Latrobe Valley Air Monitoring Network

LVAMN Inc.

LVAMN Air Monitoring Report 2017

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Latrobe Valley Air Monitoring Network

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Overview

Ecotech operated and maintained the Jeeralang Hill and Rosedale South air quality monitoring stations on behalf of the Latrobe Valley Air Monitoring Network Incorporated (LVAMN), in 2017. Ecotech conducted Quality Assurance checks on the monitoring data in accordance with NATA procedures, and provided monthly monitoring data and reports to Jacobs and LVAMN, setting out details such as equipment and monitoring specifications and data capture rates.

The purpose of this annual report is to provide an independent review of the 2017 air quality monitoring data acquired at the LVAMN Jeeralang Hill and Rosedale South monitoring stations, focussing on data interpretation.

In 2017, capture of hourly average data at Jeeralang Hill was very good, with data capture for most parameters at that site greater than 95% (the benchmark being 90%). At Rosedale South, data capture was poor at around 41%-43% due to issues with the supply of power to the site after an upgrade to the station was undertaken in June-July. Further details are provided in the main part of this report.

Sulfur Dioxide

In 2017, the SEPP(AAQ) objectives for hourly average sulfur dioxide (SO_2) were met for 99.90% of the measurements at Jeeralang Hill and for all measurements at Rosedale South. The 24-hour and annual average objectives were met throughout the year at both stations.

There were five exceedences of the SEPP(AAQ) objective for hourly average SO_2 (200 ppb). At Jeeralang Hill (data capture 91.2%), there were six exceedences of the goal to achieve no more than one day of exceedences per year. The eight highest hourly average SO_2 concentrations at Jeeralang Hill occurred mostly during the night; they were: 16/1/17 22:00-23:00 (345 ppb); 28/1/17 23:00-24:00 (318 ppb); 22/12/17 23:00-24:00 (305 ppb); 13/12/17 04:00-05:00 (262 ppb); 13/1/17 3:00-4:00 (222 ppb); 5/10/17 0:00-1:00 (220 ppb); 4/10/17 0:00-1:00 (214 ppb); and 5/10/17 1:00-2:00 (209 ppb). These maxima tended to occur during easterly wind conditions, for a range of wind speeds up to approximately 4 m/s. These and other higher SO_2 concentrations were most likely due to plumes from coal fuelled power stations intercepting high ground in the Strzelecki Ranges, including at Jeeralang Hill.

The three highest hourly average SO_2 concentrations at Rosedale South (data capture 40.9%), occurred in the hours: 1/3/2017 12:00-13:00 (56 ppb); 8/1/17 16:00-17:00 (52 ppb); and 9/1/17 11:00-12:00 (44 ppb). The higher Rosedale South concentrations tended to occur during west-south-westerly winds, for a wide range of wind speeds.

The maximum 24-hour average SO_2 concentrations at Jeeralang Hill (37 ppb) and Rosedale South (11 ppb) were less than the SEPP(AAQ) objective of 80 ppb.

Annual average SO_2 concentrations at Jeeralang Hill (3.1 ppb) and Rosedale South (2.1 ppb), (calculated from hourly averages), were less than the SEPP(AAQ) objective of 20 ppb.

Comparisons of results: as expected, the Latrobe Valley's larger SO_2 sources; e.g., the brown coal-fuelled power stations, led to higher SO_2 concentrations at Jeeralang Hill. Plume strikes may occur at Jeeralang Hill on a few hours in a year. However, the SO_2 results for the floor of the Latrobe Valley are better, and comparable with those for Altona North located in an industrial area of Melbourne.

Nitrogen Dioxide

In 2017, oxides of nitrogen (NO_x) measurements including nitrogen dioxide (NO_2) were undertaken at Jeeralang Hill and Rosedale South; NO_2 is the only NO_x component with air quality standards. There were no recorded exceedences of the SEPP(AAQ) objective for maximum hourly average nitrogen dioxide (NO_2, 120 ppb), at the two sites.

At Jeeralang Hill, the median hourly average NO_2 concentration was 0.7 ppb. The highest hourly average NO_2 concentration was 36 ppb (data capture 94.7%).

At Rosedale South, the median hourly average NO_2 concentration was 2.1 ppb, the highest hourly average NO_2 concentration recorded was 20 ppb (data capture 40.9%).

Comparisons of results: Concentrations of NO_2 measured by the EPA in the Melbourne Airshed were, as expected, higher than measured NO_2 concentrations in the Latrobe Valley in 2017. The primary reason for this is assumed to be the higher amounts of NO_x emitted from Melbourne's road traffic.

Further analysis of the NO_x data from the LVAMN stations was undertaken by investigating the ratios between the NO_2 and NO_x concentrations (NO_2/NO_x). Lower values of NO_2/NO_x can be indicative of local NO_x sources in cases where some NO has had insufficient time to convert to NO_2. The data showed that as NO concentrations increased the NO_2/NO_x ratios decreased, typical of NO_x emissions from road vehicle traffic for example. The median NO_2/NO_x ratios were approximately 33% at Jeeralang Hill and 38% at Rosedale South, for NO concentrations greater than 20 ppb. There was an upwards trend in NO_2/NO_x as NO concentrations decreased, indicative of NO_x that had been in the atmosphere for longer periods allowing more time for NO_2 to form from NO.

Ozone

In 2017, there were no recorded exceedences of the SEPP(AAQ) objectives for maximum hourly average ozone (100 ppb) and maximum 4-hourly average ozone (80 ppb), at the two sites.

At Jeeralang Hill, the median one-hour average O_3 concentration was 26 ppb. The highest hourly average O_3 concentration was 65 ppb (data capture 93.9%), and highest 4-hour O_3 concentration 66 ppb (data capture 98.7%).

At Rosedale South, the median one-hour average O_3 concentration was 17 ppb. The highest hourly average O_3 concentration was 70 ppb (data capture 41.0%), and highest 4-hour concentration 64 ppb (data capture 42.8%).

Comparisons of results: Unfortunately, in 2017 there were no O_3 monitoring stations in the Melbourne Airshed with data capture greater than 50%. Comparisons of the available data indicated that O_3 levels on the floor of the Latrobe Valley were comparable with, or slightly better than, those of Melbourne. O_3 is elevated at the LVAMN monitoring station Jeeralang Hill. Some further explanation is provided in the next paragraph.

Photochemistry

Further analysis of the NO_x and O_3 results for both LVAMN sites show the familiar pattern of higher O_3 levels being associated with smaller NO_x concentrations, and vice versa. This is a photochemical effect where O_3 is formed in the presence of ultraviolet radiation in sunlight. In the Latrobe Valley, likely sources of higher O_3 levels during the summer months were bushfires and emissions from road vehicle traffic, and in 2017, controlled burning and road vehicle traffic in March and April. Levels of O_3 were low during the winter months.

Particulate Matter

Variations to the *State Environment Protection Policy (Ambient Air Quality)*, referred to as the 'SEPP(AAQ)', were declared in the *Victoria Government Gazette G 30 28 July 2016*. The variations included new objectives for particulate matter measured as 'PM_{10}' and $PM_{2.5}$' (see Glossary for definitions). LVAMN PM_{10} data were collected throughout 2017.

In 2017, the very good correlation between the PM_{10} measurements at Jeeralang Hill and Rosedale South – located 31 kilometres apart and 430 metres apart in elevation – indicated that for the majority of days, the PM_{10} was due to regional influences rather than local sources. There were similar findings in previous years; e.g., Jacobs, 2017; Jacobs, 2018.

The SEPP(AAQ) 24-hour average objective for PM_{10} (50 µg/m^3), was met for the 358 daily averages obtained at Jeeralang Hill except one day (52 µg/m^3 on 7th April), and for all of the 154 daily averages obtained at Rosedale South. It is likely this high PM_{10} level was associated with smoke from controlled burns that commenced in early April near Glengarry and Boolarra (DELWP, 2017).

The SEPP(AAQ) annual average objective for PM_{10} (20 µg/m^3), was met at both monitoring stations. The annual averages were: 8.8 µg/m^3 (Jeeralang Hill); and 12.9 µg/m^3 (Rosedale South).

Data capture rates for hourly average PM_{10} were: 95.9% (Jeeralang Hill), and 42.5% (Rosedale South).

Comparisons of results: Particulate matter concentrations were found to be higher in Melbourne than in the Latrobe Valley, even considering the potential for plume strikes at Jeeralang Hill and the Latrobe Valley's large, open-cut coal mines. Higher particulate matter levels in Melbourne would be due in part at least to road traffic emissions. Other potential sources of particulate matter that would affect Melbourne more than the Latrobe Valley would include: raised dust from dry, exposed areas in western and northern Victoria, and 'secondary' (chemically formed) particle formation in smog.

Local Visual Distance (Rosedale South)

In 2017, in situ nephelometer measurements of the atmospheric scattering coefficient (B_{sca}) were obtained at Rosedale South. Results for B_{sca} were used to calculate Local Visual Distance (LVD) in accordance with a Victorian Government procedure set out in the *State Environment Protection Policy, The Air Environment* (VG, 1982). According to the Rosedale South measurements and calculations, the visibility minimum of 20 km was exceeded for a total of 24 hours on 7 days, in 2017. Therefore, there were four exceedences of the goal of three allowable exceedence days. Overall, the visibility results for Rosedale South were excellent, being deemed acceptable for 99.7% of the hourly measurements obtained in 2017.

Summary of LVAMN Results

A summary of results for each of the air pollutants and objectives with respect to the SEPP(AAQ) ambient air quality standards and goals is set out in the table below. In the right-hand columns of the table, results are provided for maximum concentrations (ppb) and exceedences of the goals for exceedences [days per year], for Jeeralang Hill and Rosedale South.

Indicator	**Statistic & averaging period**	**Objective**	**Goal (Exceedence)**	**Jeeralang Hill [Exceedences of Goal]**	**Rosedale South [Exceedences of Goal] ***
SO_2	Max. 1 hour	200 ppb	1 day/year	345 ppb [6]	56 ppb [0]
	Max. daily	80 ppb	1 day/year	37 ppb [0]	11 ppb [0]
	Annual	20 ppb	None	3.1 ppb [0]	2.1 ppb [0]
O_3	Max. 1 hour	100 ppb	1 day/year	65 ppb [0]	70 ppb [0]
	Max. 4 hour	80 ppb	1 day/year	61 ppb [0]	64 ppb [0]
NO_2	Max. 1 hour	120 ppb	1 day/year	36 ppb [0]	20 ppb [0]
	Annual	30 ppb	None	1.6 ppb [0]	2.6 ppb [0]
Particles as PM_{10}	Max. 24 hour	50 µg/m^3	None	52 µg/m^3 [1]	38 µg/m^3 [0]
	Annual (new)	20 µg/m^3	None	8.8 µg/m^3 [0]	12.9 µg/m^3 [0]
Local Visual Distance	Minimum 1 hour	20 km	3 days/year	N/A	13.4km [3 days]

* Note data capture for Rosedale South was less than 50% for all parameters in 2017.

Regional Air Quality Comparison: Latrobe Valley vs. Melbourne/Geelong

Key LVAMN and EPA air quality monitoring results from the Latrobe Valley were compared with corresponding EPA data for parts of Melbourne and Geelong, to place the Latrobe Valley's 2017 air quality situation in context. In general, in comparison with Melbourne and Geelong, air quality in the Latrobe Valley was found to be relatively good due to the lower concentrations of PM_{10} and NO_2.

As expected, the Latrobe Valley's larger SO_2 sources lead to higher SO_2 concentrations. The SO_2 results for the Latrobe Valley floor are reasonably good, with Traralgon comparable to Altona North. Ozone levels in the Latrobe Valley's urban areas are comparable with Melbourne and Geelong.

Important note about your report

The sole purpose of this report and the associated services performed by Jacobs is to provide data interpretation for Ecotech's 2017 Jeeralang Hill and Rosedale South air quality monitoring data in accordance with the scope of services set out in the contract between Jacobs and the Client. That scope of services, as described in this report, was developed with the Client.

In preparing this report, Jacobs has relied upon, and presumed accurate, any information (or confirmation of the absence thereof) provided by the Client and/or from other sources. Except as otherwise stated in the report, Jacobs has not attempted to verify the accuracy or completeness of any such information. If the information is subsequently determined to be false, inaccurate or incomplete then it is possible that our observations and conclusions as expressed in this report may change.

Jacobs derived the data in this report from information sourced from the Client (if any) and/or available in the public domain at the time or times outlined in this report. The passage of time, manifestation of latent conditions or impacts of future events may require further examination of the project and subsequent data analysis, and re-evaluation of the data, findings, observations and conclusions expressed in this report. Jacobs has prepared this report in accordance with the usual care and thoroughness of the consulting profession, for the sole purpose described above and by reference to applicable standards, guidelines, procedures and practices at the date of issue of this report. For the reasons outlined above, however, no other warranty or guarantee, whether expressed or implied, is made as to the data, observations and findings expressed in this report, to the extent permitted by law.

This report should be read in full and no excerpts are to be taken as representative of the findings. No responsibility is accepted by Jacobs for use of any part of this report in any other context.

Some of the 2017 Jeeralang Hill and Rosedale South data were invalidated by Ecotech and the causes were detailed in Ecotech's 2017 reports. Any further data removed from the analysis by Jacobs are described in this report. An assumption for this report was that all the reports and data provided by Ecotech were of sufficient accuracy for the purpose of data interpretation.

This report has been prepared on behalf of, and for the exclusive use of, Jacobs's Client, and is subject to, and issued in accordance with, the provisions of the contract between Jacobs and the Client. Jacobs accepts no liability or responsibility whatsoever for, or in respect of, any use of, or reliance upon, this report by any third party.

1. Introduction

The Latrobe Valley Air Monitoring Network Incorporated (LVAMN) has undertaken ambient air quality monitoring in the Latrobe Valley since the 1980s; e.g., see CSIRO (1989). Aurecon (2012) reviews some statistics for monitoring data acquired over 1980–2011. The LVAMN produces annual summary reports with the 2007-2016 summaries available on-line (LVAMN, 2018); the two most recent examples being Jacobs (2017) and Jacobs (2018).

In 2012 Ecotech Pty Ltd (Ecotech) was commissioned by LVAMN to provide monitoring and data reporting for the LVAMN stations Jeeralang Hill and Rosedale South. The Ecotech monitoring station locations for calendar year 2017 were unchanged from 2016 (Jacobs, 2018) and included:

- Jeeralang Hill, a rural site in the Strzelecki Ranges approximately 11 km southeast of Hazelwood Power Station and 13.5 km southwest of Loy Yang Power Stations.
- Rosedale South, a rural site south of the town of Rosedale approximately 5 km south of the Rosedale township and 19 km east-north-east of Loy Yang Power Stations.

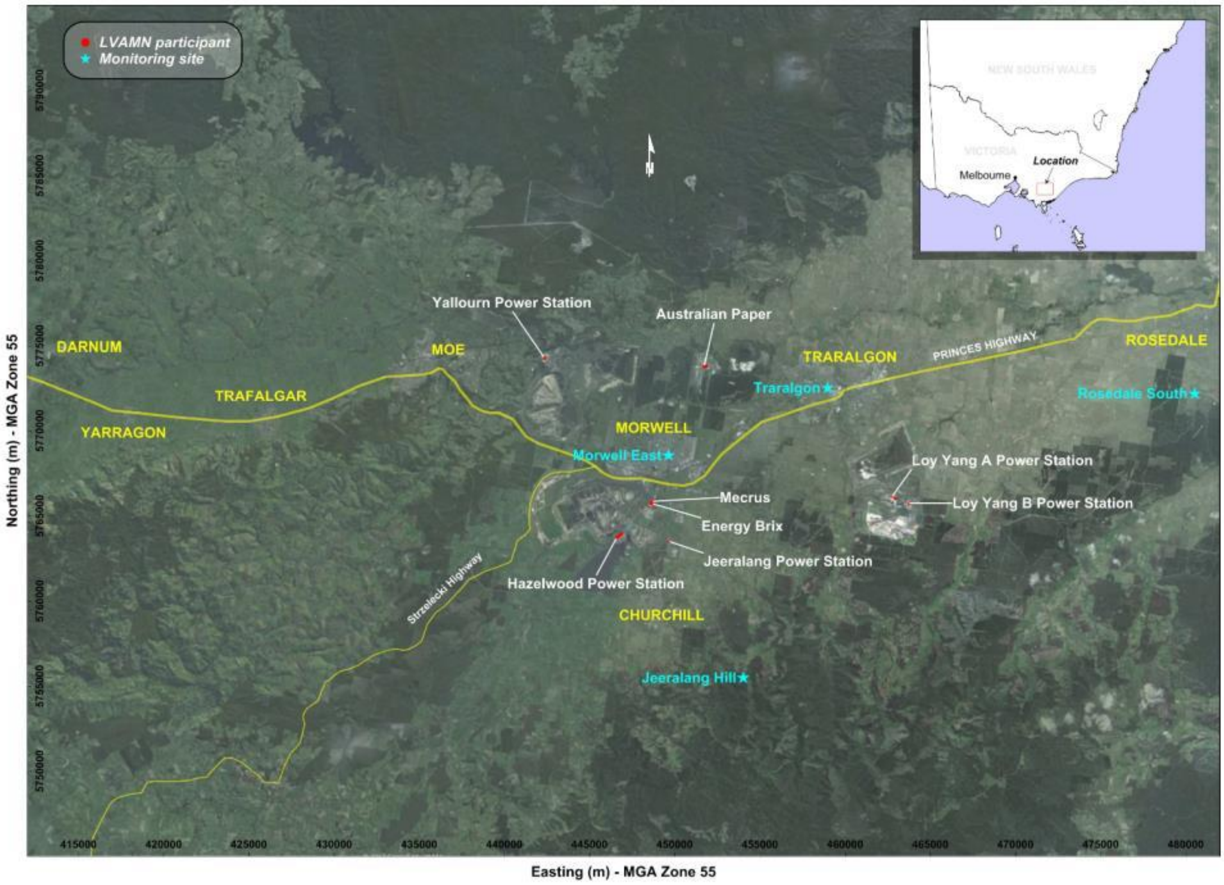
In 2017, data capture for Rosedale South was less than 50% for all measurement parameters (Ecotech was not at fault), and a brief explanation follows. LVAMN directed Ecotech to replace the air monitoring shelter at Rosedale South in June, 2017. Power was disconnected and the shelter removed in July. Re-connection of supply cables to a new shelter was completed in August. However, further delays to recommissioning were experienced over several months due to multiple problems associated with the supply of power to the site. The new power connection to the site was completed on 13th April, 2018 (LVAMN communication, 24th April, 2018).

A map of the Latrobe Valley is provided in **Figure 1-1** showing the locations of towns and the larger industrial facilities; i.e. those of the LVAMN participants. Snowy Hydro's Valley Power Station is a 'peaker plant' gas turbine power station, and located adjacent and east of the Loy Yang B Power Station. (Snowy Hydro is not a member of LVAMN).

It is noted the Hazelwood Power Station ceased operations on 31st March, 2017 (Engie, 2018). Therefore, emissions from that station could not have affected the air quality monitoring data described in this report from April 2017. Also it is noted the Morwell Power Station ceased operations on 8th September, 2014, and the adjacent briquette factory closed in August 2014 (EBAC, 2018).

The two LVAMN monitoring locations, Jeeralang Hill and Rosedale South, are shown plotted in **Figure 1-1**. Also shown are the Traralgon and Morwell East stations, operated by Victoria's Environment Protection Authority (EPA). The data from the EPA stations were compared with the LVAMN data for this report. The LVAMN and EPA stations are used for collecting information on air quality and meteorological conditions. The analysis of data acquired over many years from all these monitoring stations enables conclusions to be drawn about whether certain aspects of Latrobe Valley's air quality are worsening, or improving, over the longer term.

Figure 1-1 Latrobe Valley, LVAMN and EPA Air Monitoring Locations



1.1 Ecotech Monthly Reports

The monthly air monitoring reports for 2017 are detailed in the series of reports; Ecotech (2017a–2017k) and Ecotech (2018a). The reports include details such as:

- Monitoring equipment, methods, and measured parameters.
- Data collection methods and compliance with monitoring standards.
- Data capture rates and key statistics for the measurement parameters.
- Recording of measured exceedences of ambient air quality standards and levels.

1.2 Purpose of this Report

The purpose of this report was to interpret the 2017 ambient air monitoring data from the Ecotech-operated LVAMN sites, Jeeralang Hill and Rosedale South; this included comparisons with Victoria's air quality objectives and goals.

The Ecotech measurement parameters reviewed for this report focus on the air pollutants for which objectives and goals are listed in the Victoria Government (VG) *State Environment Protection Policy (Ambient Air Quality)* or 'SEPP(AAQ)' (VG, 1999); i.e., sulfur dioxide (SO_2); nitrogen dioxide (NO_2); ozone (O_3); particulate matter comprising particles with aerodynamic diameters less than 10 microns (µm) in size (PM_{10}); and visibility reducing particles measured as Local Visual Distance (LVD).

The *State Environment Protection Policy (Air Quality Management)* or 'SEPP(AQM)' (VG, 2001), varied the SEPP(AAQ) by removing the 8-hour average standards for O_3.

VG (2016) sets out a variation to the SEPP(AAQ) introducing new air quality objectives for PM_{10} and $PM_{2.5}$ (for definitions see Section 1.3); these new objectives were applied in this annual summary.

Victoria's ambient air quality standards are set out in more detail in **Section 2**.

1.3 Abbreviations & Definitions

Abbreviation	Definition
AQI	Air Quality Index
CO	Molecular formula for carbon monoxide
CPF	Conditional Probability Function
DELWP	Department of Environment, Land, Water and Planning (Victoria)
EPA	Environment Protection Authority (Victoria)
LVAMN	Latrobe Valley Air Monitoring Network
µm	micron (thousandth of a millimetre)
NEPC	National Environment Protection Council
NEPM	*National Environment Protection (Ambient Air Quality) Measure*
NO	Molecular formula for nitric oxide
NO_2	Molecular formula for nitrogen dioxide
NO_x	Oxides of nitrogen
O_3	Molecular formula for ozone
$PM_{2.5}$	Particulate Matter 2.5; particulate matter comprising particles with aerodynamic diameters less than 2.5 microns (µm) in size
PM_{10}	Particulate Matter 10; particulate matter comprising particles with aerodynamic diameters less than 10 microns (µm) in size
SEPP(AAQ)	*State Environment Protection Policy (Ambient Air Quality)* (VG, 1999; VG, 2016)
SEPP(AQM)	*State Environment Protection Policy (Air Quality Management)* (VG, 2001)
SO_2	Molecular formula for sulfur dioxide
USEPA	United States Environmental Protection Agency
VG	Victoria Government

2. Objectives and Goals

2.1 SEPP(AAQ) Objectives and Goals

A purpose of the SEPP(AAQ) was to adopt National Environment Protection Council (NEPC) objectives and goals set out in the *National Environment Protection (Ambient Air Quality) Measure* (NEPM) (NEPC, 2003). The SEPP(AAQ) (1999) objectives and goals that were used to review the air quality monitoring data for this report are listed in **Table 2-1**; minus the 8-hour average O_3 standards, in accordance with the SEPP(AQM).

Table 2-1 SEPP(AAQ) 1999 Objectives and Goals

Environmental Indicator	Averaging Period	Objective	Goal (exceedences)*
NO_2 (maximum conc.)	1 hour	120 ppb	1 day/year
	1 year	30 ppb	None
O_3 (maximum conc.)	1 hour	100 ppb	1 day/year
	4 hours#	80 ppb	1 day/year
SO_2 (maximum conc.)	1 hour	200 ppb	1 day/year
	1 day	80 ppb	1 day/year
	1 year	20 ppb	None
Particles as PM_{10}	1 day	50 µg/m^3	5 days/year
Visibility reducing particles (minimum visual distance)	1 hour	20 km	3 days/year

*Goals are maximum allowable exceedences of objective.
#Rolling 4-hour average based on 1 hour averages.
"Day" and "Year" mean “calendar day” and “calendar year”.

2.2 Variation to SEPP(AAQ) 28 July 2016

The national NEPM was updated in 2016 with new standards for particles (NEPC, 2016). Subsequently the Victorian Government issued a 28 July 2016 variation to the SEPP(AAQ) including new standards for particles, and further 2025 objectives for $PM_{2.5}$ (VG, 2016); these are listed in **Table 2-2**.

Table 2-2 SEPP(AAQ) 2016 Objectives for Particles and 2025 Objectives for $PM_{2.5}$

Environmental Indicator	Averaging Period	Objective	Goal (exceedences)*
Particles as PM_{10}	1 day	50 µg/m^3	Nil
	Annual	20 µg/m^3	Nil
Particles as $PM_{2.5}$	1 day	25 µg/m^3	Nil
	Annual	8 µg/m^3	Nil
Particles as $PM_{2.5}$ – goals by 2025	1 day	20 µg/m^3	Nil
	Annual	7 µg/m^3	Nil

3. Measured Parameters

3.1 Overview

This section describes the air pollution parameters measured by the LVAMN in 2017.

3.2 Sulfur Dioxide

The most significant sources of sulfur dioxide (SO_2) emissions in the Latrobe Valley are the brown coal-fuelled power stations, and the Maryvale Paper Mill. As a result, the highest SO_2 concentrations detected at the LVAMN monitoring stations can be attributed to, primarily, SO_2 emissions from these sources; their locations were plotted in **Figure 1-1**.

3.3 Oxides of Nitrogen

Oxides of nitrogen (NO_x) emissions are produced by the burning of fuels; e.g., by road vehicle fleets associated with cities and larger towns, bushfires and planned burns, and power stations. On combustion, usually NO_x comprises mostly nitric oxide (NO), and smaller amounts of NO_2. In the atmosphere, NO may be oxidised to NO_2 by the reaction with ozone (O_3): $O_3 + NO \rightarrow NO_2 + O_2$; after oxidation has occurred, for some situations, most of the atmospheric NO_x comprises NO_2.

3.4 Ozone

A significant source of ozone (O_3) in the lower atmosphere is the photolysis of NO_2 in sunlight involving ultraviolet photons (hn) with wavelengths less than 424 nanometres, described by the following (simplified) pair of reactions:

$$NO_2 + hn \rightarrow NO + O \qquad (1)$$

$$O + O_2 \rightarrow O_3 \qquad (2)$$

Other pollutants such as carbon monoxide and hydrocarbons are involved in O_3 production; e.g., Seinfeld and Pandis (2016). Therefore, an understanding of the precursor pollutants and their sources is required to understand O_3 levels. In the Latrobe Valley, local sources of NO_x and hydrocarbons associated with O_3 production include road vehicle traffic, power stations, and bushfires and controlled burns; e.g., see EPA (2007); EPA (2016).

It is noted forests are a ‘natural’ source of hydrocarbons; e.g., eucalyptus trees emit isoprene, which is involved in O_3 production (Emmerson et al., 2016).

Also, modelling by Azzi et al. (2014) has shown that on some occasions Melbourne’s air pollutants can be transported by winds into the Latrobe Valley, which would affect O_3 production in the Latrobe Valley.

3.5 Particulate Matter

Potential sources of small airborne particles measured as Particulate Matter 10 (PM_{10}) and Particulate Matter 2.5 ($PM_{2.5}$) in the Latrobe Valley include: controlled burning and bushfires; open cut coal mining; power stations; wheel generated dust on unpaved roads; domestic wood heaters and open fireplaces, road vehicle traffic (locomotives would be a minor source), and other industries. Occasionally measurements of PM_{10} and $PM_{2.5}$ in the Latrobe Valley would include significant components transported from well outside the region such as particles from air pollution sources in Melbourne, raised dust from regional areas, and sea salt aerosols from Bass Strait and beyond.

3.6 Local Visual Distance

Air pollution can affect amenity by forming a visibility-reducing haze, caused by light scattering by small particles in the atmosphere (aerosols). Aerosols is another term for airborne particulate matter, and the sources are the same; e.g., open cut coal mining; domestic wood heaters and open fireplaces; and planned burns and bushfires. In humid conditions, fog and mist also reduce visibility – in this case hygroscopic ('water loving') aerosols grow due to the condensation of water vapour on particle surfaces. Particle sizes of approximately 1-10 microns are significant with respect to light scattering, thereby affecting visibility.

The SEPP(AAQ) sets out an objective for minimum visibility of 20 km. In Victoria, compliance with the visibility objective is determined by nephelometer measurements of light scattering properties of ambient air, conditioned to a relative humidity of 70%. The *Victorian Government Gazette No. 120* (VG, 1982), sets out the following equation for determination of the Local Visual Distance (LVD) from a nephelometer-measured parameter:

$$\text{LVD} = 47 \times (10{,}000 \times B_{sca})^{-1},$$

where B_{sca} is the atmospheric light scattering coefficient (units m^{-1}), measured by an integrating nephelometer. For example, using a scattering coefficient of 4.7×10^{-5} m^{-1}, the calculated LVD is 100 km.

The Ecotech results for LVD were calculated from measurements of B_{sca} by an Aurora 1000 Nephelometer at the Rosedale South monitoring station; e.g., see Ecotech (2017a).

4. Ecotech LVAMN Operations 2017

4.1 Overview

This section sets out the results of the interpretation of measurements of air pollutants and meteorological parameters undertaken at Jeeralang Hill and Rosedale South in 2017. Some of the monitoring data were invalidated by Ecotech due to a variety of non-compliances, and the causes were detailed in the Ecotech monthly reports. Further details about equipment, specifications and data capture may be found in the monthly reports Ecotech (2017a) through to Ecotech (2017k), and Ecotech (2018a).

In 2017, at Jeeralang Hill a new Beta Attenuation Method (BAM) $PM_{2.5}$ monitor was commissioned on 3rd May, and a new shelter was commissioned in April (Ecotech, 2017e).

The Rosedale South monitoring station was decommissioned for an upgrade on 6th June, 2017. The LVAMN acquired no data at Rosedale South after that date (Ecotech, 2017f; Ecotech, 2018b).

4.2 Ecotech LVAMN Data Capture for In Situ Measurements

A statistical summary of most of the hourly average data for the air pollutants and wind parameters measured at Jeeralang Hill for 2017 is provided in **Table 4-1**, and similarly for Rosedale South in **Table 4-2**.

Table 4-1 Summary of Jeeralang Hill Monitoring Data for 2017 (Hourly Averages)

Parameter (units)	No. Hourly Average Records	Data Capture 2017 (1h avg.)
SO_2 (ppb)	7992	91.2%
NO (ppb)	8293	94.7%
NO_2 (ppb)	8293	94.7%
NO_x (ppb)	8293	94.7%
O_3 (ppb)	8230	93.9%
PM_{10} (µg/m^3)	8405	95.9%
$PM_{2.5}$ (µg/m^3)	5341	61.0%
WS_a (m/s)	8666	98.9%
WD_b (deg)	8666	98.9%
$\sigma\theta_c$ (deg)	8666	98.9%

a. Wind Speed; b. Wind Direction; c. Sigma-theta, or standard deviation of the horizontal wind direction.

Table 4-2 Summary of Rosedale South* Monitoring Data for 2017 (Hourly Averages)

Parameter (units)	No. Hourly average records	Data Capture 2017 (1h avg.)
SO_2 (ppb)	3586	40.9%
NO (ppb)	3581	40.9%
NO_2 (ppb)	3581	40.9%
NO_x (ppb)	3581	40.9%
O_3 (ppb)	3589	41.0%
PM_{10} (µg/m^3)	3722	42.5%
WS_a (m/s)	3747	42.8%
WD_b (deg)	3747	42.8%
$\sigma\theta_c$ (deg)	3747	42.8%

Parameter (units)	No. Hourly average records	Data Capture 2017 (1h avg.)
LVD_d (km)	3704	42.3%

a. Wind Speed; b. Wind Direction; c. Sigma-theta, or standard deviation of the horizontal wind direction; d. Local Visual Distance

* Rosedale South decommissioned for upgrade on 6th June, 2017.

Wind roses created from the wind speed and direction data for 2017 are provided in **Appendix C.1** (Jeeralang Hill), and **Appendix C.2** (Rosedale South–no wind data after 6th June). The wind patterns for 2017 were similar to those reported for 2016 (Jacobs, 2018).

In summary, at Jeeralang Hill, light south-westerly winds are dominant throughout most of the year. Stronger easterly winds are dominant in the summer months and to a lesser extent in autumn. At Rosedale South, south-south westerly winds are dominant throughout the year, with lighter easterly winds having more of an influence in the summer months (Jacobs, 2018).

5. LVAMN Results 2017

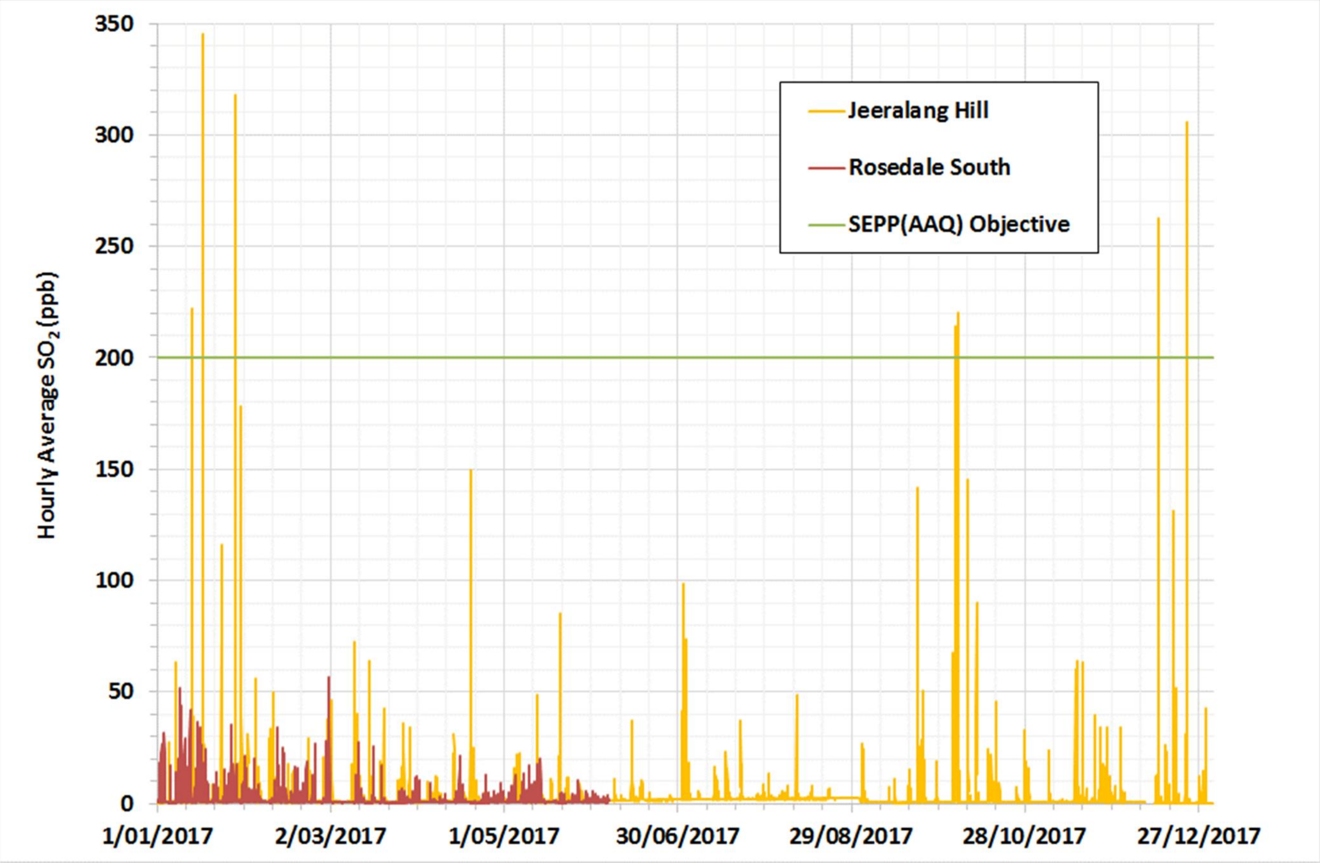
5.1 Overview

This section provides the results of data interpretation for the LVAMN air monitoring data acquired in 2017 at the air monitoring stations Jeeralang Hill and Rosedale South. Ecotech's reported 1-hour and 24-hour averages were based on a minimum of 80% valid readings within the averaging period. The same fraction was adopted for the calculations undertaken for this report. Comparisons are provided with EPA 2017 data from the Latrobe Valley and Melbourne.

5.2 Sulfur dioxide

The LVAMN 2017 results for hourly average SO_2 concentrations (ppb) measured at Jeeralang Hill and Rosedale South are provided in **Figure 5-1**.

Figure 5-1 LVAMN Results for Hourly Average SO_2 Concentration (ppb)



A summary of results of the analysis of the hourly average SO_2 concentrations acquired from Jeeralang Hill in 2017 is set out in **Table 5-1**. Daily averages were calculated for days where 80% of hourly average data were available for that day.

Table 5-1 Summary of Results: Jeeralang Hill SO_2 Concentrations 2017

Parameter	Hourly Averages	Daily Averages	Annual Average
Number of records	7992	324	1
Total records possible	8760	365	1
Data capture	91.2%	88.8%	100%

Parameter	Hourly Averages	Daily Averages	Annual Average
Median	1.2 ppb	1.8 ppb	–
Annual average	3.1 ppb	3.1 ppb (avg. of 24h avgs.)	3.1 ppb
70th percentile	2.0 ppb	2.7 ppb	–
Maximum	345 ppb	37 ppb	–
SEPP(AAQ) Objective	200 ppb	80 ppb	20 ppb
Percentage of time Objective met (of measured data)	99.90%	100%	100%
Exceedences of Objective	8 hours on 7 days	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	Exc. 1 day/year	No exceedences
Exceedences of Goal	6 days	0	0

The eight highest hourly-average SO_2 concentrations at Jeeralang Hill occurred during night hours: 16/1/17 22:00-23:00 (345 ppb); 28/1/17 23:00-24:00 (318 ppb); 22/12/17 23:00-24:00 (305 ppb); 13/12/17 04:00-05:00 (262 ppb); 13/1/17 3:00-4:00 (222 ppb); 5/10/17 0:00-1:00 (220 ppb); 4/10/17 0:00-1:00 (214 ppb); and 5/10/17 1:00-2:00 (209 ppb). Typically, these higher concentrations occurred during easterly wind conditions with wind speeds in the range 3–4 m/s. These were most likely due to plumes from the Loy Yang power stations intercepting high ground in the Strzelecki Ranges, including at Jeeralang Hill.

A summary of results of the analysis of the hourly average SO_2 concentrations acquired at Rosedale South in 2017 (results up to 6th June only), is set out in **Table 5-2**.

Table 5-2 Summary of Results: Rosedale South SO_2 Concentrations 2017 to 6th June

Parameter	Hourly Averages	Daily Averages	Annual Average
Number of records	3586	155	1
Total records possible	8760	365	1
Data capture	40.9%	42.5%	100%
Median	0.7 ppb	1.3 ppb	–
Annual average	2.1 ppb	2.1 ppb (avg. of 24h avgs.)	2.1 ppb
70th percentile	1.1 ppb	2.1 ppb	–
Maximum	56 ppb	11 ppb	–
SEPP(AAQ) Objective	200 ppb	80 ppb	20 ppb
Percentage of time Objective met (of measured data)	100%	100%	100%
Exceedences of Objective	0	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	Exc. 1 day/year	No exceedences
Exceedences of Goal	0	0	0

The three highest hourly average SO_2 concentrations at Rosedale South occurred in the hours: 1/3/2017 12:00-13:00 (56 ppb); 8/1/17 16:00-17:00 (52 ppb); and 9/1/17 11:00-12:00 (44 ppb). The higher Rosedale South concentrations tended to occur during west-south-westerly wind conditions over a wide range of wind speeds; pointing to the coal-fuelled power stations and Maryvale paper mill as the probable SO_2 sources.

The LVAMN hourly SO_2 data are compared with EPA's results in **Table 5-3**. In general, (noting the differences in data capture), air quality with respect to SO_2 emissions is approximately the same for all locations on the valley floor: Morwell, Traralgon, and further east at Rosedale South.

Table 5-3 Comparisons of Hourly Average SO_2 Results 2017: LVAMN and EPA

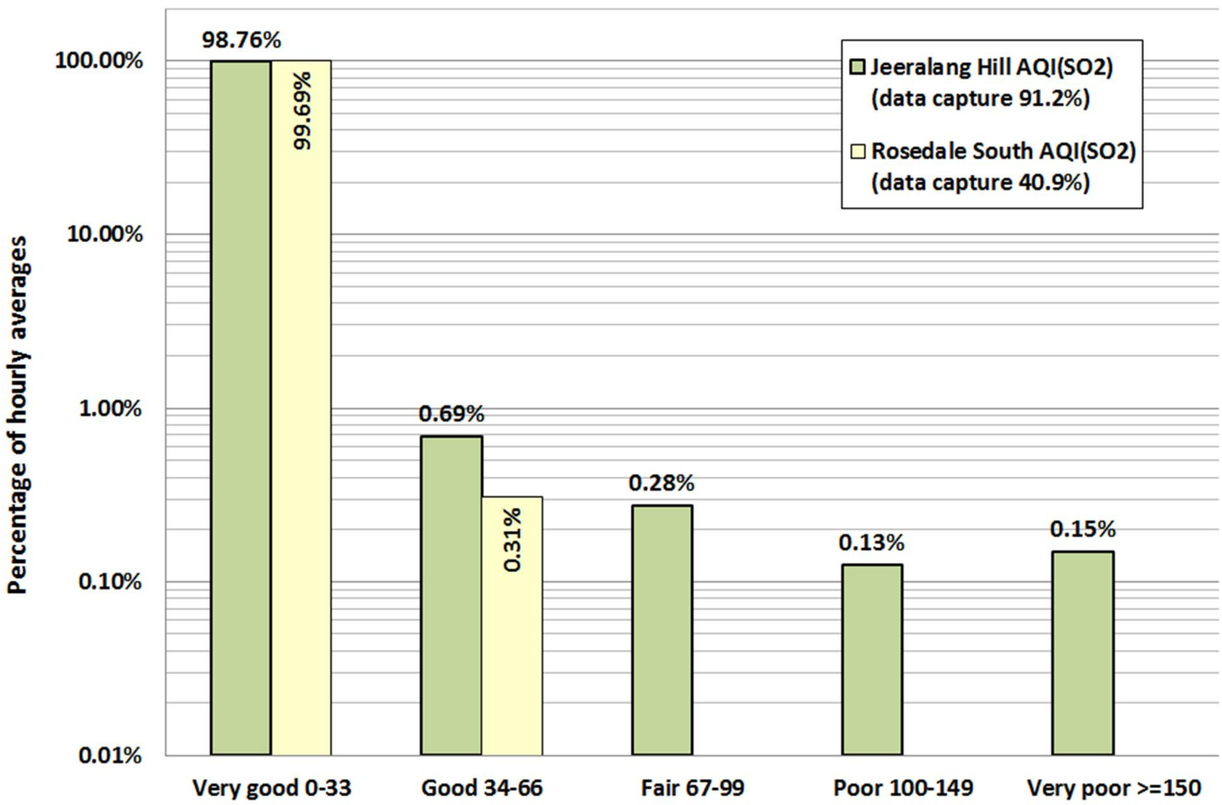
Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell East (EPA)	Morwell South (EPA)	Traralgon (EPA)
Data capture (hourly averages)	91.2%	40.9%	94.6%	93.8%	91.9%
Average (ppb)	3.1	2.1	0.5	0.6	1.0
Median (ppb)	1.2	0.7	0.2	0.3	0.4
70th percentile (ppb)	2.0	1.1	0.5	0.6	1.0
90th percentile (ppb)	3.8	4.5	1.2	1.1	2.4
99.9th percentile (ppb)	191.0	39.6	32.0	33.7	38.6
Maximum (ppb)	345	56	50.7	58.6	63.3

5.3 Air Quality Indices from LVAMN SO_2 Concentrations

Air Quality Indices (AQI) based on EPA procedures were calculated using the Jeeralang Hill and Rosedale South hourly average SO_2 data. The AQI is a concentration expressed as a percentage of the relevant air quality objective; in this case, maximum hourly average 200 ppb. The Jeeralang Hill and Rosedale South SO_2 results are provided as frequency distributions in **Figure 5-2** (logarithmic plots). Inspection of the figure clearly shows that air quality based on SO_2 levels at Jeeralang Hill and Rosedale South was very good for the majority of the time; i.e., more than 98% of the time for both locations.

As expected, Jeeralang Hill experienced the worst results for AQI using the hourly average SO_2 data, due to the proximity of the coal fuelled power stations, and its land elevation. The elevation of Jeeralang Hill is 510 metres above sea level; Rosedale South is 52 metres above sea level.

Figure 5-2 Frequency Distributions of Air Quality Indices as Logarithmic Plot – Hourly Average SO_2



5.4 Oxides of Nitrogen

Figure 5-3 provides the LVAMN 2017 results for hourly average nitrogen dioxide (NO_2) concentrations (ppb). There were no exceedences of the SEPP(AAQ) objective of 120 ppb for maximum hourly NO_2 concentration at Jeeralang Hill and Rosedale South (no data for Rosedale South after 6th June).

Figure 5-3 LVAMN Results for Hourly Average NO_2 Concentration (ppb)

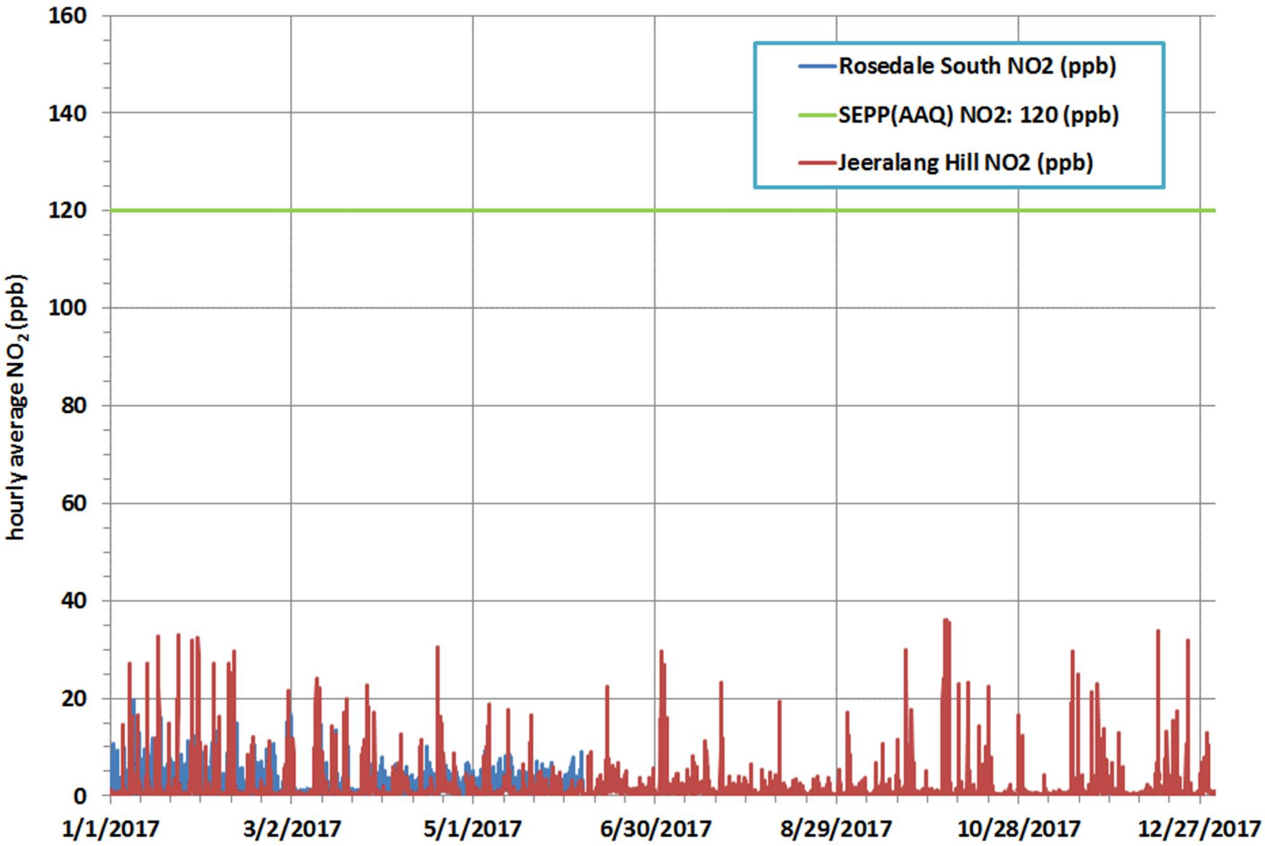


Table 5-4 sets out a summary of results of the analysis of the Jeeralang Hill hourly average NO_2 concentrations. There were no exceedences of the SEPP(AAQ) objectives and goals for NO_2.

Table 5-4 Summary of Results: Jeeralang Hill NO_2 Concentrations

Parameter	Hourly Averages	Annual Average
No. records	8293	1
Total possible	8760	1
Data capture	94.7%	100%
Median	0.7 ppb	–
Annual average	1.6 ppb	1.6 ppb
70th percentile	1.2 ppb	–
Maximum	36 ppb	–
SEPP(AAQ) Objective	120 ppb	30 ppb
Percentage of time Objective met	100%	100%
Exceedences of Objective	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	No exceedences

Parameter	Hourly Averages	Annual Average
Exceedences of Goal	0	0

A statistical summary for all the NO_x components measured at Jeeralang Hill is provided in **Table 5-5**.

Table 5-5 Statistical Summary for All NO_x Components – Jeeralang Hill

Air Pollutant	Median Conc. (ppb)	Average Conc. (ppb)	70^{th} Percentile Conc. (ppb)	Maximum Conc. (ppb)
NO	0.1	0.6	0.2	243
NO_2	0.7	1.6	1.2	36
NO_x	0.8	2.2	1.2	274

A summary of results of the analysis of the Rosedale South hourly average NO_2 concentrations is set out in **Table 5-6**. There were no exceedences of the SEPP(AAQ) objectives and goals for NO_2.

Table 5-6 Summary of Results: Rosedale South NO_2 Concentrations

Parameter	Hourly Averages	Annual Average
No. records	3581	1
Total possible	8760	1
Data capture	40.9%	Estimate using data to 6^{th} June only
Median	2.1 ppb	–
Annual average	2.6 ppb	2.6 ppb (estimate)
70^{th} percentile	3.1 ppb	–
Maximum	20 ppb	–
SEPP(AAQ) Objective	120 ppb	30 ppb
Percentage of time Objective met	100%	100%
Exceedences of Objective	0	0 (likely)
SEPP(AAQ) Goal	Exc. 1 day/year	No exceedences (likely)
Exceedences of Goal	0	0 (likely)

A statistical summary for all the NO_x components measured at Rosedale South is provided in **Table 5-7**.

Table 5-7 Statistical Summary for All NO_x Components – Rosedale South (data to 6^{th} June)

Air Pollutant	Median Conc. (ppb)	Average Conc. (ppb)	70^{th} Percentile Conc. (ppb)	Maximum Conc. (ppb)
NO	0.4	0.8	0.7	23
NO_2	2.1	2.6	3.1	20
NO_x	2.5	3.4	3.8	37

The LVAMN hourly NO_2 data are compared with EPA's results for Morwell South and Traralgon, in **Table 5-8**. Comparisons with the EPA data indicate that in general air quality effects due to NO_2 are slightly worse in the urban areas of Morwell and Traralgon than at Rosedale South ('background') and Jeeralang Hill (Strzelecki Ranges). The higher NO_2 concentrations in the urban areas are likely to be due to road vehicle traffic. The maximum NO_2 concentration at Jeeralang Hill (36 ppb) occurred at the same time as a high SO_2 concentration measured there (218 ppb), as such was very likely due to a plume strike from coal-fired power stations.

Table 5-8 Comparisons of Hourly Average NO_2 Results: LVAMN and EPA

Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell East (EPA)	Morwell South (EPA)	Traralgon (EPA)
Median	0.7 ppb	2.1 ppb	No data	4.0 ppb	4.8 ppb
70^{th} percentile	1.2 ppb	3.1 ppb	No data	6.2 ppb	7.4 ppb
Maximum	36 ppb	20 ppb	No data	31 ppb	34 ppb

5.5 Analysis of LVAMN NO_2/NO_x Ratios

Analysis of the NO_x data was undertaken by investigations of the ratios between the NO_2 and NO_x concentrations (NO_2/NO_x). Lower values of NO_2/NO_x can be indicative of local NO_x sources, in cases where the NO has generally had insufficient time to convert to NO_2.

A select few of the NO_x data were used in this analysis to remove large numerical errors associated with small measured quantities. Data were selected by the following steps: (1) Negative and zero results for NO_x concentrations were removed; (2) NO_2/NO_x ratios greater than unity and less than or equal to zero were removed; and (3) NO concentrations less than 1 ppb were removed. The results are listed in **Table 5-9**.

Table 5-9 Summary of Calculated NO_2/NO_x Ratios

NO Range (ppb)	Median NO_2/NO_x Ratio	No. Hourly Records	Percentage of Hourly Data Used for Ratio
Jeeralang Hill			
$1 \leq [NO] < 5$	74%	239	60%
$5 \leq [NO] < 10$	61%	62	16%
$10 \leq [NO] < 20$	57%	52	13%
$[NO] \geq 20$	33%	46	12%
Rosedale South			
$1 \leq [NO] < 5$	65%	724	86%
$5 \leq [NO] < 10$	51%	76	11%
$10 \leq [NO] < 20$	41%	25	3%
$[NO] \geq 20$	38%	1	0%

Inspection of the results listed in **Table 5-9** indicates that as the NO concentrations increase the NO_2/NO_x ratios decrease, as expected from the combustion of fossil fuels. The NO_2/NO_x ratios ranged between 12% and 25% for the nine NO concentrations greater than 100 ppb (all measured at Jeeralang Hill). There was an upwards trend in the NO_2/NO_x ratios as the NO concentrations decreased, indicative of NO_x that has been in the atmosphere for longer periods, allowing more time for NO_2 to form. These results for NO_2/NO_x are similar to those determined for 2015 (Jacobs, 2017); and 2016 (Jacobs, 2018).

5.6 Ozone

The LVAMN 2017 results for hourly average O_3 concentrations for Jeeralang Hill and Rosedale South are provided in **Figure 5-4**. The results are shown with the SEPP(AAQ) hourly average objective (100 ppb); all the hourly O_3 data were less than the objective. The peak O_3 concentrations during the summer were most likely due to emissions from fires and road vehicle traffic. A fuel reduction program conducted by the Department of Environment, Land, Water and Planning, and Parks (DELWP), comprising a number of controlled burns in various parts of Gippsland (DELWP, 2017), would have contributed to the higher O_3 concentrations in March and April 2017.

Summaries of results of the analysis of the hourly average O_3 concentrations are set out in **Table 5-10** (Jeeralang Hill); and **Table 5-11 (**Rosedale South).

Figure 5-4 Ecotech LVAMN Results for Hourly Average O_3 Concentration (ppb)

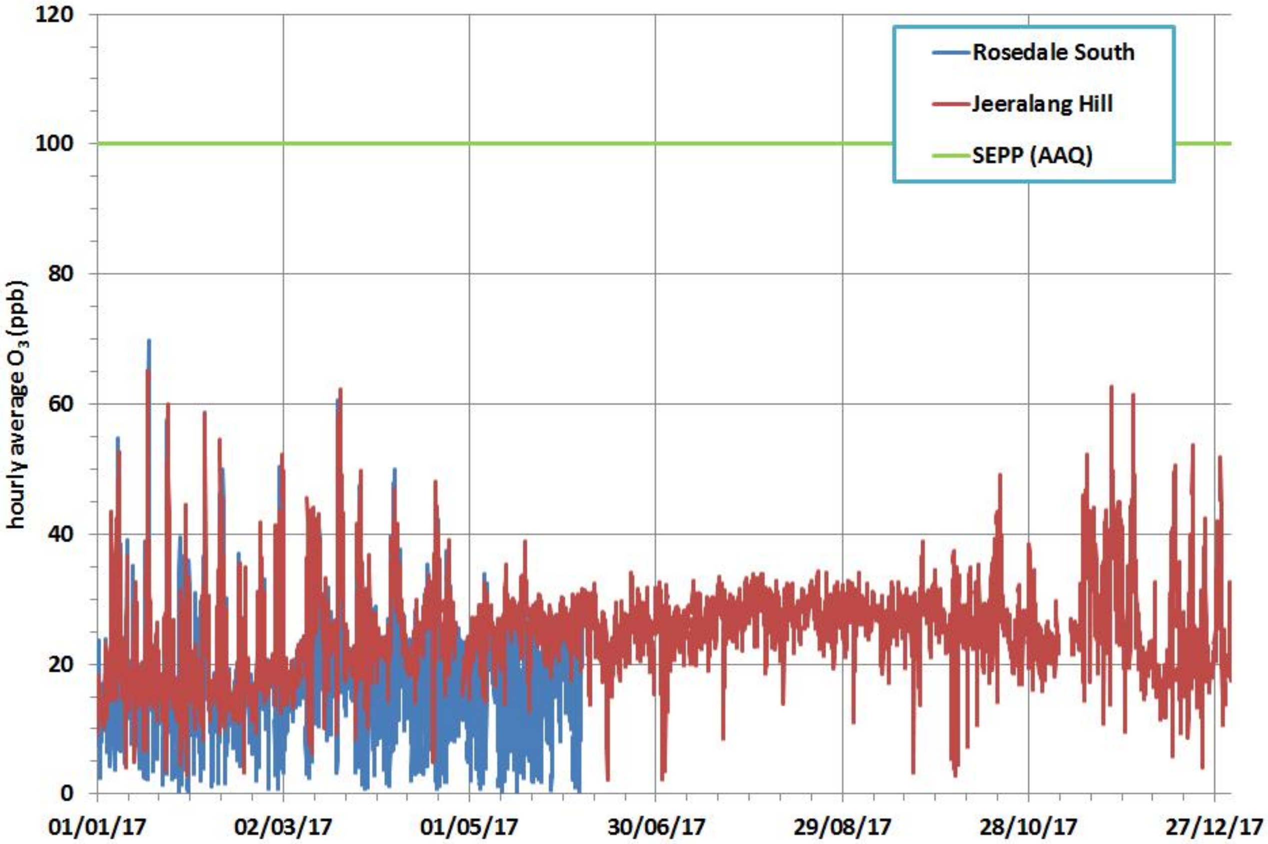


Table 5-10 Summary of Results: Jeeralang Hill O_3 Concentrations

Parameter (Jeeralang Hill)	1h Average	4h Rolling Average
No. records	8230	8532
Total possible	8760	8757
Data capture	93.9%	97.4%
Median (ppb)	26	26
Annual average (ppb)	26	24
70th percentile (ppb)	28	28
Maximum (ppb)	65	61
SEPP(AAQ) Objective (ppb)	100	80
Percentage of time Objective met	100%	100%
Exceedences of Objective	0	0
SEPP(AAQ) Goal	Exc. 1 day/year	Exc. 1 day/year
Exceedences of Goal	0	0

Note: VG (2001) varied VG (1999) by removing the 8-hour average objectives for O_3.

Table 5-11 Summary of Results: Rosedale South O_3 Concentrations

Parameter (Rosedale South)	1h Average	4h Rolling Average
No. records	3589	3744
Total possible	8760	8757

Parameter (Rosedale South)	1h Average	4h Rolling Average
Data capture	41.0%	42.8%
Median (ppb)	17	17
Annual average (ppb)	18	18
70th percentile (ppb)	22	21
Maximum (ppb)	70	64
SEPP(AAQ) Objective (ppb)	100	80
Percentage of time Objective met	0	0
Exceedences of Objective	Exc. 1 day/year	Exc. 1 day/year
SEPP(AAQ) Goal	0	0
Exceedences of Goal	0	0

Note: VG (2001) varied VG (1999) by removing the 8-hour average objectives for O_3.

The LVAMN hourly O_3 data are compared with EPA's results for Morwell South in **Table 5-12** (there were no O_3 data for Morwell East and Traralgon). The results indicate that air quality effects due to O_3 are slightly worse at Jeeralang Hill than on the valley floor. The reason for this may be NO_x emissions from road vehicle traffic having a quenching effect on O_3 in the urban areas (see **Section 3.4**).

Table 5-12 Comparisons of Hourly Average O_3 Results: LVAMN and EPA

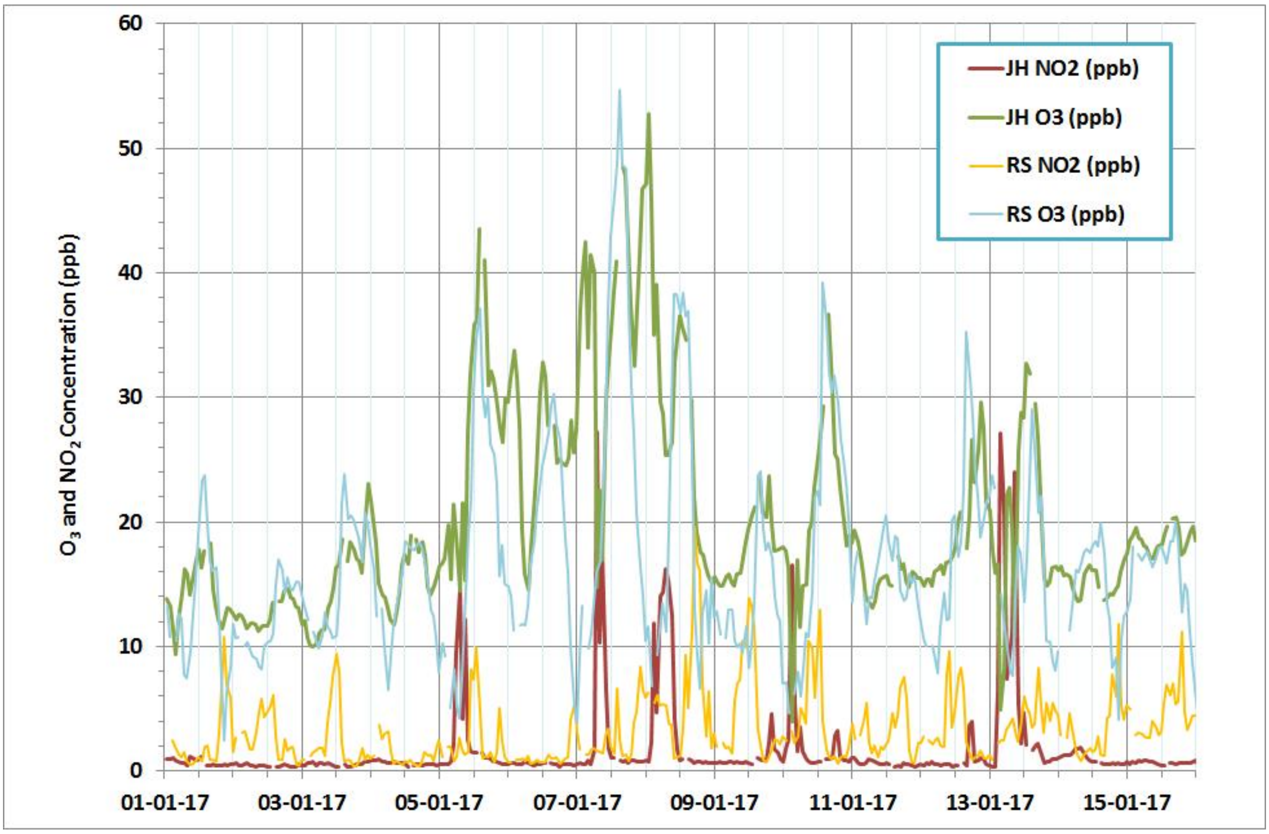
Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Morwell East (EPA)	Morwell South (EPA)	Traralgon (EPA)
Median	26	17	No data	17	No data
70th percentile	28	22	No data	21	No data
Maximum	65	70	No data	67	No data

5.7 Products of Photolysis – O_3 and NO_2

This section provides a sample of results for concurrent hourly average O_3 and NO_2 concentrations measured by the LVAMN. In general, there was clear evidence of photolysis occurring at Jeeralang Hill and Rosedale South (see **Section 3.3** and **Section 3.4**), with several well defined O_3 peaks occurring around midday during the summer. For example, the hourly average data for 11-25 January 2016 are shown in **Figure 5-5**.

In the example for January 2017 shown in **Figure 5-5**, the higher NO_2 concentrations that occurred earlier in the mornings, in the presence of sunlight, would have provided the oxygen needed for the formation of O_3. Spikes of NO_2 that occurred in the mornings, probably due to road vehicle traffic, reduced O_3 levels at those times. Also, emissions from fires would have contributed to O_3 peaks in the summer months and also during the controlled burning season from March to June (DELWP, 2017).

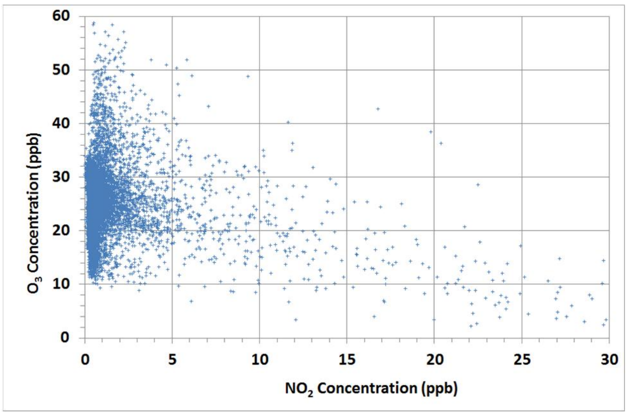
Figure 5-5 Example of O_3 and NO_2 Measurements at Jeeralang Hill and Rosedale South: 1/1/17–16/1/17

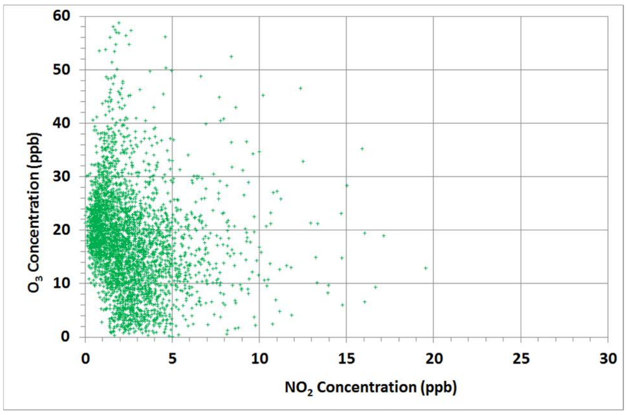


Note: Relevant SEPP (AAQ) Objectives are 100 ppb (O_3) and 120 ppb (NO_2).

Some of the O_3 concentrations measured at Jeeralang Hill and Rosedale South matched very well, which is indicative of the homogeneity of photochemical smog across the Latrobe Valley region at those times. The hourly average O_3 and NO_2 data pairs are shown in **Figure 5-6** as scatter plots for Jeeralang Hill (left), and Rosedale South (right). The plots show different relationships between the pollutants for the two sites. It is surmised that the lack of a constant supply of NO_x from road vehicle emissions at Jeeralang Hill meant that O_3 could become more dominant there, whereas slightly larger amounts of NO_x at Rosedale South meant that O_3 tended to become quenched at that site. These results are similar to those from in previous annual reports; e.g., Jacobs (2018).

Figure 5-6 Hourly Average O_3 and NO_2: Jeeralang Hill (left) and Rosedale South (right)





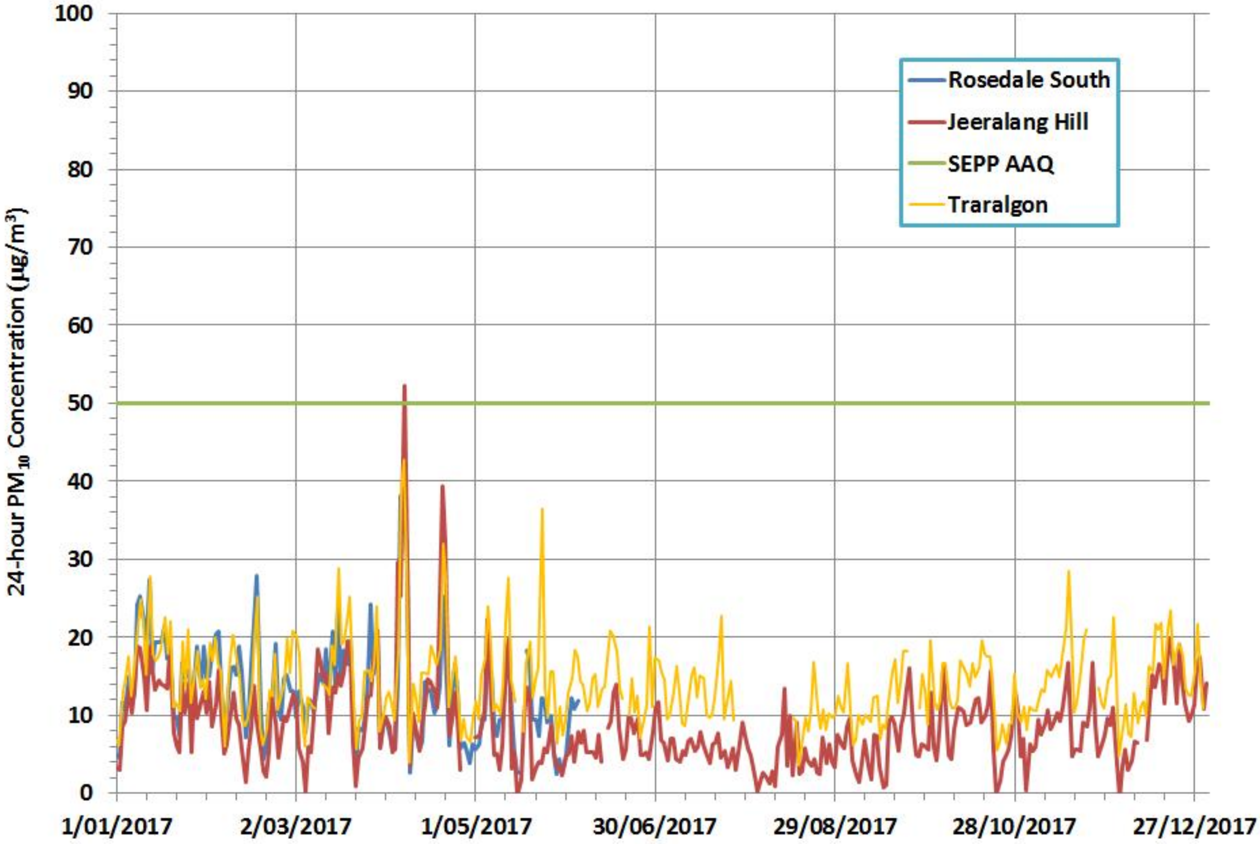
Jeeralang Hill; O_3 more dominant

Rosedale South; O_3 less dominant

5.8 Particulate Matter as PM_{10} – Jeeralang Hill and Rosedale South

The LVAMN Jeeralang Hill and Rosedale South results for daily average PM_{10} concentrations (µg/m^3) are provided in **Figure 5-7**. Also shown are the EPA Traralgon results, and the SEPP(AAQ) objective (50 µg/m^3). It can be seen from this figure that this key PM_{10} objective is met most of the time in the Latrobe Valley. There are excellent correlations between these two sites' data: the linear correlation coefficients are: between Rosedale South and Jeeralang Hill, 0.76; and between Traralgon and Jeeralang Hill, 0.77. This means most of the variability in the PM_{10} that can be seen in **Figure 5-7** was characteristic of conditions across much of the Latrobe Valley region, not local sources such as stacks. The higher results for the valley floor (Traralgon) indicate the primary PM_{10} sources are located in the valley, or at least are concentrated in the valley. It is probable that temperature inversions serve to concentrate PM_{10} on the valley floor at night.

Figure 5-7 LVAMN Results for 24-Hour Average PM_{10} Concentration (µg/m^3)



A summary of results for PM_{10} data acquired at Jeeralang Hill and Rosedale South is set out in **Table 5-13**. In 2017, one exceedence of the SEPP(AAQ) 24-hour average objective of 50 µg/m^3 was detected at Jeeralang Hill (7 April; 52 µg/m^3). This exceedence, and other days of higher PM_{10} concentrations during March and April 2017, may have been due to a fuel reduction program comprising a number of controlled burns in various parts of Gippsland, conducted by the Department of Environment, Land, Water and Planning, and Parks (DELWP, 2017). Analysis of the DELWP (2017) data indicates a 95-hectare burn 4 km northwest of Glengarry and two smaller fires near Boolarra were ignited on 5 April, so those fires may have been the cause of the high PM_{10} readings in the valley on 7 April.

Table 5-13 Summary of Results for PM_{10} Concentrations (µg/m^3) – Jeeralang Hill and Rosedale South

Parameter	Jeeralang Hill	Rosedale South
No. of hourly averages	8405	3722
Data capture (hourly data)	95.9%	42.5%

Parameter	Jeeralang Hill	Rosedale South
Median of hourly averages	7.0 µg/m^3	11.0 µg/m^3
Maximum hourly average	235 µg/m^3	274 µg/m^3
Annual average of hourly averages	8.8 µg/m^3	12.9 µg/m^3
SEPP(AAQ) Objective – annual average	20 µg/m^3 (not exceeded)	20 µg/m^3 (not exceeded)
No. of daily averages	358	154
70th percentile of 24h averages	10.5 µg/m^3	15.4 µg/m^3
Maximum daily average	52.3 µg/m^3	38.3 µg/m^3
SEPP(AAQ) Objective – 24h average	50 µg/m^3	50 µg/m^3 (not exceeded)
Exceedences of Objective	1	0
Percentage of measurement time 24h Objective met	99.7%	100%
Days of exceedences and values	7 April 2017 (52.4 µg/m^3)	Nil exceedences

Table 5-14 provides comparisons between the LVAMN results for 24-hour and annual average PM_{10} and corresponding results from EPA Traralgon (noting the low data capture for Rosedale South). Inspection of the plotted and tabled results indicates air quality effects due to PM_{10} were approximately the same across the Latrobe Valley. By inspection of the lower ‘background’ PM_{10} levels it is surmised that the lower-lying areas such as Morwell and Traralgon were affected more by smoke from bushfires in summer and controlled burns than Jeeralang Hill. The smoke particles would be better dispersed at higher levels.

The SEPP(AAQ) standard for annual average PM_{10} (20 mg/m^3) was easily met at all three monitoring sites.

Table 5-14 Comparisons of PM_{10} Results: LVAMN and EPA–Latrobe Valley

Parameter	Jeeralang Hill (LVAMN)	Rosedale South (LVAMN)	Traralgon (EPA)
Median 24h PM_{10}	7.7 µg/m^3	12.2 µg/m^3	13.6 µg/m^3
70th percentile 24h PM_{10}	10.5 µg/m^3	15.4 µg/m^3	16.3 µg/m^3
Maximum 24h PM_{10}	52.3 µg/m^3	38.3 µg/m^3	42.8 µg/m^3
Annual average PM_{10} (1h avgs.)	8.8 µg/m^3	12.9 µg/m^3	14.2 µg/m^3

5.9 Local Visual Distance (Rosedale South)

This section sets out the LVAMN results for Local Visual Distance (LVD) in 2017, measured only at Rosedale South. Units of per metre (m^{-1}) are used for the nephelometer light scattering coefficient (B_{sca}) in accordance with the procedure set out in VG (1982); see **Section 3.6**. The Rosedale South results for LVD were used with the VG (1982) procedure to calculate hourly average B_{sca} (m^{-1}). For each of these B_{sca} statistics LVD was calculated using VG (1982). A statistical summary of the results is provided in **Table 5-15**.

Table 5-15 Summary of results for calculated B_{sca} and corresponding LVD; Rosedale South 2017

Statistic	B_{sca}	Calculated LVD
Number of hourly averages	3704 (42.3% of year)	N/A
Maximum hourly average B_{sca}	3.5×10^{-4} m^{-1}	13.4 km
70th percentile hourly average B_{sca}	4.7×10^{-5} m^{-1}	100 km
Median hourly average B_{sca}	3.9×10^{-5} m^{-1}	119 km
Minimum hourly average B_{sca}	2.3×10^{-5} m^{-1}	205 km

A summary of results for the hourly average Ecotech results for LVD is provided in **Table 5-16**; the corresponding B_{sca} (m^{-1}) are calculated using VG (1982).

Table 5-16 Summary of results for Ecotech Results for LVD and Calculated B_{sca}; Rosedale South 2017

Statistic	LVD (km)	Calculated B_{sca} (m^{-1})
Number of hourly averages	3704 (42.3% of year)	N/A
Maximum hourly average LVD	204 km	2.3×10^{-5} m^{-1}
70^{th} percentile hourly average LVD	138 km	3.4×10^{-5} m^{-1}
Median hourly average LVD	119 km	3.9×10^{-5} m^{-1}
Minimum hourly average LVD	13.4 km	3.5×10^{-4} m^{-1}
Number of exceedences of the minimum hourly average LVD; 20 km	20 (0.5% of 3704 hourly averages), occurring on 6 days	N/A
Exceedences of goal (not >3 days)	3 days	N/A

The 20 exceedences of the hourly average minimum LVD (20 km), occurred on: 17 hours in autumn over 6-8 April, which is a good match to the period of the controlled burns started on 5 April (DLWP, 2017); 2 hours at night on 24-25 April; and 1 hour (midnight to 1am) on 18 May. Another potential and likely source of enhanced PM_{10} on the Latrobe Valley floor is smoke from residential wood fires.

6. Air Quality: Latrobe Valley vs. Melbourne-Geelong

The purpose of this section is to place the Latrobe Valley's air quality situation in context by comparing air quality monitoring data for 2017 with results from EPA's monitoring network around Melbourne. These EPA results should be checked after the anticipated publication of EPA's *Air Monitoring Report 2017 – Compliance with NEPM* (publication expected in the second half of 2018).

The focus of this section is on key air pollutants measured by the LVAMN: SO_2, PM_{10}, NO_2, and O_3. Where possible, data were compared for monitoring stations with capture rates for hourly average data equal to or better than 85%. Data from Rosedale South were not included in these comparisons due to that station's low data capture in 2017.

The comparisons are provided as the following tables of results:

- **Table 6-1 Comparisons of SO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne** – As expected, the Latrobe Valley's larger SO_2 sources; e.g., the brown coal-fuelled power stations, lead to higher SO_2 concentrations at Jeeralang Hill. Plume strikes may occur at Jeeralang Hill on a few hours in a year. However, the SO_2 results for the floor of the Latrobe Valley are better, and they are comparable with those for Altona North, which is located in an industrial area of Melbourne.

- **Table 6-2 Comparisons of PM_{10} Monitoring Data (µg/m^3): Latrobe Valley vs. Melbourne** – Comparisons of these statistics indicate that particulate pollution is worse in Melbourne than in the Latrobe Valley, even considering the potential for plume strikes at Jeeralang Hill and the Latrobe Valley's large, open-cut coal mines. Higher particulate matter levels would be due in part at least to Melbourne's road traffic over the broader Melbourne region. Other potential sources of particulate matter that would affect Melbourne more than the Latrobe Valley would include: 'secondary' (chemical) particle formation in smog, and raised dust from dry, exposed areas in western and northern Victoria.

- **Table 6-3 Comparisons of NO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne** – The results for NO_2 are worse in the Melbourne Airshed than in the Latrobe Valley. The primary reason for this would be NO_x emissions from road traffic over the wider Melbourne region.

- **Table 6-4 Comparisons of O_3 Monitoring Data (ppb): Latrobe Valley vs. Melbourne** – In 2017 there were no O_3 monitoring stations in the Melbourne Airshed with data capture better than 50%. Where O_3 data were available in Melbourne, NO_2 data capture tended to be poor also (except for Dandenong). Results for O_3 are presented for the best three stations in Melbourne Airshed for data capture: Dandenong, Mooroolbark, and Point Cook. Comparisons of the available data indicate that O_3 levels in the Latrobe Valley's towns are comparable with, or slightly better than, those of Melbourne. O_3 is elevated at the LVAMN monitoring station Jeeralang Hill. The reason for this, (as explained in **Section 5.6**), is likely to be due to the lack of NO_x emissions in the more remote areas to quench production of O_3 in the daytime. Also, the Jeeralang Hill results may be indicative of O_3 forming in higher levels in the boundary layer.

In general, in comparison with the Melbourne Airshed, the air quality situation in the Latrobe Valley is good due to the lower concentrations of PM_{10}, and NO_2. The comparisons highlighted the main issue for the Latrobe Valley; higher SO_2 levels.

Further improvements to O_3 data capture in Melbourne and Latrobe Valley are needed to better understand the higher O_3 levels recorded in the Latrobe Valley, especially the higher levels experienced at Jeeralang Hill.

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Table 6-1 Comparisons of SO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2017

		Latrobe Valley				Melbourne/Geelong		
Statistic, SO_2	**SEPP (AAQ) Objective**	**LVAMN Jeeralang Hill**	**EPA Morwell East**	**EPA Morwell South**	**EPA Traralgon**	**EPA Alphington**	**EPA Altona North**	**EPA Geelong South**
Data capture, 1h avg.	--	91.2%	94.6%	93.8%	91.9%	93.2%	92.5%	88.4%
1h, median	--	1.2	0.2	0.3	0.4	0.3	0.5	0.2
1h, 70th percentile	--	2.0	0.4	0.6	0.8	0.5	1.0	0.4
1h, maximum	200	345	50.7	58.6	63.3	11.0	48.6	16.6
24h, median	--	1.8	0.3	0.4	0.7	0.4	1.0	0.3
24h, 70th percentile	--	2.7	0.5	0.7	1.2	0.6	1.8	0.6
24h, maximum	80	37	12.1	13.2	15.1	2.6	13.7	2.4
Annual avg. (1h avgs.)	20	3.1	0.5	0.6	1.0	0.5	1.6	0.4

Table 6-2 Comparisons of PM_{10} Monitoring Data (µg/m³): Latrobe Valley vs. Melbourne 2017

		Latrobe Valley				Melbourne/Geelong		
Statistic, PM_{10}	**SEPP (AAQ) Objective**	**LVAMN Jeeralang Hill**	**EPA Morwell East**	**EPA Morwell South**	**EPA Traralgon**	**EPA Alphington**	**EPA Footscray (no data AN)**	**EPA Geelong South**
Data capture, 1h avg.	--	95.9%	--	--	92.8%	98.0%	93.6%	88.5%
1h, median	--	7.0	--	--	12.7	13.5	14.6	14.3
1h, 70th percentile	--	11.0	--	--	16.6	18.2	20.1	20.0
1h, maximum	--	235	--	--	109	198	297	473
24h, median	--	7.7	--	--	13.6	14.6	16.1	15.7
24h, 70th percentile	--	10.5	--	--	16.3	18.3	20.2	21.0
24h, maximum	50	52.3	--	--	42.8	35.5	50.3	74.0
Annual avg. (1h avgs.)	20	8.8	--	--	14.2	15.3	17.1	17.6

Table 6-3 Comparisons of NO_2 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2017

	Latrobe Valley				Melbourne/Geelong		
Statistic, NO_2	**SEPP (AAQ) Objective**	**LVAMN Jeeralang Hill**	**EPA Morwell South**	**EPA Traralgon**	**EPA Alphington**	**EPA Dandenong**	**EPA Geelong South**
Data capture, 1h avg.	--	94.7%	93.8%	88.2%	90.8%	93.7%	88.8%
1h, median	--	0.7	4.0	4.8	7.8	8.4	4.1
1h, 70^{th} percentile	--	1.2	6.2	7.4	11.5	13.5	7.1
1h, maximum	120	36	31	34	57	48	42
Annual avg. (1h avgs.)	30	1.6	5.3	6.2	9.7	10.7	6.5

Table 6-4 Comparisons of O_3 Monitoring Data (ppb): Latrobe Valley vs. Melbourne 2017

	Latrobe Valley				Melbourne/Geelong		
Statistic, O_3	**SEPP (AAQ) Objective**	**LVAMN Jeeralang Hill**	**EPA Morwell South**	**EPA Traralgon**	**EPA Mooroolbark**	**EPA Dandenong**	**EPA Point Cook**
Data capture, 1h avg.	--	93.9%	94.6%	--	51.0%	44.9%	45.2%
1h, median	--	26	16.7	--	17.1	16.9	18.9
1h, 70^{th} percentile	--	28	21.3	--	23.0	22.7	23.6
1h, maximum	100	65	67	--	71	69	80
Annual avg. (1h avgs.)	20	26	16.4	--	18.6	18.6	20.3*

*The O_3 result for Point Cook is highlighted as exceeding the objective for annual average O_3 (20 ppb); however, note the poor data capture (45.2%).

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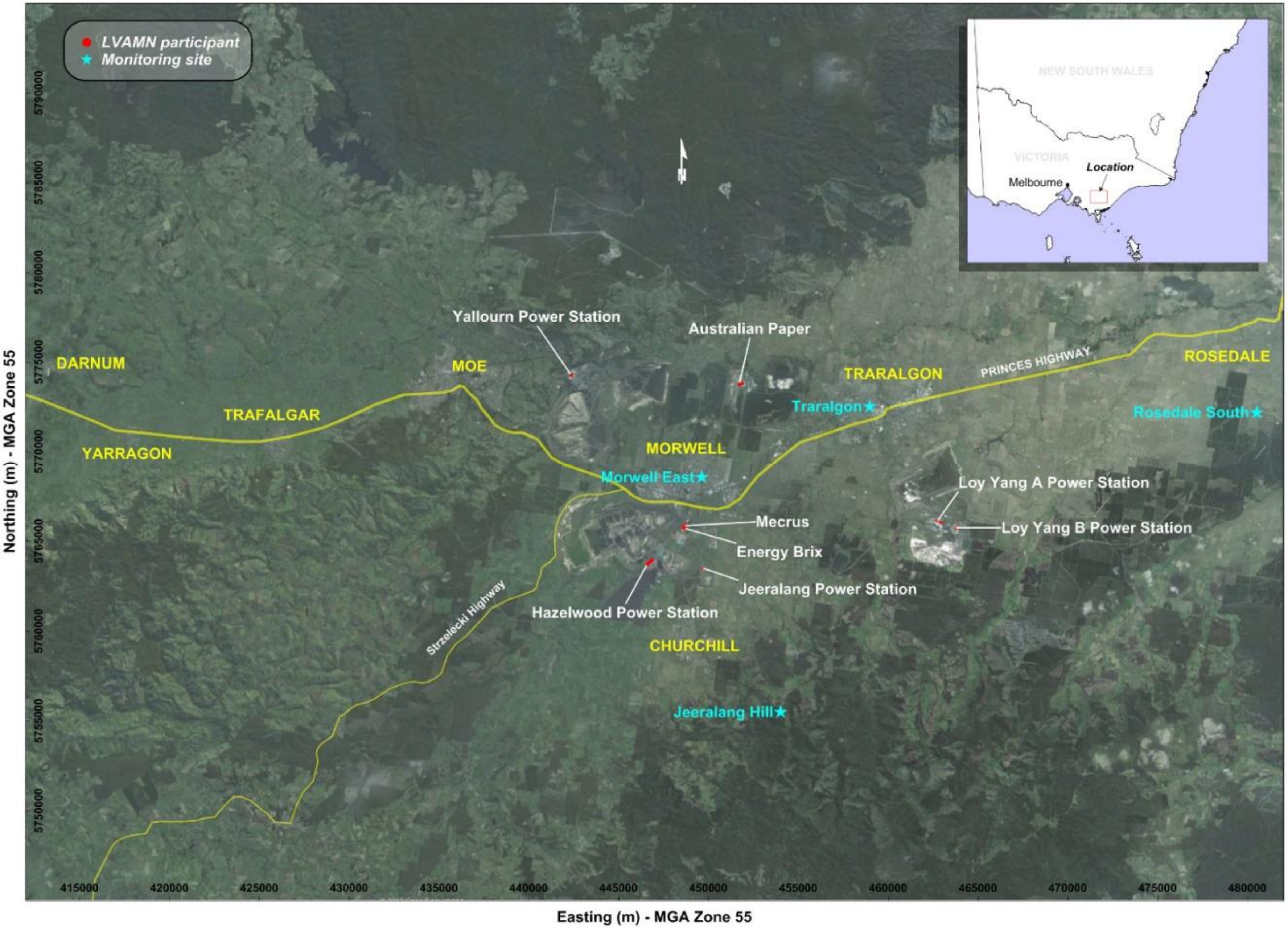
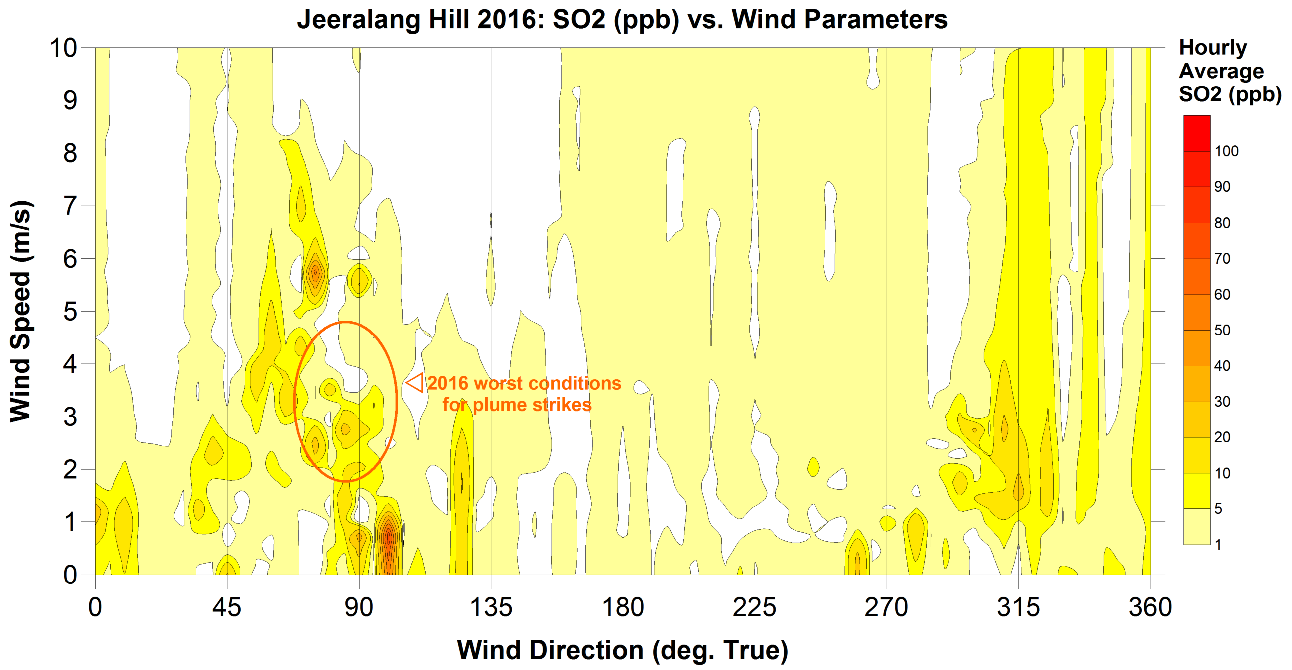
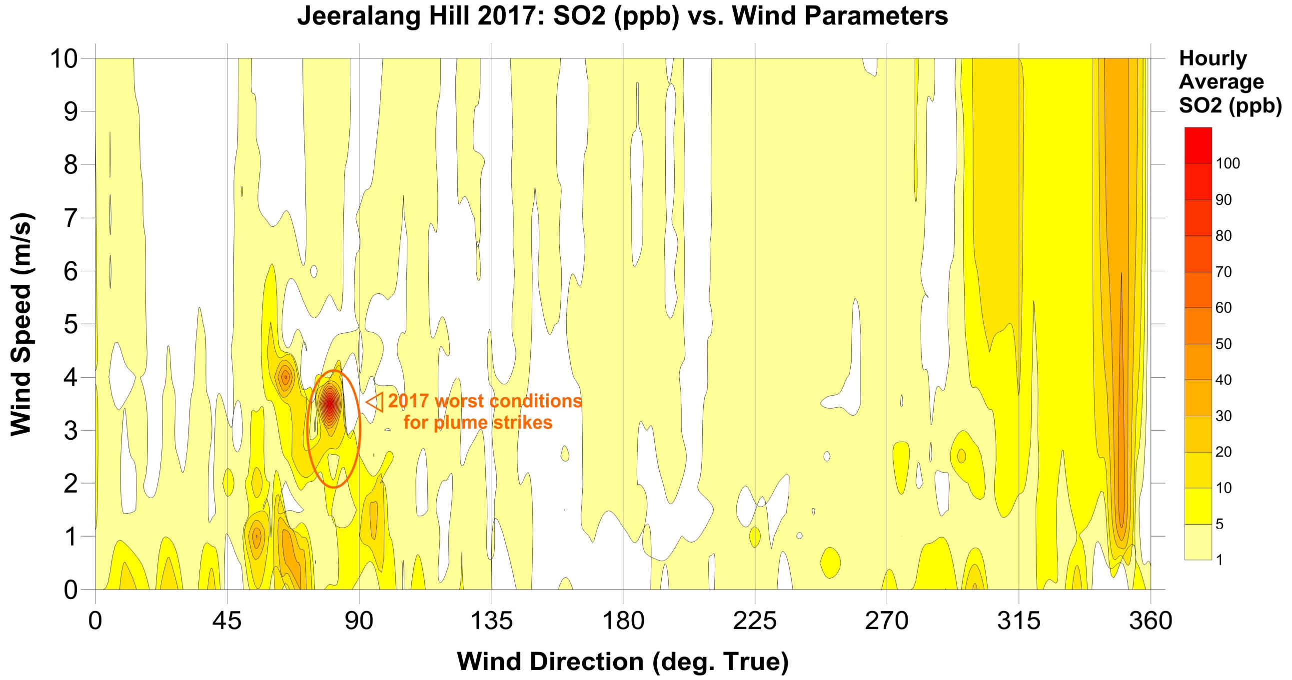
Appendix A. Map of Latrobe Valley


LVAMN participant
Monitoring site
NEW SOUTH WALES
VICTORIA
Location
Melbourne
Yallourn Power Station
Australian Paper
DARNUM
MOE
TRARALGON
PRINCES HIGHWAY
ROSEDALE
TRAFALGAR
Traralgon
Rosedale South
YARRAGON
MORWELL
Morwell East
Loy Yang A Power Station
Mecrus
Loy Yang B Power Station
Energy Brix
Jeeralang Power Station
Hazelwood Power Station
Strzelecki Highway
CHURCHILL
Jeeralang Hill
5790000
5785000
5780000
5775000
5770000
5765000
5760000
5755000
5750000
415000
420000
425000
430000
435000
440000
445000
450000
455000
460000
465000
470000
475000
480000
Northing (m) - MGA Zone 55
Easting (m) - MGA Zone 55

Appendix B. Jeeralang Hill 2016-2017: SO_2 and Winds

The SO_2-wind maps for 2016 (Jacobs, 2018) and 2017 (bottom figure), were created from hourly average SO_2 concentrations measured at Jeeralang Hill in 2016-2017, versus concurrent hourly average wind direction, and wind speed. The results highlight the complexity of air pollutant dispersion in the Strzelecki Ranges of the Latrobe Valley. In 2017, the highest SO_2 concentrations at Jeeralang Hill occurred during easterly winds with wind speeds in the range 2-4 m/s, which is similar to the 2016 case.

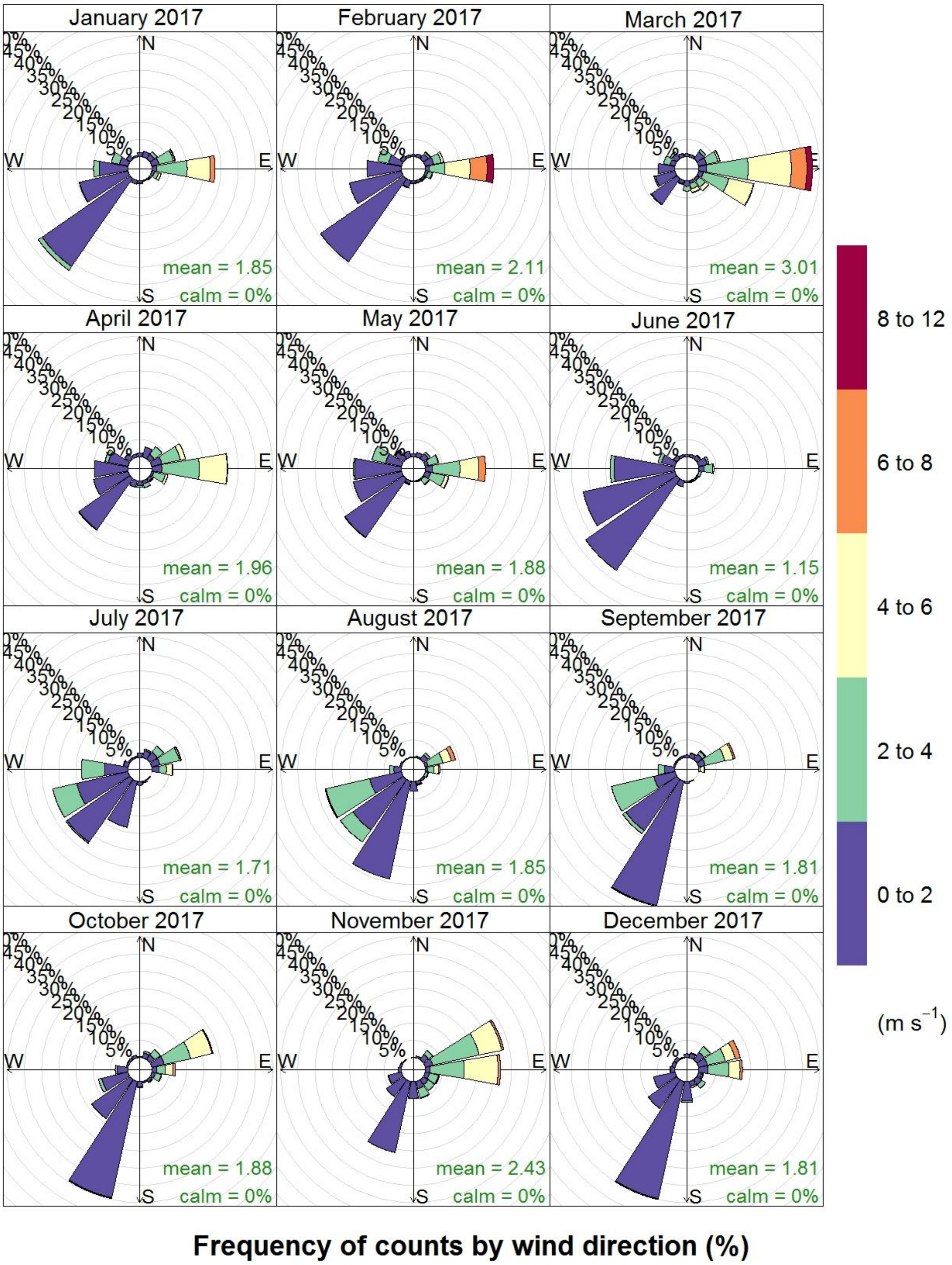




Appendix C. Wind Roses

C.1 Jeeralang Hill 2017 Wind Roses

The Jeeralang Hill 2017 monthly wind rose plots were created using 8666 records of hourly average wind speed and wind direction data (for data capture see **Section 4.2**).



C.2 Rosedale South 2017 Wind Roses

The Rosedale South 2017 monthly wind rose plots, for January-May only, were created using 3747 records of hourly average wind speed and wind direction data.

Note data capture for June was 43%, and no wind data were acquired in July-December; see **Section 4.2**.