 2018

6.5.2 Relative humidity

Relative Humidity data for all AAQMS sites are presented in Figure 13 for the reporting period.

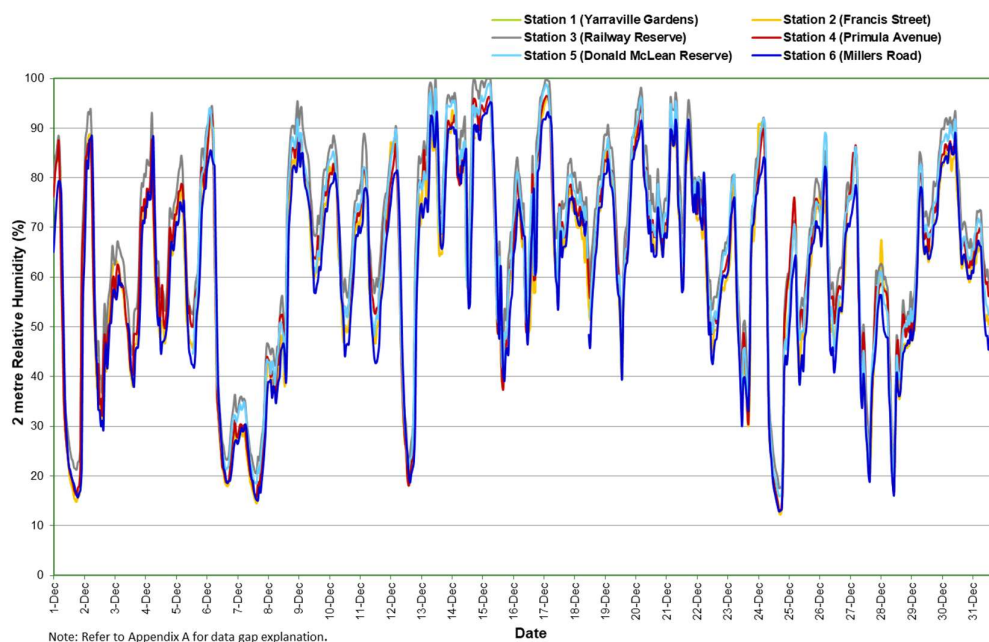


Figure 13: Relative humidity (1 hour average) All AAQMs – December 2018

6.5.3 Atmospheric pressure

Atmospheric pressure data for Station 4 (Primula Avenue AAQMS) is presented in Figure 14 for the reporting period.



Figure 14: Atmospheric pressure (1 hour average) Station 4 (Primula Avenue) – December 2018

6.5.4 Wind speed

Wind Speed data for all AAQMS sites are presented in Figure 15 for the reporting period.

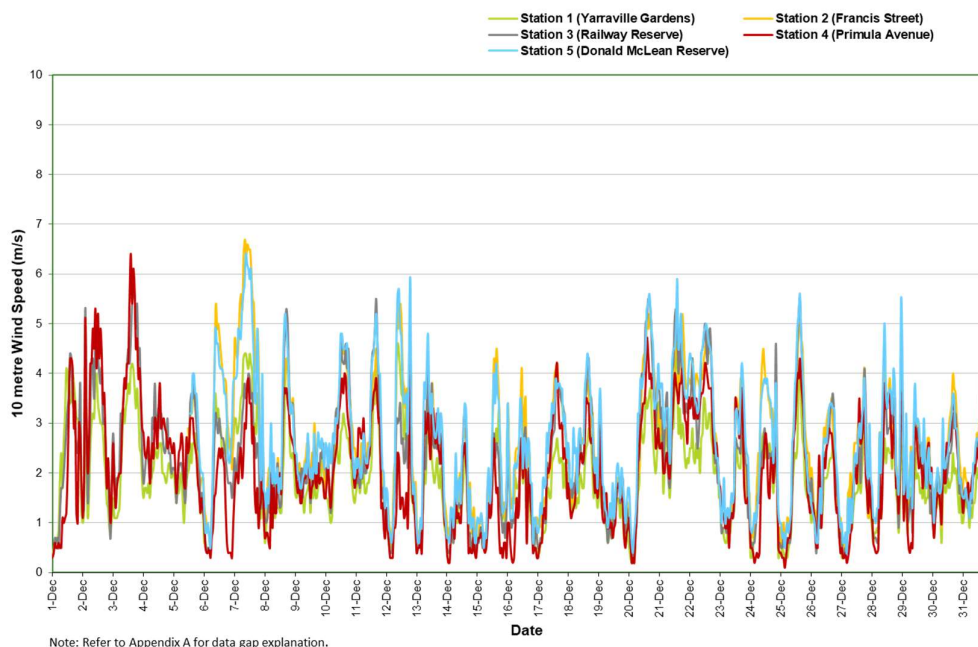


Figure 15: Wind speed (1 hour average) All AAQMs – December 2018

6.5.5 Wind rose – Station 1 (Yarraville Gardens)

A wind rose (1 hour average) for Station 1 (Yarraville Gardens AAQMS) is presented in Figure 16.

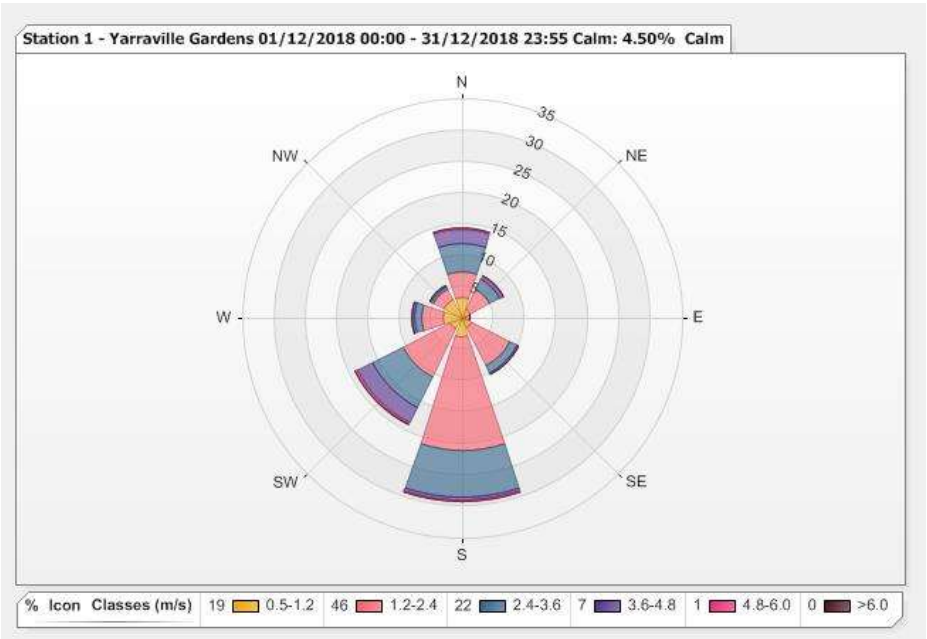


Figure 16: Wind speed (1 hour average) Station 1 Yarraville Gardens AAQMS

6.5.6 Wind rose – Station 2 (Francis Street)

A wind rose (1 hour average) for Station 2 (Francis Street AAQMS) is presented in Figure 17.

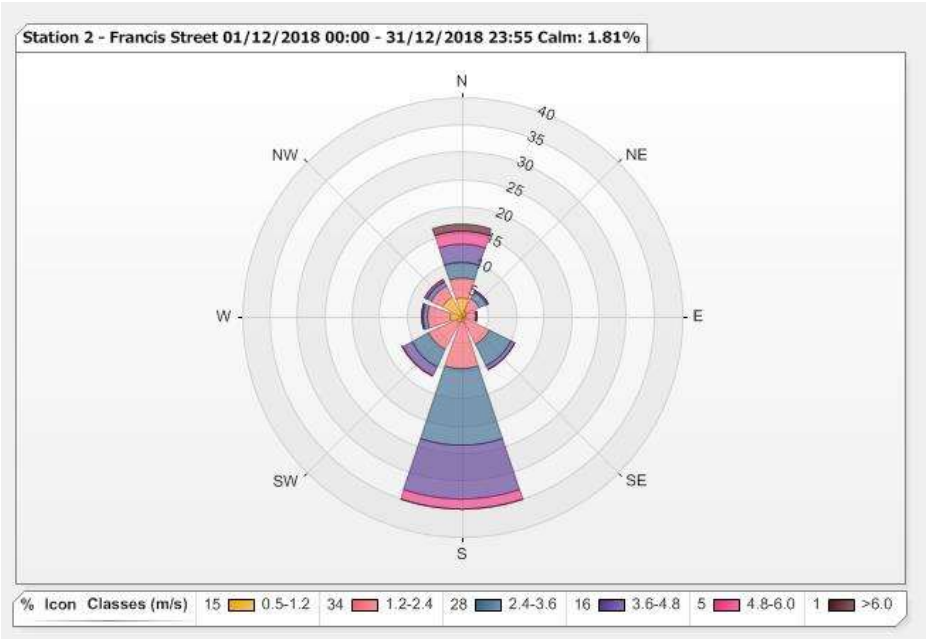


Figure 17: Wind speed (1 hour average) Station 2 Francis Street AAQMS

6.5.7 Wind rose – Station 3 (Railway Reserve)

A wind rose (1 hour average) for Station 3 (Railway Reserve AAQMS) is presented in Figure 18.

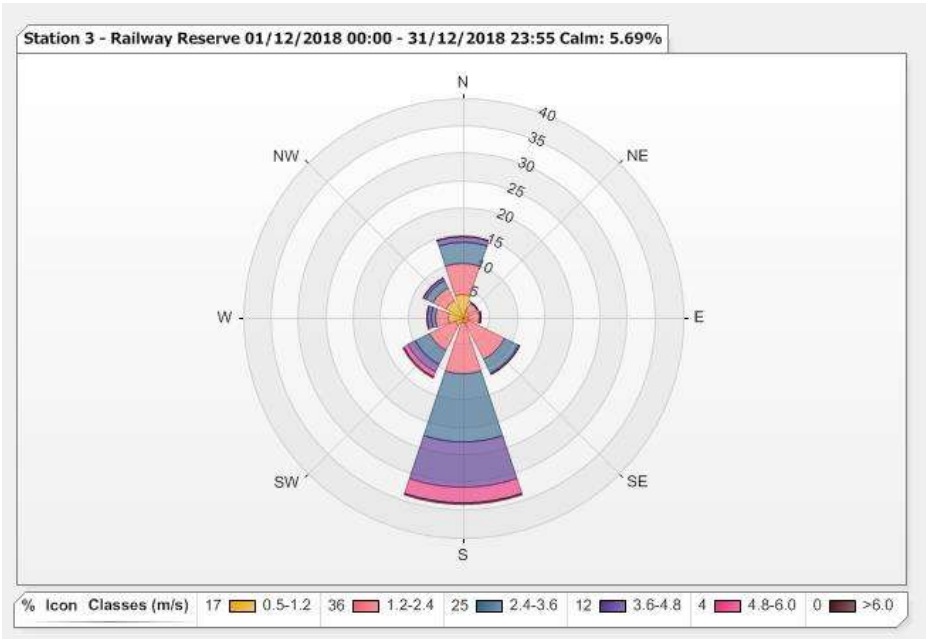


Figure 18: Wind speed (1 hour average) Station 3 Railway Reserve AAQMs

6.5.8 Wind rose – Station 4 (Primula Avenue)

A wind rose (1 hour average) for Station 4 (Primula Avenue AAQMS) is presented in Figure 19.

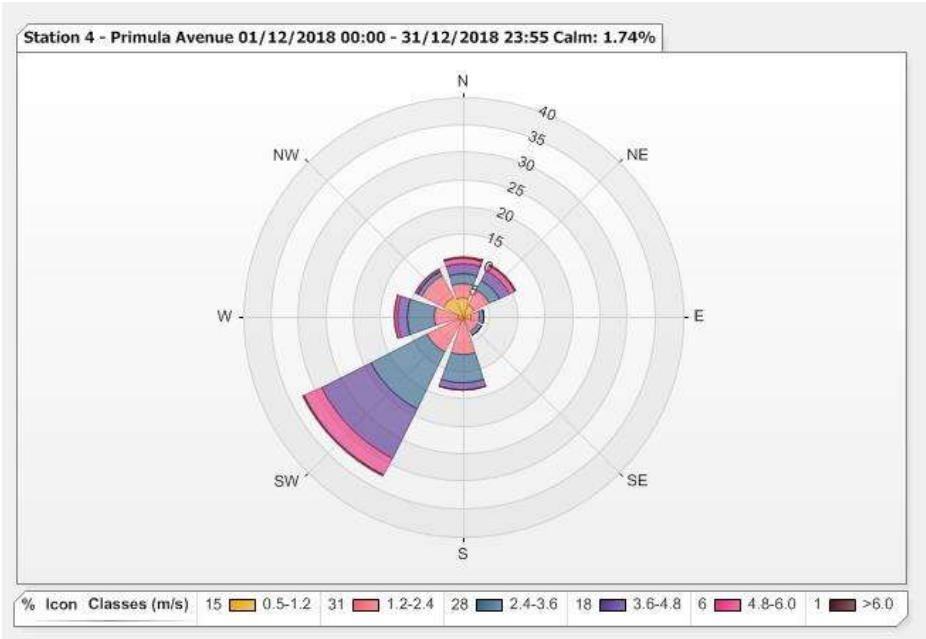


Figure 19: Wind speed (1 hour average) Station 4 Primula Avenue AAQMs

6.5.9 Wind rose – Station 5 (Donald McLean Reserve)

A wind rose (1 hour average) for Station 5 (Donald McLean Reserve AAQMS) is presented in Figure 20.

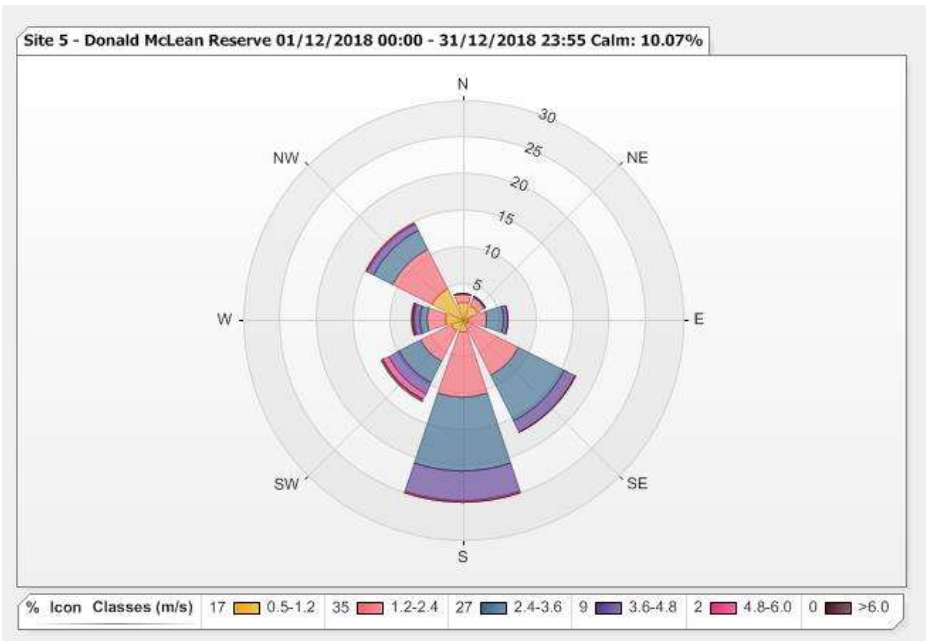


Figure 20: Wind speed (1 hour average) Station 5 Donald McLean Reserve AAQMs

7.0 QUALITY ASSURANCE

7.1 Data capture

Data capture is defined as the number of valid data periods collected divided by the number of available data periods. Valid data excludes periods where the instrument is unavailable due to calibration and maintenance and excludes periods where the data has been rejected due to quality assurance/data validation procedures.

Automatic calibrations are conducted for NO₂ and CO daily to monitor and correct instrument drift where necessary. NO₂ and CO automatic calibrations are conducted once per day between 01:00 and 01:45 hours.

Data capture statistics for the reporting period 1 December to 31 December 2018 are shown in Table 17. Averages were only collected for those periods where the 5 minute data constituted 75% data capture.

Data capture statistics for December 2018 were above 90 percent for all parameters at AAQMS 1, 3 and 5.

However, data loss for all parameters unless otherwise stated, was observed at;

- AAQMS 2 (Francis Street) from 1/12/2018 to 5/12/2018 due to power supply to the site being disconnected by the power supply company.
- AAQMS 2 (Francis Street) PM₁₀ from 5/12/2018 to 8/12/2018 due to an instrument detector failure. Repair performed under warranty by equipment supplier.
- AAQMS 4 (Primula Avenue) from 1/12/2018 to 5/12/2018 due to power supply to the site being disconnected by the power supply company.
- AAQMS 6 (Millers Road) PM₁₀ from 18/12/2018 to 21/12/2018 due to an instrument detector failure. Repair performed under warranty by equipment supplier.

Table 17: Data capture

Parameter	Averaging period	Station	Collected periods	Available periods	Data capture
PM _{2.5}	24 hour	1 – Yarraville Gardens	30	31	96.8%
	24 hour	2 – Francis Street	26	31	83.9%
	24 hour	3 – Railway Reserve	31	31	100%
	24 hour	4 – Primula Avenue	26	31	83.9%
	24 hour	5 – Donald McLean Reserve	31	31	100%
	24 hour	6 – Millers Road	31	31	100%
PM ₁₀	24 hour	1 – Yarraville Gardens	29	31	93.5%
	24 hour	2 – Francis Street	23	31	74.2%
	24 hour	3 – Railway Reserve	31	31	100%
	24 hour	4 – Primula Avenue	26	31	83.9%
	24 hour	5 – Donald McLean Reserve	31	31	100%
	24 hour	6 – Millers Road	27	31	87.1%
NO ₂	1 hour	4 – Primula Avenue	604	744	81.2%
CO	1 hour	4 – Primula Avenue	607	744	81.6%

Ambient temperature & relative humidity	1 hour	1 – Yarraville Gardens	727	744	97.7%
	1 hour	2 – Francis Street	636	744	85.5%
	1 hour	3 – Railway Reserve	735	744	99.9%
	1 hour	4 – Primula Avenue	634	744	85.2%
	1 hour	5 – Donald McLean Reserve	743	744	99.5%
	1 hour	6 – Millers Road	740	744	99.5%
Wind speed and direction	1 hour	1 – Yarraville Gardens	728	744	97.8%
	1 hour	2 – Francis Street	637	744	85.6%
	1 hour	3 – Railway Reserve	736	736	100%
	1 hour	4 – Primula Avenue	635	744	85.3%
	1 hour	5 – Donald McLean Reserve	744	744	100%

7.2 Data validation

Data contained in this report has been validated against performance and calibration requirements for each instrument. Data during commissioning, maintenance and calibration periods has been removed from the validated data sets. Appendix A lists the data exceptions for all AAQMS. Missing data periods during automatic calibrations of the gaseous atmospheric contaminants NO₂ and CO are not shown.

8.0 DISCUSSION

Table 18 presents the maximum measured concentration during the reporting period at Station 1 for PM_{2.5} and PM₁₀ compared with the respective criteria.

Table 18: Station 1 Summary – December 2018

Parameter	Units	Averaging period	Maximum concentration	Air quality objective ^A	Exceedances
PM _{2.5}	ug/m ³	24 hour	13	25	Pass
PM ₁₀	ug/m ³	24 hour	41	50	Pass

Notes:

A - SEPP(AAQ) objective

Table 19 presents the maximum measured concentration during the reporting period at Station 2, Station 3, Station 5 and Station 6 for PM_{2.5} and PM₁₀ compared with the respective criteria.

Table 19: Station 2, Station 3, Station 5 and Station 6 Summary – December 2018

Parameter	Units	Averaging period	Maximum concentration				Air quality objective ^A	Exceedances
			Station 2	Station 3	Station 5	Station 6		
PM _{2.5}	ug/m ³	24 hour	15	12	13	14	36	Nil
PM ₁₀	ug/m ³	24 hour	32	37	40	57	60	Nil

Notes:

A- SEPP(AQM) Intervention level

Table 20 presents maximum measured concentration during the reporting period at Station 4 for PM_{2.5}, PM₁₀, NO₂, CO and BTEX compared with the respective criteria.

Table 20: Station 4 Summary – December 2018

Parameter	Units	Averaging period	Maximum concentration	Air quality objective	Exceedances
PM _{2.5}	ug/m ³	24 hour	17	36 ^A	Nil
PM ₁₀	ug/m ³	24 hour	123	60 ^A	5
NO ₂	ppb	1 hour	50	140 ^A	Nil
CO	ppm	1 hour	0.8	29 ^A	Nil
Benzene	ppb	24 hour	<0.5	3.0 ^B	Nil
Toluene	ppb	24 hour	6.1	1000 ^B	Nil
Total xylene isomers	ppb	24 hour	1.5	250 ^B	Nil

Notes:

A - SEPP(AQM) Intervention level

B - Air NEPM Monitoring investigation level

The December ambient air quality monitoring programme results were less than the respective air quality objectives for all parameters measured at stations 1, 2, 3, 5 and 6. Station 4 (Primula Avenue) exceeded the PM₁₀ air quality objective on five days (6/12/2018, 7/12/2018, 8/12/2018, 11/12/2018 and 12/12/2018), all other parameters monitored at station 4 were less than the respective air quality objectives.

Station 4 is now located in a construction area (Millers Road exit ramp and noise wall relocation) and the measured PM₁₀ concentrations may not be representative of impacts at the closest residential receptor.

9.0 IMPORTANT INFORMATION RELATING TO THIS REPORT

Your attention is drawn to the document - "Important Information Relating to this Report" (LEG04, RL2), which is included in Appendix C of this report. The statements presented in this document are intended to advise you of what your realistic expectations of this report should be. The document is not intended to reduce the level of responsibility accepted by Golder, but rather to ensure that all parties who may rely on this report are aware of the responsibilities each assumes in so doing. We would be pleased to answer any questions the reader may have regarding this document.

Signature Page

Golder Associates Pty Ltd



Anthony Myszka
Environmental Technician



Marl Tulau
Senior Environmental Scientist

AM/MDT/am

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APPENDIX A

Data Exceptions

Data exceptions - December 2018

Date from	Date to	Station	Parameters	Reason
01/12/2018 00:00	05/12/2018 10:20	2	All Parameters	Power Outage
01/12/2018 00:00	05/12/2018 21:55	4	All Parameters	Power Outage
01/12/2018 12:20	01/12/2018 23:55	1	PM ₁₀	Maintenance / Calibration
03/12/2018 06:50	03/12/2018 09:45	6	All Parameters	Maintenance / Calibration
05/12/2018 10:25	05/12/2018 19:25	2	PM _{2.5}	Invalid ¹
05/12/2018 10:25	08/12/2018 16:55	2	PM ₁₀	Replaced Detector
06/12/2018 21:30	06/12/2018 21:30	4	PM ₁₀	Logger Error
07/12/2018 11:20	07/12/2018 11:20	4	PM ₁₀	Logger Error
08/12/2018 17:25	08/12/2018 17:25	4	PM ₁₀	Logger Error
11/12/2018 15:20	11/12/2018 15:20	4	PM ₁₀	Logger Error
12/12/2018 03:25	12/12/2018 03:25	5	Wind Sensor	Logger Error
12/12/2018 11:15	12/12/2018 11:50	4	NO, NO ₂ , NO _x	Maintenance / Calibration
12/12/2018 13:10	12/12/2018 13:10	4	PM ₁₀	Logger Error
13/12/2018 08:40	13/12/2018 08:40	4	Meteorological Parameters	Logger Error
13/12/2018 23:00	13/12/2018 23:00	4	All Parameters	Logger Error
14/12/2018 18:50	15/12/2018 15:35	1	All Parameters	Power Outage
15/12/2018 11:15	15/12/2018 11:50	4	All Parameters	Maintenance / Calibration
15/12/2018 13:15	15/12/2018 13:20	3	Wind Sensor	Maintenance / Calibration
15/12/2018 18:00	15/12/2018 18:00	2	Temperature / RH	Invalid ¹
16/12/2018 23:05	16/12/2018 23:05	1	Wind Sensor	Intermittent Sensor
17/12/2018 09:45	17/12/2018 09:55	5	PM ₁₀	Maintenance / Calibration
17/12/2018 10:05	17/12/2018 10:35	5	PM _{2.5}	Maintenance / Calibration
17/12/2018 10:05	17/12/2018 10:35	5	Temperature / RH	Maintenance / Calibration
17/12/2018 11:25	17/12/2018 11:45	2	Temperature / RH	Maintenance / Calibration
17/12/2018 11:30	17/12/2018 11:45	2	PM _{2.5}	Maintenance / Calibration
17/12/2018 12:30	17/12/2018 12:50	3	PM _{2.5}	Maintenance / Calibration
17/12/2018 12:30	17/12/2018 12:50	3	Temperature / RH	Maintenance / Calibration
17/12/2018 13:30	17/12/2018 14:00	1	PM _{2.5}	Maintenance / Calibration
17/12/2018 13:30	17/12/2018 14:00	1	Temperature / RH	Maintenance / Calibration
18/12/2018 06:55	18/12/2018 08:40	4	NO, NO ₂ , NO _x	Invalid ¹
18/12/2018 10:10	18/12/2018 10:45	6	Temperature / RH	Logger Error
18/12/2018 10:15	18/12/2018 11:55	6	PM _{2.5}	Maintenance / Calibration
18/12/2018 10:50	21/12/2018 16:55	6	PM ₁₀	Replaced Detector

Date from	Date to	Station	Parameters	Reason
18/12/2018 10:55	18/12/2018 11:20	4	PM _{2.5}	Maintenance / Calibration
18/12/2018 11:00	18/12/2018 11:15	4	Meteorological Parameters	Logger Error
18/12/2018 11:30	18/12/2018 12:05	4	NO, NO ₂ , NO _x	Maintenance / Calibration
18/12/2018 23:00	18/12/2018 23:00	6	Temperature / RH	Logger Error
19/12/2018 06:30	19/12/2018 06:35	4	NO, NO ₂ , NO _x	Invalid ¹
20/12/2018 04:05	20/12/2018 04:05	5	10m Wind Sensor	Logger Error
21/12/2018 09:00	21/12/2018 09:00	6	Temperature / RH	Maintenance / Calibration
21/12/2018 09:35	21/12/2018 09:35	2	Temperature / RH	Maintenance / Calibration
21/12/2018 09:50	21/12/2018 09:55	1	Temperature / RH	Maintenance / Calibration
21/12/2018 10:10	21/12/2018 10:15	3	Temperature / RH	Intermittent sensor error
21/12/2018 10:15	21/12/2018 10:40	3	PM ₁₀	Maintenance / Calibration
21/12/2018 10:15	21/12/2018 12:20	3	PM _{2.5}	Maintenance / Calibration
21/12/2018 10:55	21/12/2018 10:55	5	Temperature / RH	Logger Error
21/12/2018 17:10	21/12/2018 17:20	4	Meteorological Parameters	Logger Error
22/12/2018 09:10	22/12/2018 09:10	5	Temperature / RH	Logger Error
22/12/2018 09:50	22/12/2018 09:55	2	Temperature / RH	Maintenance / Calibration
22/12/2018 10:25	22/12/2018 10:25	1	Temperature / RH	Maintenance / Calibration
22/12/2018 10:55	22/12/2018 10:55	3	Temperature / RH	Intermittent Sensor
22/12/2018 12:00	22/12/2018 12:15	6	All Parameters	Maintenance / Calibration
23/12/2018 17:30	23/12/2018 17:35	4	PM _{2.5}	Logger Error
27/12/2018 03:00	27/12/2018 03:00	4	All Parameters	Logger Error
27/12/2018 06:45	27/12/2018 07:40	4	NO, NO ₂ , NO _x	Maintenance / Calibration
27/12/2018 07:10	27/12/2018 07:10	4	All Parameters	Logger Error
30/12/2018 07:50	30/12/2018 08:15	4	NO, NO ₂ , NO _x	Maintenance / Calibration
30/12/2018 08:20	30/12/2018 10:20	4	PM _{2.5} / PM ₁₀	Maintenance / Calibration
30/12/2018 08:20	30/12/2018 08:20	4	Meteorological Parameters	Logger Error

Note: 1 – In the opinion of the data reviewer.

APPENDIX B

Laboratory Certificates

CERTIFICATE OF ANALYSIS

CLIENT: Golder Associates
Building 7, Botanicca Corporate Park
570 - 588 Swan Street
Richmond VIC 3121

ATTN: Carl Van Brink

Laboratory Reference : SSP63190
Client Order Number : PO 13960
Quote Number : n/a
Client Project : 1789878
Client Batch Reference : n/a
Date Received : 14-Jan-2019
Date Commenced : 14-Jan-2019
Laboratory Number/s : 19KS43-48

CC:

Submitting Authority : Golder Associates

Number of Samples : Six (6) Summa canisters

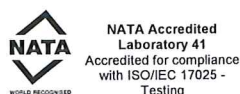
Reason for Analysis : Analysis of Volatile Organic Compounds (VOCs) in air

Method/s of Analysis : QIS28237 V3.0 – Identification, Confirmation and Quantitation by GCMS Using the Shimadzu 2010+ and the EnTech 7200 Preconcentrator system

Remarks : Sample details and results are summarised in Table 1.



David Pass
Senior Chemist, Organics Laboratory
15th January 2019



SSP63190

This report overrides all previous reports. The results relate solely to the sample/s as received and are limited to the specific tests undertaken as listed on the report. The results of this report are confidential and are not to be used or disclosed to any other person or used for any other purpose, whether directly or indirectly, unless that use is disclosed or the purpose is expressly authorised in writing by Queensland Health and the named recipient on this report. To the fullest extent permitted by law, Queensland Health will not be liable for any loss or claim (including legal costs calculated on an indemnity basis) which arise because of (a) problems related to the merchantability, fitness or quality of the sample/s, or (b) any negligent or unlawful act or omissions by Queensland Health that is connected with any activities or services provided by Queensland Health under this agreement (including the timing and/or method under which the sample/s were taken, stored or transported).

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CERTIFICATE OF ANALYSIS

Laboratory Reference: SSP63190
Laboratory Number: 19KS43 - 48

Table 1: Results for Summa canister analysis

Client Reference		18-1112	18-1113	18-1114	18-1115	18-1116	19-0001		
Sample Type		Silco Canister #2389	Silco Canister #2399	Silco Canister #1606	Silco Canister #6032	Silco Canister #1994	Silco Canister #1989		
Sampling Time / Date		10:39 04/12/2018	00:00 10/12/2018	00:00 16/12/2018	00:00 22/12/2018	00:00 28/12/2018	14:15 09/01/2019		
Sample Description		ambient air	ambient air	ambient air	ambient air	ambient air	ambient air		
Method	Volatile Organic Compounds (VOCs) by GCMS	Units	Reporting Limit	19KS43	19KS44	19KS45	19KS46	19KS47	19KS48
28237	Benzene	ppbv	0.5	< LOR	< LOR	< LOR	< LOR	< LOR	0.7
28237	Toluene	ppbv	0.5	1.9	6.1	0.9	0.5	1.1	1.6
28237	Ethylbenzene	ppbv	0.5	< LOR	1.2	< LOR	< LOR	< LOR	0.6
28237	m- & p-Xylene	ppbv	0.5	< LOR	1.0	< LOR	< LOR	0.8	1.9
28237	o-Xylene	ppbv	0.5	< LOR	0.5	< LOR	< LOR	< LOR	< LOR

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APPENDIX C

**Important Information Relating to
this Report**



IMPORTANT INFORMATION RELATING TO THIS REPORT

The document ("Report") to which this page is attached and which this page forms a part of, has been issued by Golder Associates Pty Ltd ("Golder") subject to the important limitations and other qualifications set out below.

This Report constitutes or is part of services ("Services") provided by Golder to its client ("Client") under and subject to a contract between Golder and its Client ("Contract"). The contents of this page are not intended to and do not alter Golder's obligations (including any limits on those obligations) to its Client under the Contract.

This Report is provided for use solely by Golder's Client and persons acting on the Client's behalf, such as its professional advisers. Golder is responsible only to its Client for this Report. Golder has no responsibility to any other person who relies or makes decisions based upon this Report or who makes any other use of this Report. Golder accepts no responsibility for any loss or damage suffered by any person other than its Client as a result of any reliance upon any part of this Report, decisions made based upon this Report or any other use of it.

This Report has been prepared in the context of the circumstances and purposes referred to in, or derived from, the Contract and Golder accepts no responsibility for use of the Report, in whole or in part, in any other context or circumstance or for any other purpose.

The scope of Golder's Services and the period of time they relate to are determined by the Contract and are subject to restrictions and limitations set out in the Contract. If a service or other work is not expressly referred to in this Report, do not assume that it has been provided or performed. If a matter is not addressed in this Report, do not assume that any determination has been made by Golder in regards to it.

At any location relevant to the Services conditions may exist which were not detected by Golder, in particular due to the specific scope of the investigation Golder has been engaged to undertake. Conditions can only be verified at the exact location of any tests undertaken. Variations in conditions may occur between tested locations and there may be conditions which have not been revealed by the investigation and which have not therefore been taken into account in this Report.

Golder accepts no responsibility for and makes no representation as to the accuracy or completeness of the information provided to it by or on behalf of the Client or sourced from any third party. Golder has assumed that such information is correct unless otherwise stated and no responsibility is accepted by Golder for incomplete or inaccurate data supplied by its Client or any other person for whom Golder is not responsible. Golder has not taken account of matters that may have existed when the Report was prepared but which were only later disclosed to Golder.

Having regard to the matters referred to in the previous paragraphs on this page in particular, carrying out the Services has allowed Golder to form no more than an opinion as to the actual conditions at any relevant location. That opinion is necessarily constrained by the extent of the information collected by Golder or otherwise made available to Golder. Further, the passage of time may affect the accuracy, applicability or usefulness of the opinions, assessments or other information in this Report. This Report is based upon the information and other circumstances that existed and were known to Golder when the Services were performed and this Report was prepared. Golder has not considered the effect of any possible future developments including physical changes to any relevant location or changes to any laws or regulations relevant to such location.

Where permitted by the Contract, Golder may have retained subconsultants affiliated with Golder to provide some or all of the Services. However, it is Golder which remains solely responsible for the Services and there is no legal recourse against any of Golder's affiliated companies or the employees, officers or directors of any of them.

By date, or revision, the Report supersedes any prior report or other document issued by Golder dealing with any matter that is addressed in the Report.

Any uncertainty as to the extent to which this Report can be used or relied upon in any respect should be referred to Golder for clarification.



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