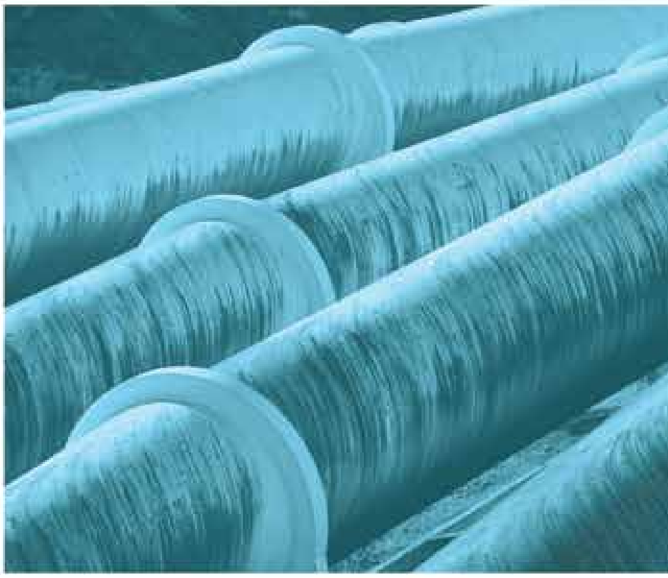
APPENDIX

# AIR QUALITY IMPACT ASSESSMENT


# Proposed Segment Factory

## Air Quality Impact Assessment

**Prepared for Snowy Hydro Limited**
**September 2019**

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# Proposed Segment Factory

Air Quality Impact Assessment

**Report Number**

J17188 RP97

**Client**

Snowy Hydro Limited

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Final

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# Executive Summary

This air quality impact assessment (AQIA) supports the Environmental Impact Statement (EIS) for the proposed segment factory located in Polo Flat, NSW. It documents the existing air quality and meteorological environment, applicable impact assessment criteria, air pollutant emission calculations, dispersion modelling of calculated emissions and assessment of predicted impacts relative to criteria.

The AQIA has been prepared in general accordance with the guidelines specified by the NSW Environment Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales*.

Existing environmental conditions were quantified using data from the BoM Cooma Airport Automatic Weather Stations (AWS) and the three Australian Capital Territory (ACT) monitoring stations: Civic, Florey and Monash.

Emissions estimation and dispersion modelling was completed for one operational scenario corresponding to peak operations at the proposed segment factory. Emissions of total suspended particulates (TSP), particulate matter less than 10 micrometres (µm) in aerodynamic diameter ($PM_{10}$), particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$) and oxides of nitrogen ($NO_x$) were estimated and modelled.

The atmospheric dispersion of air pollutant emissions from one operational scenario was simulated using the CALPUFF model.

The results of the dispersion modelling indicated that the proposed segment factory will not result in any exceedances of the applicable cumulative impact assessment criteria at any of the surrounding private residences. Three industrial locations were predicted to experience a maximum of two additional days above the impact assessment criterion for 24-hour average $PM_{2.5}$, however these exceedances were predicted for days with elevated background concentrations and are not considered significant. It is therefore considered that the operation of the proposed segment factory is unlikely to cause adverse air quality impacts to the surrounding environment.

The design of the project will incorporate a range of dust mitigation and management measures. These include paving roads on-site, water flushing and sweeping of paved roads, windbreaks (walls) on sand and aggregate bunkers, enclosed weigh hopper and central mixer and minimising idling of diesel equipment where practical. These measures have been taken into account in the emissions estimation for the project.

A greenhouse gas (GHG) assessment was also undertaken for the proposed segment factory. The predicted total GHG emissions (Scope 1, 2 and 3) for the proposed segment factory represent approximately 0.008% of total GHG emissions for NSW and 0.002% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

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# 1 Introduction

## 1.1 Snowy 2.0

Snowy Hydro Limited (Snowy Hydro) proposes to develop Snowy 2.0, a large-scale pumped hydro-electric storage and generation project which would increase hydro-electric capacity within the existing Snowy Mountains Hydro-electric Scheme (Snowy Scheme). Snowy 2.0 is the largest committed renewable energy project in Australia and is critical to underpinning system security and reliability as Australia transitions to a decarbonised economy. Snowy 2.0 will link the existing Tantangara and Talbingo reservoirs within the Snowy Scheme through a series of underground tunnels and a new hydro-electric power station will be built underground.

Snowy 2.0 has been declared to be State significant infrastructure (SSI) and critical State significant infrastructure (CSSI) by the NSW Minister for Planning under Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). CSSI is infrastructure that is deemed by the NSW Minister for Planning and Public Spaces to be essential for the State for economic, environmental or social reasons. An application for CSSI must be accompanied by an environmental impact statement (EIS).

Separate applications are being submitted by Snowy Hydro for different phases of Snowy 2.0, including Exploratory Works for Snowy 2.0 (the Exploratory Works) and Snowy 2.0 Main Works (the Main Works).

The first phase of Snowy 2.0, the Exploratory Works (Application Number SSI 9208), includes an exploratory tunnel and portal and other exploratory and construction activities primarily in the Lobs Hole area of the Kosciuszko National Park (KNP). Exploratory Works has been assessed in a separate EIS and is subject to an approval issued by the former NSW Minister for Planning on 7 February 2019. Construction for Exploratory Works has already commenced.

The second phase of Snowy 2.0, the Snowy 2.0 Main Works (Application Number SSI-9687), covers the major construction elements of Snowy 2.0, including permanent infrastructure (such as the underground power station, power waterways, access tunnels, chambers and shafts), temporary construction infrastructure (such as construction adits, construction compounds and accommodation), management and storage of extracted rock material and establishing supporting infrastructure (such as road upgrades and extensions, water and sewage treatment infrastructure, and the provision of construction power). Snowy 2.0 Main Works also includes the operation of Snowy 2.0. The EIS for Snowy 2.0 Main Works is currently being prepared.

A separate application has also been submitted for a proposed factory that would manufacture precast concrete segments that would line the tunnels being excavated for Snowy 2.0 (Application Number SSI 10034). This air quality impact assessment (AQIA) supports the EIS for the proposed segment factory.

On 26 June 2019, Snowy Hydro referred the proposed segment factory (Reference Number 2019/8481) to the Commonwealth Minister for the Environment under the provisions of the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). On 13 August 2019, the proposed segment factory was determined by the Acting Assistant Secretary Assessments and Waste Branch of the Commonwealth Department of the Environment and Energy (DEE), as delegate to the Minister, to be 'not a controlled action' and therefore does not require further assessment or approval under the EPBC Act.

## 1.2 The proposed segment factory

The tunnels for Snowy 2.0, including the exploratory tunnel for Exploratory Works and underground tunnels linking Tantangara and Talbingo reservoirs for the Main Works, would be excavated, for the most part, using tunnel boring machines (TBMs) and would be lined using precast concrete segments. These segments are proposed to be manufactured at the proposed segment factory to be located on the south-eastern side of Polo Flat (the site), which is an industrial area located to the east of Cooma.

The proposed segment factory would contain a building for the casting and curing of the segments, uncovered storage areas for raw materials and segments, vehicle parking areas and associated offices and workshops.

Main inputs for the segments include aggregate, sand, cement, water and rebar steel. Primary outputs include the segments which would be transported to the TBM launch sites for Exploratory Works and Main Works within KNP.

The construction phase of the proposed segment factory would last about five months utilising a workforce of about 30 people. Construction would take place six days a week (from Monday to Saturday) and for 10 hours per day.

The factory would operate over a period of about 3.5 years utilising a workforce of about 125 people. It would be operational 24 hours a day, seven days a week.

The proposed segment factory would be constructed and operated by Future Generation Joint Venture (FGJV) which has been contracted by Snowy Hydro to construct Snowy 2.0.

At the completion of the construction of Snowy 2.0, the proposed segment factory would be decommissioned.

Further details of the proposed segment factory are provided in Chapter 2 of this report.

## 1.3 Location of the site

The site of the proposed segment factory is located on the south-eastern side of Polo Flat, predominantly on the southern part of the land owned by Snowy Hydro. The site is located to the east of Polo Flat Road and to the north of Carlaminda Road.

Figure 1.1 shows the location of the site in a regional context and Figure 1.2 shows the location of the site in a local context.

The site contains the following land parcels:

- southern part of Lot 14 in Deposited Plan (DP) 250029 – also known as 9 Polo Flat Road, Polo Flat;
- Lot 3 in DP 238762 – also known as 33 Carlaminda Road, Polo Flat; and
- an unmade road corridor, directly south of the aforementioned lots.

Except for a few buildings located on the southern part of Lot 3 in DP 238762, the site is vacant and dominated by grassland. A third order watercourse flows in a north-westerly direction through the middle of the site.

Lot 14 in DP 250029 is a large parcel of land which contains a private airfield predominantly located in the middle and northern part of the land. This airfield was originally established in 1921 and further developed in the late 1950s and 1960s to service the Snowy Scheme. It became the base for the Snowy Mountains Hydro-electric Authority's (the predecessor to Snowy Hydro) flying unit and aircraft. The land was sold by Snowy Hydro in 1998 where it continued use as a private airfield. Snowy Hydro purchased the land again in early 2019.

The site is surrounded by industrial development to the west and predominantly rural land to the south and east. To the north of the site is the remainder of Lot 14 in DP 250029 which contains the private airfield, and other industrial development. Snowy Hydro's private airfield contains a main north-south aligned runway, hangers and offices. It also contains an above ground fuel tank for the refuelling of planes and helicopters.

Lot 3 in DP 238762 contains a communications tower which was due to cease use (ie transmission) in August 2019.

There is an isolated industrial operation containing a residence located about 150 metres (m) to the south-east of the site, and an abattoir located about 350 m to the east.

The nearest residence is a rural residence located about 450 m to the south-south-east of the site. The nearest residences within Cooma are located about 1 km to the west of the site.

## 1.4 Proponent

Snowy Hydro is the proponent for the proposed segment factory. Snowy Hydro is an integrated energy business – generating energy, providing price risk management products for wholesale customers and delivering energy to homes and businesses. Snowy Hydro is the fourth largest energy retailer in the NEM and is Australia's leading provider of peak, renewable energy.

As previously stated, the proposed segment factory would be constructed and operated by FGJV which has been contracted by Snowy Hydro to construct Snowy 2.0.

## 1.5 Purpose of this report

This AQIA supports the EIS for the proposed segment factory. It documents the existing air quality and meteorological environment, applicable impact assessment criteria, air pollutant emission calculations, dispersion modelling of calculated emissions and assessment of predicted impacts relative to criteria.

This AQIA consists of the following sections:

- a description of the local setting and surrounds of the proposed segment factory;
- the pollutants which are relevant to the assessment, and the applicable impact assessment criteria;
- a description of the existing environment, specifically:
  - the meteorology and climate; and
  - the existing air quality environment;
- a detailed air pollutant emissions inventory for the construction phase of the proposed segment factory;
- atmospheric dispersion modelling for the quantified emissions, including an analysis of the proposed segment factory operation-only and cumulative (project plus background) impacts accounting for baseline air quality;
- an overview of mitigation measures and air quality monitoring requirements; and
- a greenhouse gas assessment.

The AQIA has been prepared in general accordance with the guidelines specified by the NSW Environment Protection Authority (EPA) in the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2016), referred to hereafter as 'the Approved Methods for Modelling'. The greenhouse gas assessment has been prepared using project-specific inputs and emission factors from the National Greenhouse Accounts Factors (NGAF) workbook (DEE 2018).

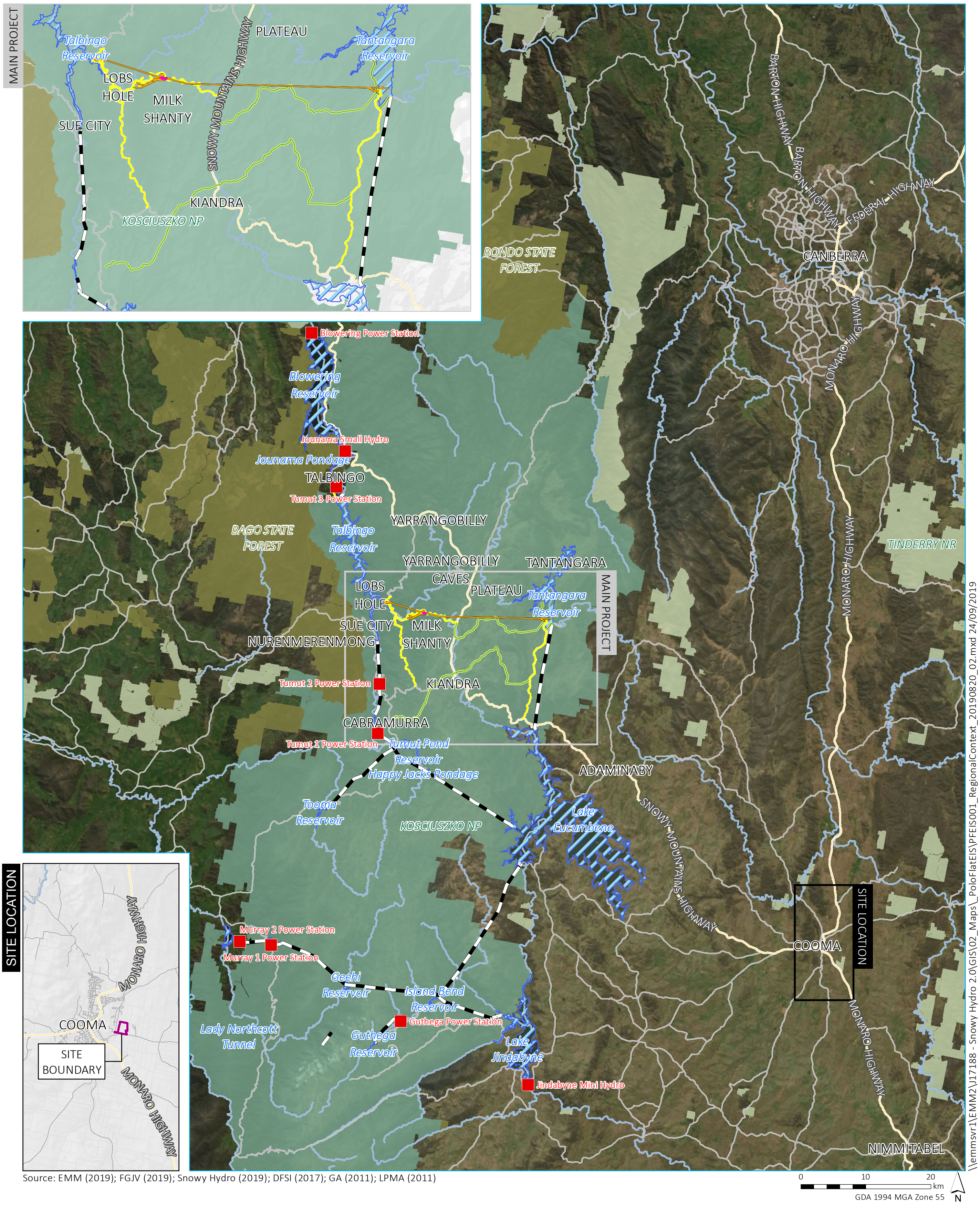
## 1.6 Assessment guidelines and requirements

This AQIA has been prepared in accordance with the Secretary's Environmental Assessment Requirements (SEARs), issued by the NSW Department of Environment, Industry and Planning (DPIE) on 31 July 2019.

The SEARs must be addressed in the EIS. Table 1.1 lists the matters relevant to this assessment and where they are addressed in this report.

**Table 1.1 Relevant matters raised in SEARs**

| Requirement | Section addressed |
|---|---|
| **Air**: an assessment of the particulate matter and greenhouse gas emissions of the project | Entire report |




Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); GA (2011); LPMA (2011)

KEY

- Site boundary
- Snowy 2.0 project elements
  - Utilities
  - Tunnels, portals, intakes
  - Power station
  - Permanent roads and surface infrastructure
- Existing Snowy Scheme
  - Existing power station
  - Existing pipeline tunnel
  - Scheme storage
- Main road
- Local road or track
- Watercourse
- Kosciuszko National Park
- NPWS reserve
- State forest

Location of the project area

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 1.1


Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); GA (2011); LPMA (2011)

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KEY
- Site boundary
- Rail line
- Main road
- Local road or track
- Watercourse
- Cadastral boundary
- NPWS reserve

Location of site in local context

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 1.2

# 2 Project and site description

## 2.1 Project description

It is proposed to construct and operate a factory on the site to supply precast concrete segments that would line the tunnels for Snowy 2.0.

The construction phase of the proposed segment factory would last about five months utilising a workforce of about 30 people. The operational phase would last about 3.5 years utilising a workforce of about 125 people.

The proposed segment factory would be decommissioned at the completion of operations.

### 2.1.1 Construction

#### i Main activities

The following main activities would be undertaken for the construction of the proposed segment factory:

- demolition and removal of buildings and decommissioned telecommunications tower on southern part of site;
- clearing, removal of topsoil and vegetation (topsoil excavated would be stockpiled on site for later use);
- undertaking earthworks to establish level surfaces;
- establishment of primary access road;
- installation of site services (power, water and communications);
- establishment of site surfaces (ie concrete, asphalt and cement soil); and
- construction of site facilities and buildings. including precast building, concrete batching plant (CBP), workshops, offices, parking areas, storage areas and associated facilities.

#### ii Earthworks

Excavation will be carried out at the site to provide level surfaces, establish the access road and create the required trenches for drainage.

Where possible excavated material would be reused on site for filling and compaction (including benching areas of the site where required). Where there is a deficit of excavated material, additional material would be sourced from local quarries.

#### iii Traffic movements

Construction vehicle movements will comprise construction worker's light vehicles and heavy vehicles transporting equipment, building and construction materials, waste and fill material if required.

#### iv Construction timeframe and hours

The construction phase of the proposed segment factory would last about five months (estimated to commence in March 2020 subject to obtaining the required approvals). Construction would be undertaken from Monday to Saturday for 10 hours per day. Access to the site would generally start at 6 am for pre-starts and toolbox talks, and construction would commence at 7 am.

#### v Workforce

A workforce of about 30 people would be required to construct the proposed segment factory.

### 2.1.2 Operations

#### i General

The segments would be produced by casting concrete (made in the CPB) in reusable steel which would then be cured in a chamber. Following curing, the segments would be temporarily stored onsite before being transported to the TBM launch sites within KNP.

The casting and curing would be undertaken in the precast building. Storage of the segments would predominantly be undertaken in uncovered storage areas.

Main inputs for the segments include aggregate, sand, cement, steel rebar and water.

Approximately 130,500 segments would be manufactured over the operational period.

### 2.1.3 Site layout

The layout of the proposed segment factory is shown in Figure 2.1. Details of the site layout are provided below.

#### i General layout

The CBP and precast building (which contains a casting room and curing chamber) would be located at the southern end of the site. Open storage areas would be located predominantly to the north of the building on the northern part of the site.

Site offices and workshops would be located in the south-western corner of the site.

#### ii Ingress and egress

Vehicle ingress and egress to the site would be provided on a new access road which would connect to Polo Flat Road. The access road would be constructed on an existing informal service road located in the unmade road corridor immediately north of Carlaminda Road. Following completion, the access road would be dedicated to Snowy Monaro Regional Council (SMRC) as a public road.

#### iii Raw materials storage

Cement silos, and aggregate and sand storage areas for the CBP would be located adjacent to the CBP. Storage would be sized to hold approximately three days production.

Other raw materials include steel rebar and concrete admixtures which would be stored in, or adjacent to, the precast building.

### iv Parking

Two large parking areas are proposed in the south-western corner of the site, and to the north of the precast building. Parking in the south western area would be used for light vehicles, trucks and buses. Parking to the north of the precast building would be used for trucks.

### v Drainage

A diversion drain would be constructed around the eastern perimeter of the site to divert water from the third order watercourse. The drain diversion would be constructed to match the general width and depth of the existing watercourse.

A detention basin would be provided to the north of the site to collect surface flows. Overflows from the detention basin would be directed into the diversion drain.

### vi Utility connections

The proposed segment factory would be connected to utility mains, including communications, electricity, water, wastewater and gas.

### vii Segment inputs

As previously stated, main inputs for the precast concrete segments include aggregate, sand, cement and steel rebar. These main inputs would likely be sourced from quarries near Canberra.

In addition to these main inputs, several accessories are also required to produce the segments, such as reinforcement cages, steel fibres, gaskets and inserts. These inputs would likely be sourced from Canberra.

### viii Segment transport

Following casting, curing and storage, the segments would be transported to the TBM launch sites within KNP.

### ix Traffic movements

Operational vehicle movements will comprise light vehicles (worker's vehicles and service vehicles) and heavy vehicles required for the transportation of the main inputs for the segments and for the transportation of the segments from the site to the TBM launch sites within KNP.

### x Staff and manpower

A workforce of about 125 people would be required to operate the proposed precast segment factory. Most of this workforce would be sourced locally from Cooma and surrounding localities.

### xi Hours of operation

It is proposed to operate the proposed segment factory 24 hours a day, seven days a week. It is estimated that the factory would operate for a period of about 3.5 years.


Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

0 100 200 m

GDA 1994 MGA Zone 55

N

KEY

- Site boundary
- Local road or track
- Cadastral boundary
- Indicative site layout
- Precast yard, concrete plant, aggregates area, precast warehouse, segment storage
- Bus stop and parking
- Offices, guard house and first aid
- Mechanical and plant workshop with parking
- Trailer parking
- Storage area
- Emergency storage area
- Detention basin
- Drainage

Proposed layout

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 2.1

snowy2.0

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### 2.1.4 Decommissioning

As previously stated, the proposed segment factory would be decommissioned at the completion of construction of Snowy 2.0 which would include removal of all plant and equipment. Snowy Hydro would retain the main structures such as the precast building, workshops and offices and seek to use these for an alternative industrial use.

It is envisaged that Snowy Hydro would submit a separate application for approval for an alternative use of the site prior to the decommissioning phase of the project.

## 2.2 Site and surrounding area

The site is located to the east of the township of Cooma. It is generally flat with an elevation range of between 820 m and 830 m Australian Height Datum (AHD). Further afield, the elevation increases to the west and south of the site beyond the township of Cooma and features predominately rolling terrain to the north and east of the site. A three-dimensional representation of the local topography is presented in Figure 2.2.

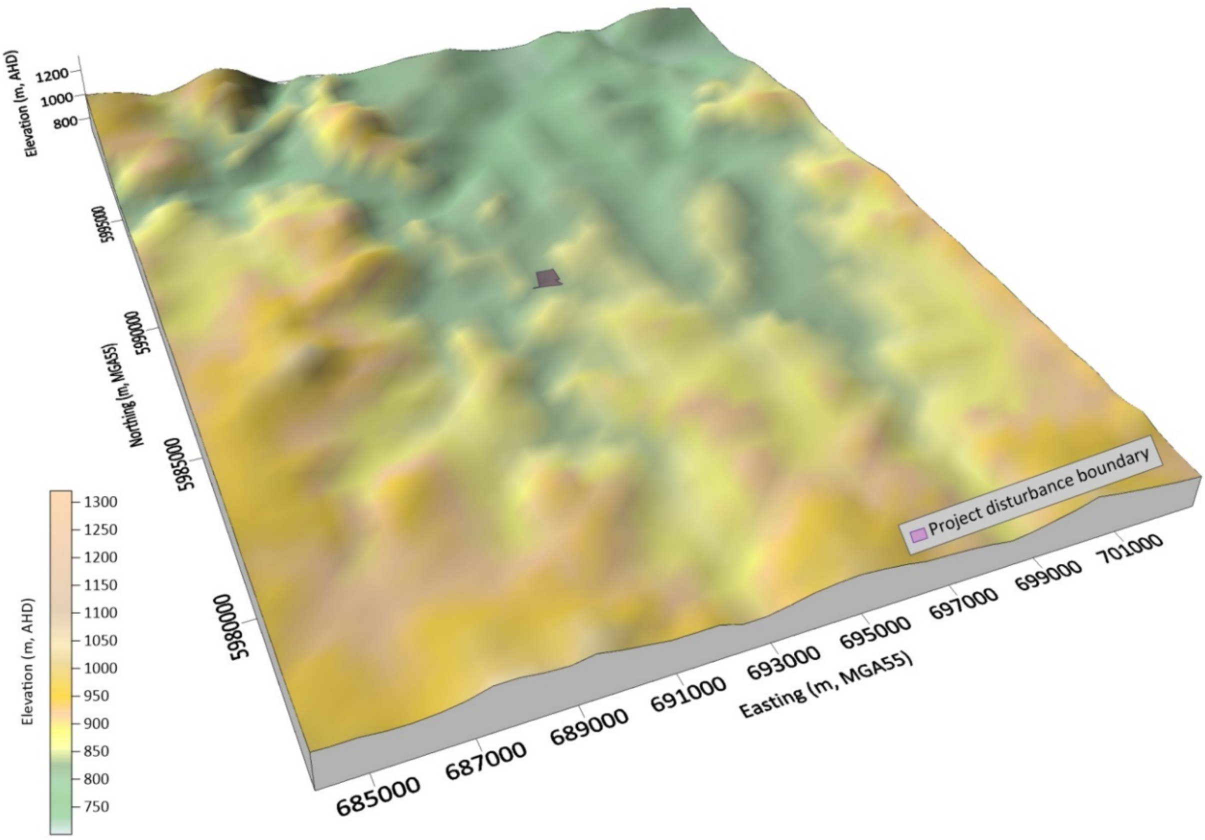


**Figure 2.2 3-dimensional topography surrounding the site**

Source: NASA Shuttle Radar Topography Mission data

## 2.3 Assessment locations

The nearest representative air quality sensitive locations to the site have been identified for the purpose of assessing potential air quality impacts. Details are provided in Table 2.1 and their locations are shown in Figure 2.3. They are referred to in this report as assessment locations.

### Table 2.1 Air quality assessment locations

| ID | Description | Assessment location type* | Easting | Northing |
|---|---|---|---|---|
| R1 | 14 Warra Street, Cooma | Residential | 693057 | 5989409 |
| R2 | 10 Carlaminda Road, Polo Flat | Residential | 692758 | 5987347 |
| R3 | 103 Bombala Street, Cooma | Residential | 691580 | 5987112 |
| R4 | 57 Bradley Street, Cooma | Residential | 691813 | 5987775 |
| R5 | 91 Baron Street, Cooma | Residential | 691954 | 5987213 |
| R6 | 82 Baron Street, Cooma | Residential | 691964 | 5987291 |
| R7 | 1 Albert Street, Cooma | Residential | 691849 | 5987414 |
| R8 | 63 Bradley Street, Cooma | Residential | 691798 | 5987683 |
| R9 | 1 Short Street, Cooma | Residential | 691842 | 5988048 |
| R10 | 3 Monaro Highway, Cooma | Residential | 691871 | 5988605 |
| R11 | 57 Yareen Road, Cooma | Residential | 692242 | 5989152 |
| R12 | 32 Woolala Street, Cooma | Residential | 692664 | 5989240 |
| R13 | 12 Windarra Place, Cooma | Residential | 692910 | 5989259 |
| R14 | 4 Yamba Crescent, Cooma | Residential | 693189 | 5989323 |
| R15 | 130 Carlaminda Road, Cooma | Residential | 693910 | 5987127 |
| R16 | 112 Carlaminda Road Cooma | Residential | 693796 | 5987246 |
| R17 | Monbeef Abattoir, Carlaminda Road, Cooma | Commercial | 693827 | 5987837 |
| R18 | 73 Polo Flat Road, Polo Flat | Industrial | 692901 | 5987822 |
| R19 | 58 Polo Flat Road, Polo Flat | Industrial | 692844 | 5988383 |
| R20 | 11 Geebung Street, Polo Flat | Industrial | 693219 | 5988898 |
| R21 | 65 Polo Flat Road, Polo Flat | Industrial | 692969 | 5987982 |
| R22 | 85 Polo Flat Road, Polo Flat | Industrial | 692777 | 5987590 |
| R23 | 3 Kaiser Street, Polo Flat | Residential | 692727 | 5988127 |
| R24 | 2 Holland Road, Polo Flat | Residential | 692762 | 5988806 |
| R25 | 2 Geebung Street, Polo Flat | Residential | 693079 | 5989001 |

Notes: Assessment location type reflects the general use of that location only and is not intended to reflect land zoning. Impact assessment criteria applies in the same way to all assessment location types.


Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

0 250 500 m
GDA 1994 MGA Zone 55
N

KEY

- Site boundary
- Indicative site layout
- Rail line
- Main road
- Local road or track
- Watercourse
- Cadastral boundary

Receptor type

- Industrial
- Residential

Air quality assessment locations

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 2.3

snowy 2.0

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# 3 Pollutants and assessment criteria

## 3.1 Potential air pollutants

The proposed segment factory has the potential to generate emissions of various air pollutants to the atmosphere. Emissions calculated in relation to this project, have been quantified in Section 6.

Air pollution emission sources will comprise of a mixture of the following:

- fugitive sources of particulate matter, such as material handling and transfer activities, movement of mobile plant and equipment, and wind erosion of storage piles; and
- combustion sources, such as exhaust emissions from the mobile equipment fleet (ie trucks, forklifts, front end loader) and steam boilers.

A detailed description of the emission sources associated with the proposed segment factory is presented in Section 6. The main air pollutants emitted by the proposed segment factory will be:

- particulate matter, specifically:
  - total suspended particulate matter (TSP);
  - particulate matter less than 10 micrometres (µm) in aerodynamic diameter ($PM_{10}$); and
  - particulate matter less than 2.5 µm in aerodynamic diameter ($PM_{2.5}$).
- gaseous pollutants, specifically:
  - oxides of nitrogen ($NO_x$)[1], including nitrogen dioxide ($NO_2$);
  - sulfur dioxide ($SO_2$);
  - carbon monoxide (CO); and
  - volatile organic compounds (VOCs).

Of the above listed pollutants, this assessment will focus on emissions and impacts from particulate matter (TSP, $PM_{10}$ and $PM_{2.5}$) and $NO_2$. Impact assessment criteria applicable to particulate matter and $NO_2$ is presented in the following sections as defined in the Approved Methods for Modelling (NSW EPA 2016). The impact assessment criteria are designed to maintain ambient air quality that allows for the adequate protection of human health and well-being.

1 By convention, NOx = nitrous oxide (NO) + $NO_2$.

## 3.2 Applicable air quality assessment criteria

### 3.2.1 Particulate matter

The NSW EPA's impact assessment criteria for particulate matter, as documented in Section 7 of the Approved Methods for Modelling, are presented in Table 3.1. The assessment criteria for $PM_{10}$ and $PM_{2.5}$ are consistent with the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) national reporting standards (Department of the Environment 2016).

TSP, which relates to airborne particles less than around 45 µm in diameter (US-EPA 1999), is used as a metric for assessing amenity impacts (reduction in visibility, dust deposition and soiling of buildings and surfaces) rather than health impacts (NSW EPA 2013). Particles less than 10 µm and 2.5 µm in diameter, a subset of TSP, are fine enough to enter the human respiratory system and can lead to adverse human health impacts. The NSW EPA impact assessment criteria for $PM_{10}$ and $PM_{2.5}$ are therefore used to assess the potential impacts on human health of particulate matter concentrations.

The Approved Methods for Modelling classifies TSP, $PM_{10}$, $PM_{2.5}$ and dust deposition as criteria pollutants. Assessment criteria for criteria pollutants are applied at the nearest existing or likely future off-site sensitive receptor and compared against the $100^{th}$ percentile (ie the highest) dispersion modelling prediction in the case of 24-hour impacts. Both the incremental (proposed segment factory only) and cumulative (proposed segment factory + background) impacts need to be presented, the latter requiring consideration of existing ambient background concentrations for the criteria pollutants assessed.

For dust deposition, the NSW EPA (2016) specifies criteria for the project increment and cumulative dust deposition levels. Dust deposition impacts are derived from TSP emission rates and particle deposition calculations in the dispersion modelling process.

**Table 3.1 Impact assessment criteria for particulate matter**

| PM metric | Averaging period | Impact assessment criterion |
|---|---|---|
| TSP | Annual | 90 µg/m³ |
| $PM_{10}$ | 24 hours | 50 µg/m³ |
| | Annual | 25 µg/m³ |
| $PM_{2.5}$ | 24 hours | 25 µg/m³ |
| | Annual | 8 µg/m³ |
| Dust deposition | Annual | 2 g/m²/month (project increment only) |
| | | 4 g/m²/month (cumulative) |

Notes: µg/m³: micrograms per cubic metre; g/m²/month: grams per square metre per month. Dust deposition is assessed as insoluble solids as defined by AS 3580.10-1-1991.

### 3.2.2 Gaseous pollutants

The proposed segment factory is anticipated to generate emissions of a range of gaseous pollutants, including $NO_x/NO_2$, CO, $SO_2$ and VOCs from fuel combustion. This assessment focuses on $NO_2$ as the indicator[2] for all gaseous pollutants and emissions of $NO_x$ has been quantified in Section 6.4.

The impact assessment criteria for $NO_2$, as defined by the NSW EPA (2016), are summarised in Table 3.2.

**Table 3.2 Impact assessment criteria for $NO_2$**

| Pollutant | Averaging period | Impact assessment criterion |
|---|---|---|
| $NO_2$ | 1 hour | 246 µg/m$^3$ |
| | Annual | 62 µg/m$^3$ |

The impact assessment criteria for $NO_2$ are applicable at the nearest existing or likely future off-site sensitive receptor. In assessing compliance against the applicable criteria, the maximum cumulative concentration (project increment plus background concentration) at each receptor must be reported as the 100$^{th}$ percentile concentration (ie maximum concentration) for 1-hour impacts.

2 For combustion sources $NO_2$ is often the critical gaseous pollutant when considering emission rates, existing background concentrations and compliance with ambient air quality standards. This assessment therefore assumes that $NO_2$ represents a worst-case gaseous pollutant in this assessment.

# 4 Meteorology and climate

## 4.1 Monitoring data resources

There are no meteorological measurements collected at the site. In order to review and characterise the meteorological and climate environments of the surrounding area, data was collated from the Bureau of Meteorology (BoM) Automatic Weather Station (AWS) at Cooma Airport (Station Number 070217), located 17 km south-west of the site.

For the purpose of this assessment, one-hour average wind speed, wind direction, humidity, temperature, rainfall and barometric pressure data have been analysed for the BoM AWS at Cooma Airport for the period 2014 to 2018.

Figure 4.1 shows the location of the BoM AWS at Cooma Airport in relation to the site. The figure also shows the location of the ambient air quality monitors considered in this assessment (discussed further in Section 5).

## 4.2 Prevailing winds

Meteorological data recorded by the BoM AWS at Cooma Airport for the five-year period between 2014 and 2018 were analysed. Details relating to the selection of meteorological year and the representativeness of the dataset are provided in Annexure A.

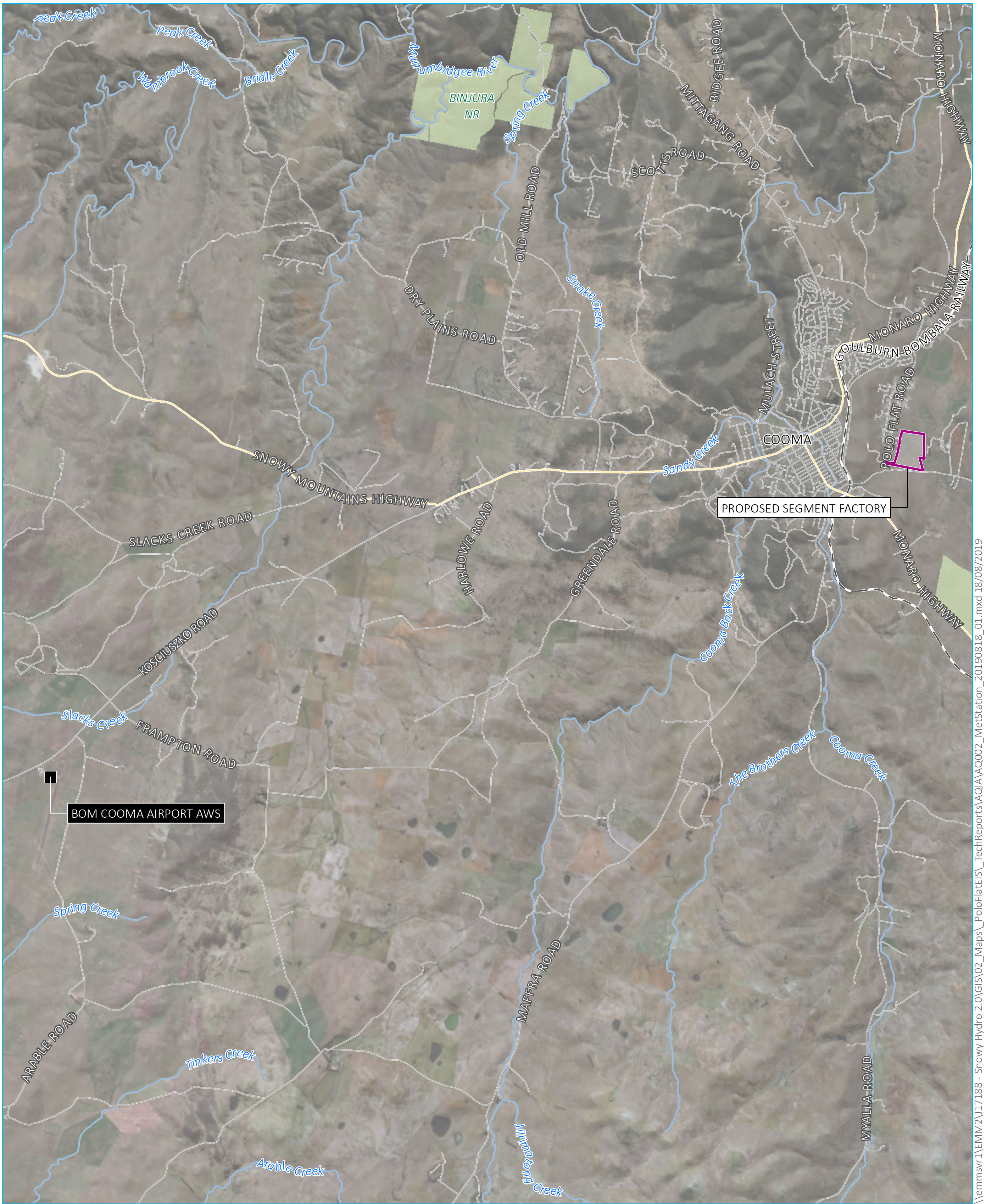
The 2017 calendar year was deemed representative of meteorological conditions in the project area (see Annexure A) and therefore was adopted as the 12-month modelling period for the purpose of this AQIA.

Annual wind roses for the BoM AWS at Cooma Airport are shown in Figure 4.2. Similar to the inter-annual wind roses presented in Annexure A, the recorded wind patterns for 2017 were dominated by north-easterlies. The annual average wind speed at the BoM AWS at Cooma Airport for 2017 was 4.2 m/s. Calm conditions (wind speeds less than 0.5 m/s) were 6.1% annually.

Seasonal and diurnal wind roses for the BoM AWS at Cooma Airport are provided in Annexure A.

The seasonal variation in wind speed at BoM AWS at Cooma Airport was minor, with the mean ranging from 3.6 m/s in autumn to 4.8 m/s in spring. Wind direction was also consistent throughout the seasons with each wind rose showing the dominant north-easterly wind flow. Winds from the west were more prominent in the spring, summer and winter months.

Diurnal variation in wind direction was minor with the dominant north-westerly wind pattern shown in both wind roses. Westerly winds were more prominent in the daylight wind rose. Wind speed was more varied diurnally. The mean wind speed during daylight hours was 4.9 m/s and 3.6 m/s during the night-time. The annual percentage of calms was 2.9% during the daylight hours and 9.5% during the night-time.




Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); BoM (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

KEY

- Site boundary
- BoM Cooma Airport AWS
- Rail line
- Main road
- Local road or track
- Watercourse
- NPWS reserve

Location of the BoM Cooma Airport AWS in relation to the proposed segment factory

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 4.1

snowy 2.0

EMM creating opportunities

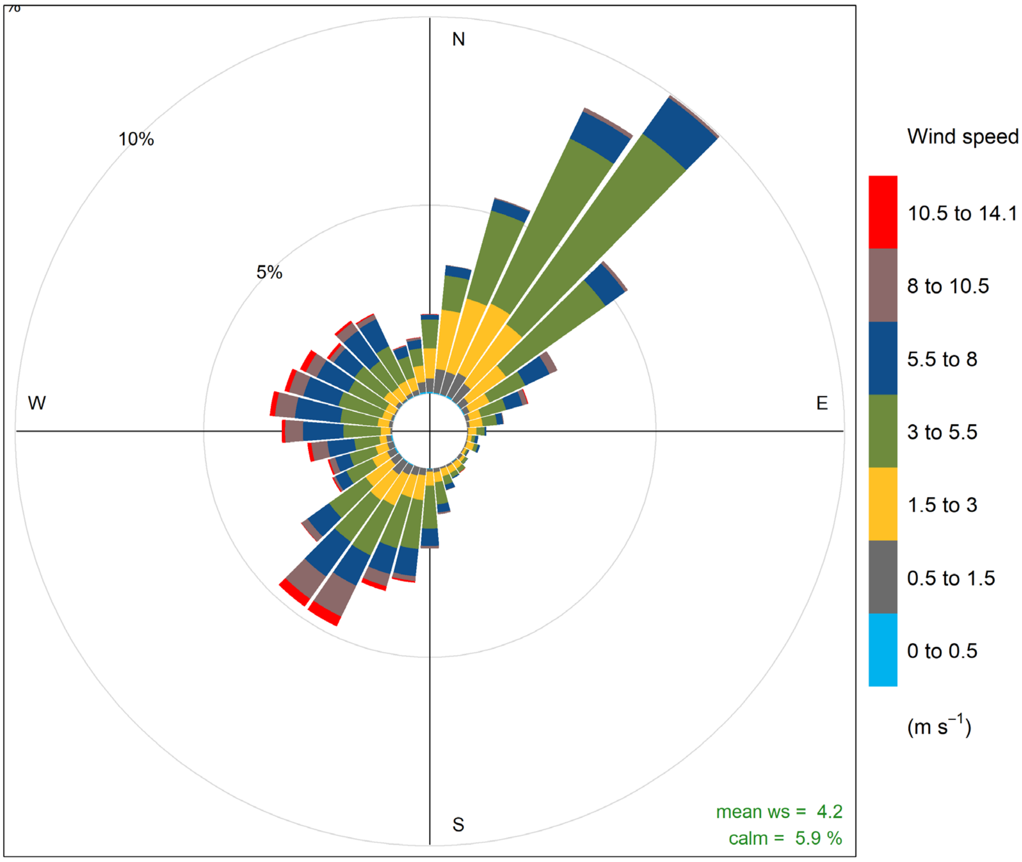



**Figure 4.2 Recorded wind speed and direction – BoM AWS Cooma Airport– 2017**

## 4.3 Meteorological modelling

### 4.3.1 Overview

Atmospheric dispersion modelling for this assessment has been completed using The Air Pollution Model (TAPM) and the CALMET/CALPUFF model suite.

Section 4.1 of the Approved Methods for Modelling specifies that meteorological data representative of a site can be used in the absence of suitable on-site observations. The data should cover a period of at least one year with a percentage completeness of at least 90%. Data can be obtained from either a nearby meteorological monitoring station or synthetically generated using the CSIRO prognostic meteorological model TAPM.

Hourly average meteorological data from the BoM AWS at Cooma Airport were used as observations in the TAPM and CALMET modelling. Periods of missing data, approximately 1% for the AWS Cooma Airport 2017 dataset, were replaced through interpolation.

Further details of the TAPM and CALMET meteorological modelling is presented in Annexure B.

### 4.3.2 CALMET predicted winds

As stated, hourly observations from the BoM AWS at Cooma Airport were used as input to the CALMET meteorological modelling completed. Hourly meteorological predictions were extracted at the site to compare with the measured data at the BoM AWS at Cooma Airport and verify the performance of CALMET in predicting local meteorological conditions. Verification was completed to confirm that the predicted winds at the site appeared reasonable and reflected local terrain features. Adopted CALMET settings, such as the RMAX and R1 factors are further explained in Section B.2.

An annual wind rose created from the CALMET data extract at the site is presented in Figure 4.3.

The annual wind rose for the site shows a similar pattern to the BoM AWS at Cooma Airport wind rose shown in Figure 4.2. There is a lower frequency of winds from the northeast in the CALMET wind rose when compared to the BoM AWS at Cooma Airport wind rose. It is noted that the local terrain features at the BoM AWS at Cooma Airport, specifically a gap in elevated terrain to the north-east of the airport, is likely channelling air flow and influencing this recorded pattern. The terrain to the north-east of the extract location (ie the site) is predominantly flat in comparison. The annual average wind speed from the CALMET extract is 3.1 m/s and the annual percentage of calms is 3.8%.

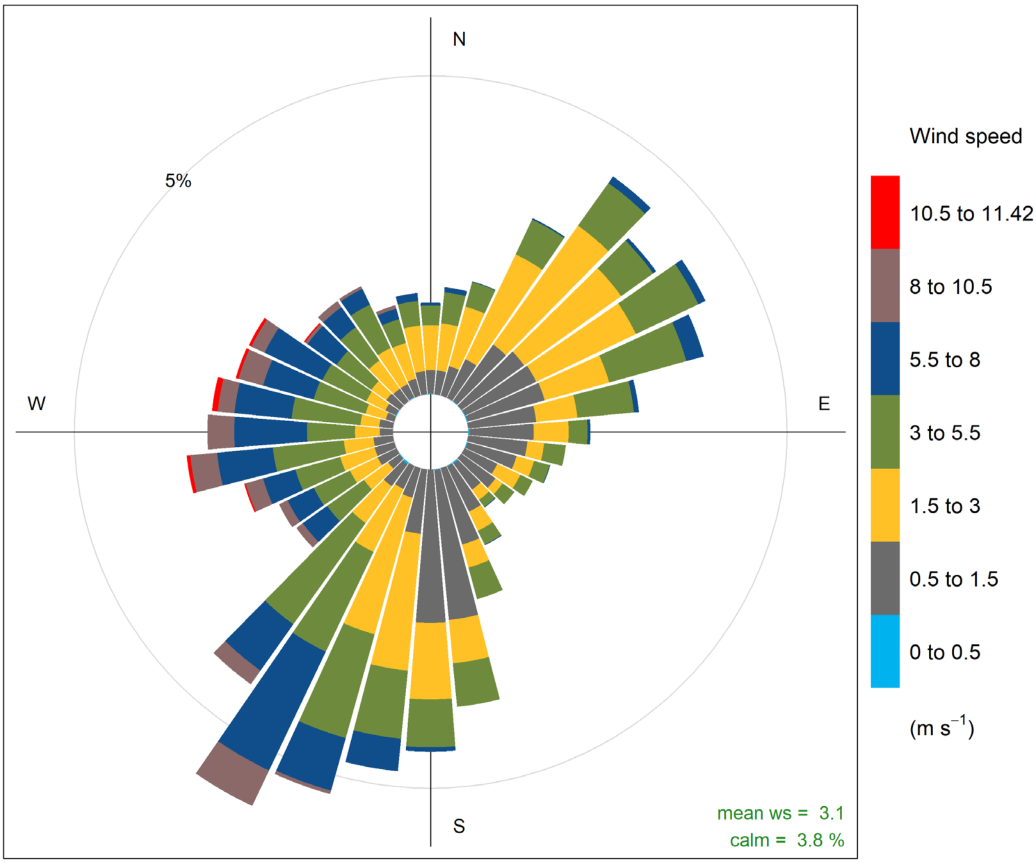



**Figure 4.3 CALMET-predicted wind speed and direction – proposed segment factory site– 2017**

### 4.3.3 Atmospheric stability and mixing depth

Atmospheric stability refers to the degree of turbulence or mixing that occurs within the atmosphere and is a controlling factor in the rate of atmospheric dispersion of pollutants.

The Monin-Obukhov length (L) provides a measure of the stability of the surface layer (ie the layer above the ground in which vertical variation of heat and momentum flux is negligible; typically about 10% of the mixing height). Negative L values correspond to unstable atmospheric conditions, while positive L values correspond to stable atmospheric conditions. Very large positive or negative L values correspond to neutral atmospheric conditions.

Figure 4.4 illustrates the diurnal variation of atmospheric stability, derived from the Monin-Obukhov length calculated by CALMET, extracted at the site. The diurnal profile shows that atmospheric instability increases during the daylight hours as the sun generated convective energy increases, whereas stable atmospheric conditions prevail during the night-time. This profile indicates that the potential for effective atmospheric dispersion of emissions would be greatest during daytime hours and lowest during evening through to early morning hours.

Mixing depth refers to the height of the atmosphere above ground level within which the dispersion of air pollution can be dispersed. The mixing depth of the atmosphere is influenced by mechanical (associated with wind speed) and thermal (associated with solar radiation) turbulence. Similar to the Monin-Obukhov length analysis above, higher daytime wind speeds and the onset of incoming solar radiation increases the amount of mechanical and convective turbulence in the atmosphere. As turbulence increases, so too does the depth of the boundary layer, generally contributing to higher mixing depths and greater potential for the atmospheric dispersion of pollutants.

Figure 4.5 presents the hourly-varying atmospheric boundary layer depths generated by CALMET. Greater boundary layer depths occur during the daytime hours, peaking in the mid to late afternoon.

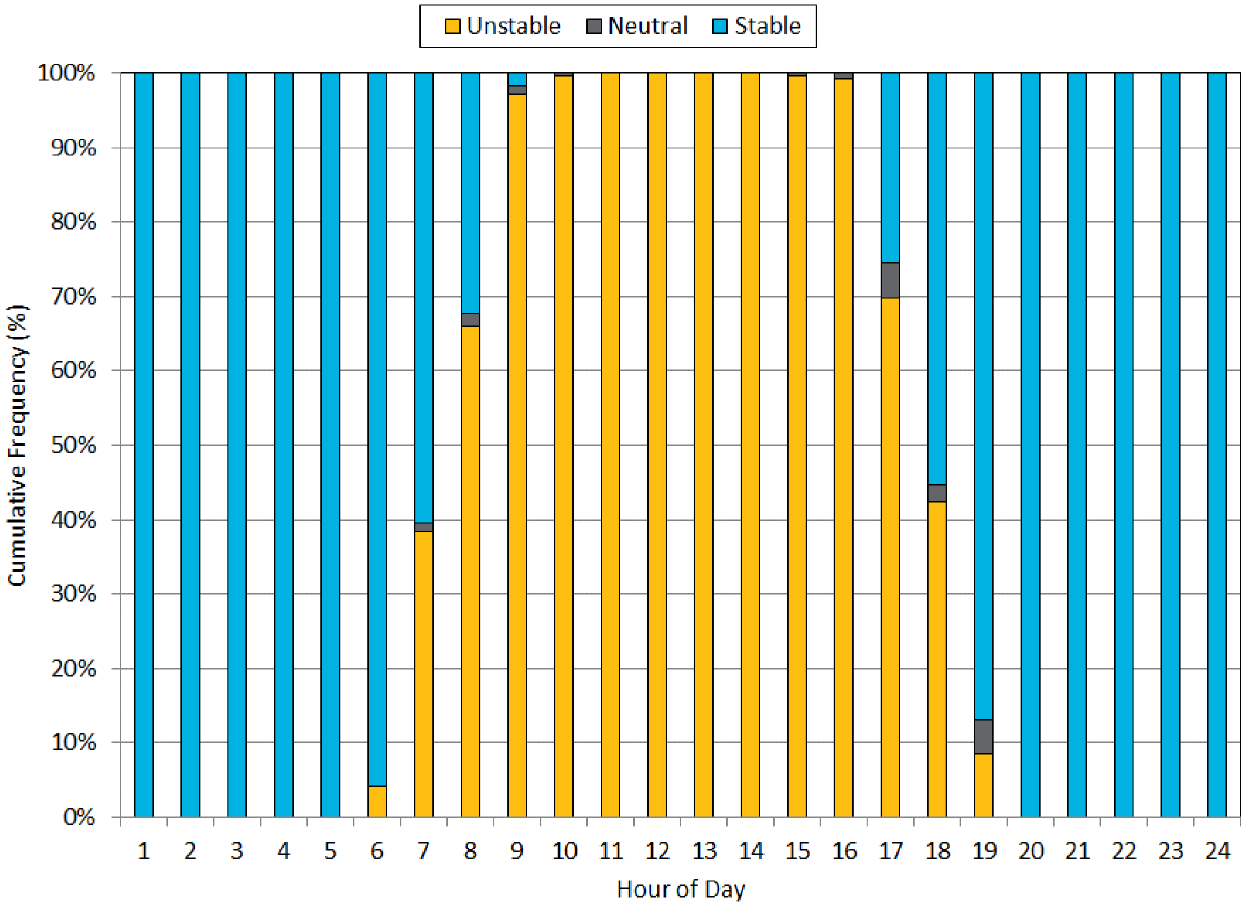



**Figure 4.4** **CALMET-calculated diurnal variation in atmospheric stability – proposed segment factory site– 2017**

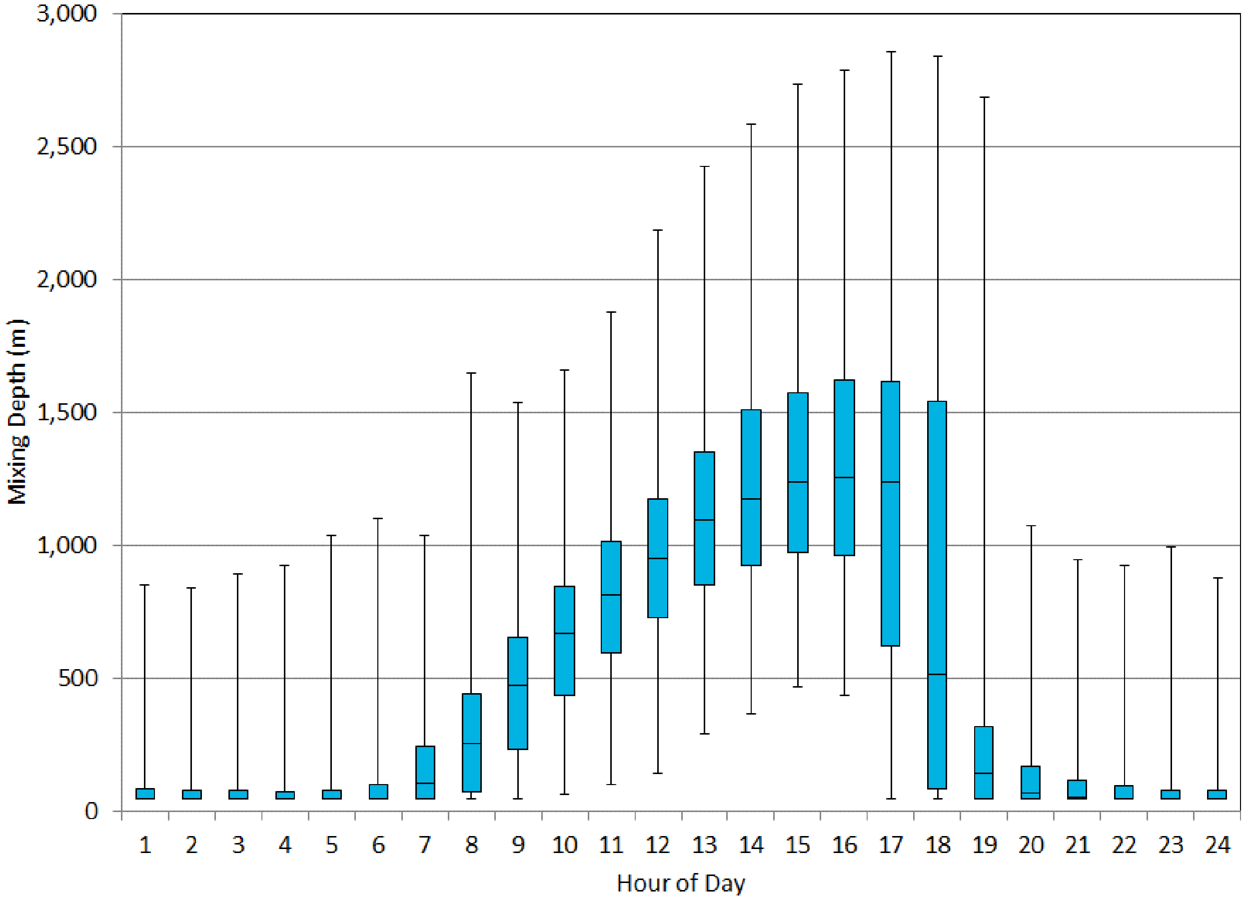



**Figure 4.5** **CALMET-calculated diurnal variation in atmospheric mixing depth – proposed segment factory site– 2017**

# 5 Background air quality

## 5.1 Overview

When assessing the air quality impacts of a project against the criteria in the NSW Approved Methods for Modelling, the standard approach is to add the project's modelled contribution to the existing 'background' concentration. In theory, the background concentration represents the contribution from all sources other than the modelled project. It typically includes, for example, contributions from natural sources and domestic activity.

The Approved Methods for Modelling states the following:

> Including background concentrations of pollutants in the assessment enables the total impact of the proposal (ie impact of emissions on existing air quality) to be assessed. The background concentrations of air pollutants are ideally obtained from ambient monitoring data collected at the proposed site. As this is extremely rare, data is typically obtained from a monitoring site as close as possible to the proposed location where the sources of air pollution resemble the existing sources at the proposal site. (NSW EPA 2016)

The concentrations of some air pollutants, including $PM_{10}$, $PM_{2.5}$ and $NO_2$, vary significantly in time. In the case of particulate matter, events such as dust storms, natural bush fires and planned burning activities are often associated with high concentrations. This temporal variation should be captured where possible in the definition of the background.

It is also important that the same year is used for the background air quality data and the meteorological data used in the dispersion modelling, given the strong influence of the latter on the former. For this assessment, the selected year for the meteorological data and modelling was 2017 (see Section 4).

The approaches used to determine long-term and short-term background concentrations for $PM_{10}$, $PM_{2.5}$ and $NO_2$ in this assessment are explained below. The implications of the selection of 2017 with respect to background air quality for the project are also discussed.

## 5.2 Existing sources of emissions

Airborne particulate matter is a complex mixture of substances that are derived from a range of sources and processes. The contributions of these sources and processes, and hence the physical and chemical properties of particulate matter, vary according to many factors including location, season, time of day, and both local and regional weather conditions.

The National Pollutant Inventory (NPI) and NSW EPA environment protection licence (EPL) databases have been reviewed to identify significant existing sources of air pollutants within 10 km of the proposed segment factory. The following reporting sources were identified:

- Ocwen Energy (fuel) Depot, Cooma, located 3 km north-west of the site;
- Elgas Cooma gas supplier, located 0.6 km to the north-west of the site;
- Jemena Eastern Gas Pipeline, Cooma Main Line Valve and Meter Station, located 1.5 km east of the site;
- Snowy Monaro Regional Council, the Glen Wastewater Treatment Facility, located 5 km north-west of the site;
- Monbeef Cooma Abattoir, located 0.35 km to the north-east of the site; and
- Cooma landfill located 1 km to the south-east of the site.

Of these reporting industrial operations, only the landfill operations generate emissions similar to the proposed segment factory (ie particulate matter and fuel combustion pollutants). Given the separation distance of the landfill from the proposed segment factory, it is considered unlikely that landfill emissions would result in significant direct cumulative impacts at surrounding receptors. The primary pollutants for the remaining sources are fugitive gaseous pollutant releases (fuel depots, gas pipeline meter station) or odour (abattoir and wastewater treatment plant) and are therefore unlikely to influence cumulative impacts from the proposed segment factory.

While not included in the NPI or NSW EPA EPL databases, a number of smaller industrial sources are located in the Polo Flats industrial estate to the west of the proposed segment factory, including a concrete batching plant, an auto wrecker, an aggregate materials processing yard and assorted manufacturing operations. It is considered that none of these sources are likely to generate significant cumulative impacts when considered with impacts generated by the proposed segment factory.

Finally, in addition to these neighbouring industrial sources, other contributing sources of air pollutant emissions to baseline air quality in the vicinity of the proposed segment factory include:

- dust entrainment due to vehicle movements along unsealed and sealed town and rural roads with high silt loadings;
- agricultural practices;
- fuel combustion-related emissions from on-road and non-road engines;
- wind generated dust from exposed areas within the surrounding region;
- seasonal emissions from household wood burning;
- episodic emissions from vegetation fires; and
- remote emissions sources such as regional scale dust storms and bushfires.

It is expected that the adopted baseline air quality dataset, detailed in Section 5.5, is sufficiently conservative to account for the contribution of these local and regional emission sources.

## 5.3 Air quality monitoring data resources

There are no current air quality measurements available for the Cooma area. The closest government monitoring stations to the proposed segment factory site are located in the Australian Capital Territory (ACT), between around 90 and 110 km to the north of Cooma. Three air quality monitoring stations (Civic, Florey and Monash) are operated by ACT EPA for compliance with the AAQ NEPM and are illustrated on Figure 5.1.

While spatially remote from Cooma, it is considered that the ACT monitoring stations provide the most representative publicly available source of monitoring data to quantify background air quality at the proposed segment factory site. Discussion of recorded concentrations at the ACT monitoring stations is presented in Section 5.4.

Other monitoring datasets considered included a $PM_{2.5}$ monitoring station within the broader Snowy 2.0 project area at Yarrangobilly and NSW Office of Environment and Heritage (OEH) monitoring stations at Wagga Wagga North and Albury.

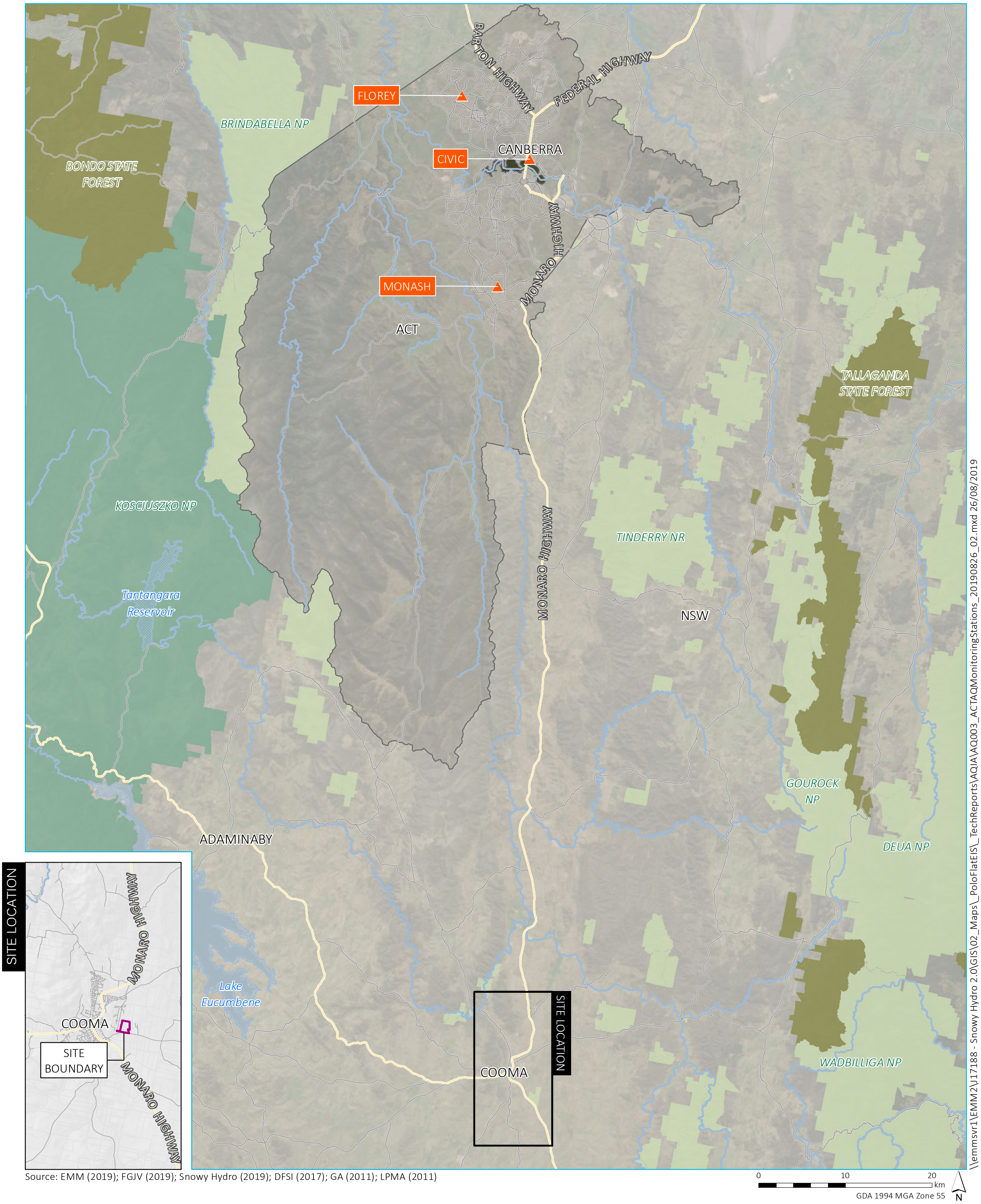
Long term monitoring of $PM_{2.5}$ was conducted by Australian Nuclear Science and Technology Organisation (ANSTO) at a single location in the Snowy Mountains, as reported by Tadros et al. (2018). The monitoring was conducted between 2013 and 2017 at a location above Jillabenan Cave within the Yarrangobilly Caves system in the northern part of KNP. The sampler was installed at an altitude of 1,059 m AHD, which is somewhat higher than Cooma (approximately 800 m AHD), and given the virtual absence of human activity at the sampling location the mix of pollution sources would be much less extensive than at Cooma. It is noted that 24-hour average $PM_{2.5}$ concentrations were only recorded two days per week at the CSIRO station, and therefore the dataset does not completely meet the requirements of the Approved Methods for Modelling. Furthermore, $PM_{10}$ concentrations were not measured at the location. Data from this station is referenced for comparison against the ACT monitoring datasets.

The NSW OEH monitoring stations at Wagga Wagga North (approximately 200 km inland from Cooma) and Albury (approximately 190 km inland from Cooma) were also considered. The OEH stations were therefore considerably further away from the site than the ACT stations. In addition, the altitude at Cooma is around 800 m AHD whereas the two NSW OEH stations are located at approximately 200 m AHD. Based on Köppen climate classification maps provided by the BoM[3], the climate classification of the site (temperate/no dry season/mild summer) is more comparable to that of the ACT monitoring stations (temperate/no dry season/warm summer) than the NSW OEH stations (temperate/no dry season/hot summer). Finally, the NSW OEH stations are located to the west of the Great Dividing Range, where there can be an influence on air pollution from emission sources that are not relevant to the project area such as extensive agricultural activities. For example, at Wagga Wagga particle levels[4] are impacted by wide-scale agricultural activities (including stubble burning) during the cooler months (NSW OEH 2018).

For these reasons, the NSW OEH monitoring stations at Wagga Wagga North and Albury were not considered further in this AQIA.

[3] http://www.bom.gov.au/jsp/ncc/climate_averages/climate-classifications/index.jsp

[4] During 2017 the highest daily $PM_{10}$ concentration recorded at Wagga Wagga was 171.6 $\mu g/m^3$. This was probably due to widespread agricultural burning (OEH 2017).




Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); GA (2011); LPMA (2011)

KEY

- Site boundary
- ACT air quality monitoring station
- Main road
- Local road or track
- Watercourse
- Kosciuszko National Park
- NPWS reserve
- State forest
- Waterbody

Locations of ACT air quality monitoring stations – regional context

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 5.1

snowy 2.0

EMM creating opportunities

## 5.4 Recorded concentrations

The measurements of $PM_{10}$, $PM_{2.5}$ and $NO_2$ at the three ACT stations between 1 January 2014 and 31 December 2018 were considered in the assessment, with the data being obtained from the ACT Government web site[5]. As noted in Section 3.2, the impact assessment criteria for $PM_{10}$ and $PM_{2.5}$ are stated in terms of annual average and 24-hour average concentrations, whereas those for $NO_2$ are stated in terms of annual average and 1-hour average concentrations.

The time series of 24-hour average $PM_{10}$ and $PM_{2.5}$ concentrations are shown in Figure 5.2 and Figure 5.3 respectively. In the case of $PM_{10}$ the figure contains an inset to show that some particularly elevated concentrations were recorded on 16 December 2018. Figure 5.4 shows the time series for maximum daily 1-hour average $NO_2$ concentrations. It should be noted that the measurement of $NO_2$ at the Civic station ceased in February 2014.

The temporal patterns in the $PM_{10}$ and $PM_{2.5}$ monitoring data are shown in Annexure C. Some basic statistics for $PM_{10}$ and $PM_{2.5}$ at the three stations are also presented in Table 5.1, and statistics for $NO_2$ are given in Table 5.2.

[5] https://www.data.act.gov.au/Environment/Air-Quality-Monitoring-Data/94a5-zqnn

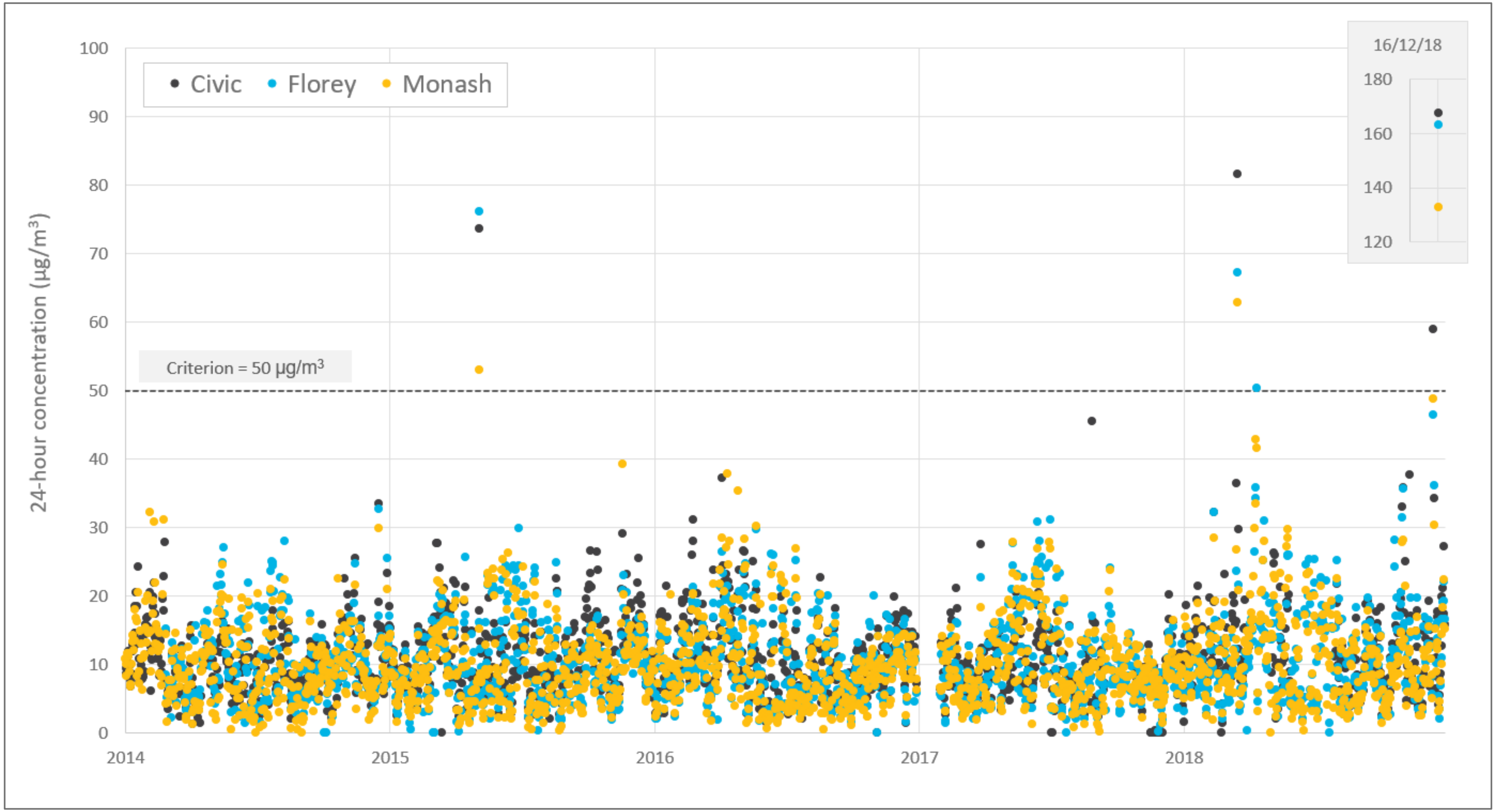



**Figure 5.2 Time series of 24-hour average $PM_{10}$ concentrations at ACT stations**

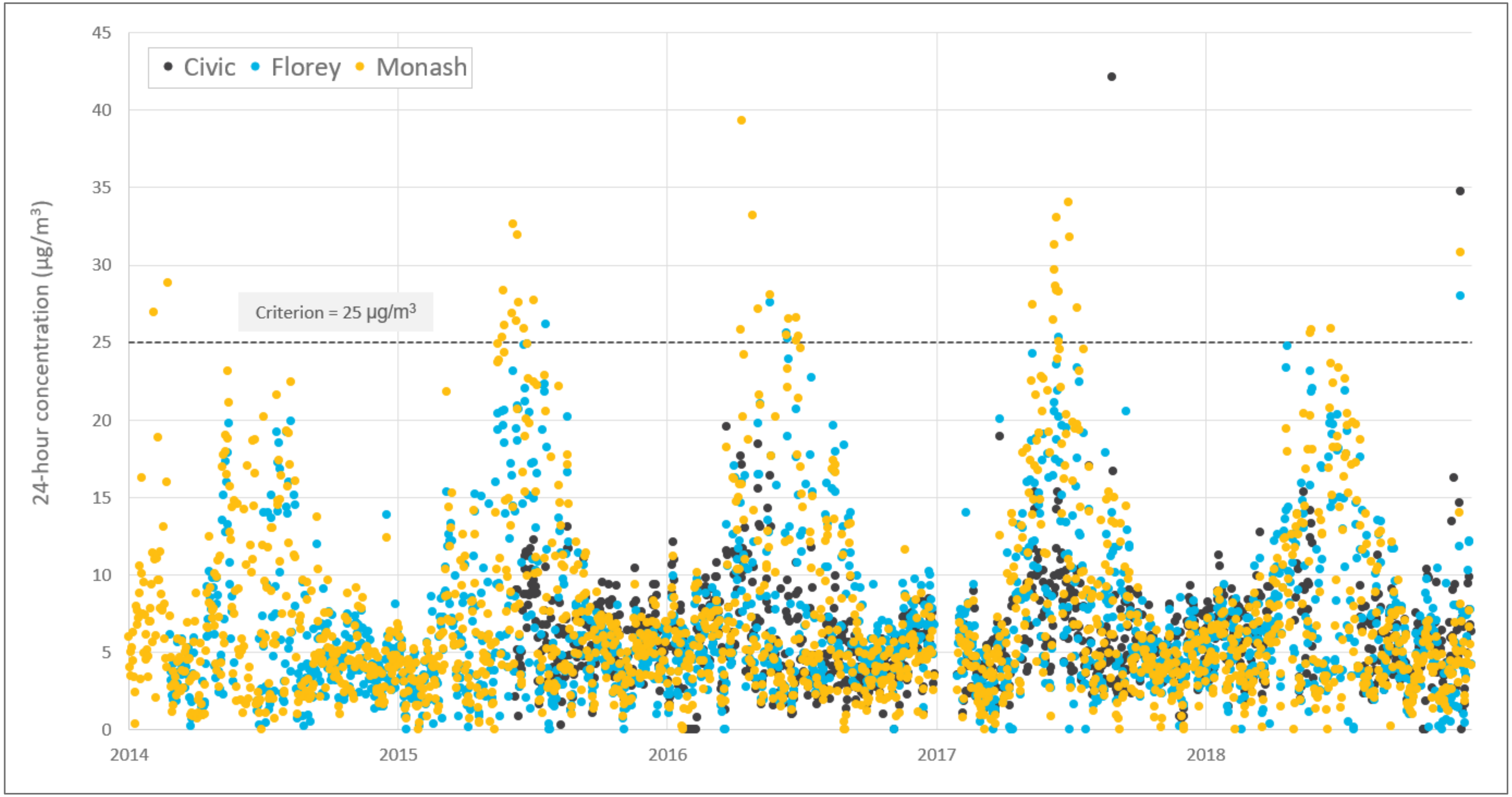



**Figure 5.3 Time series of 24-hour average $PM_{2.5}$ concentrations at ACT stations**

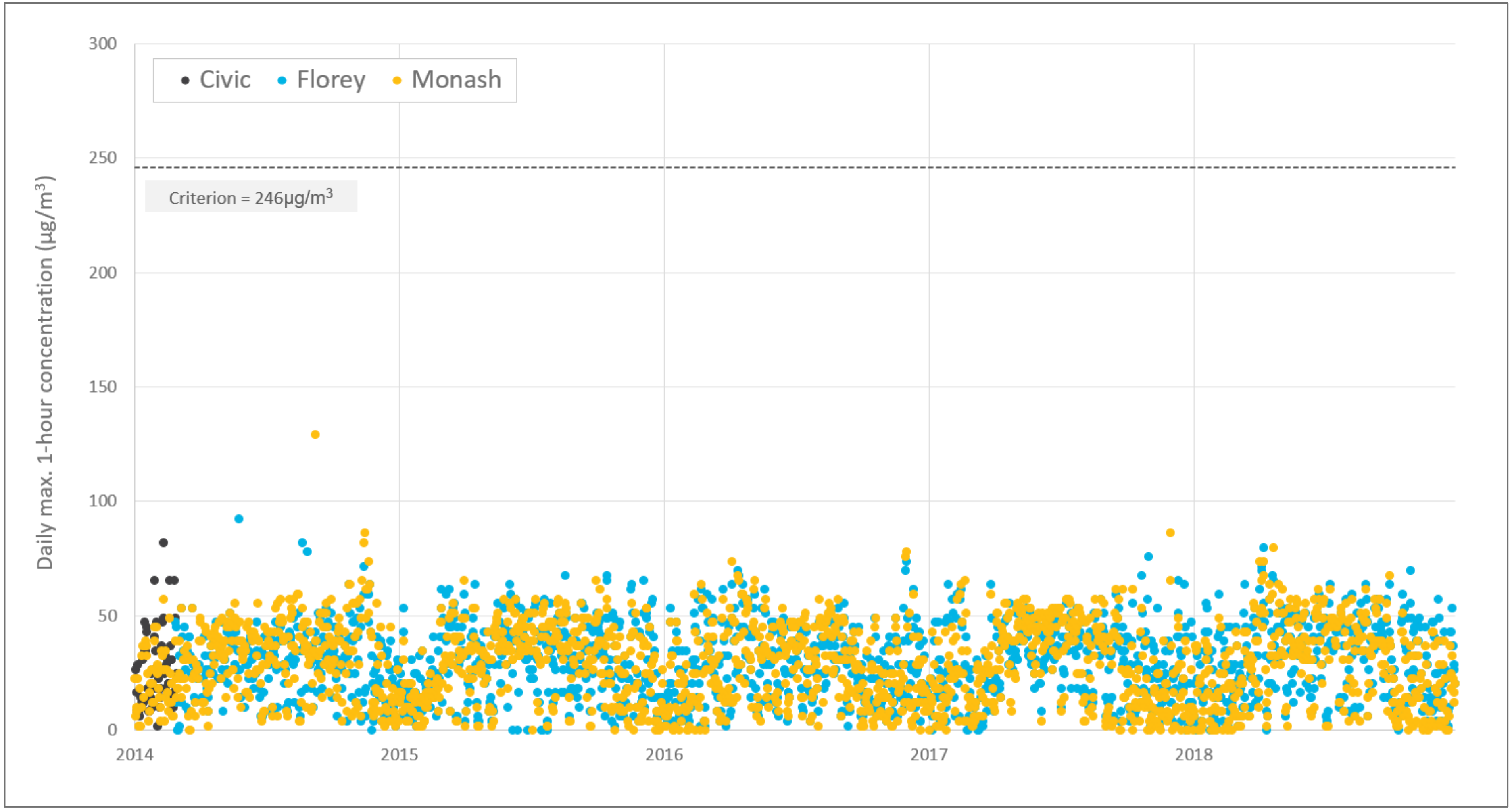



**Figure 5.4** **Time series of maximum daily 1-hour average $NO_2$ concentrations at ACT stations**

## Table 5.1 Summary of $PM_{10}$ and $PM_{2.5}$ measurements at ACT stations

| Statistic | Year | $PM_{10}$ (µg/m$^3$) | | | $PM_{2.5}$ (µg/m$^3$) | | |
|---|---|---|---|---|---|---|---|
| | | Civic | Florey | Monash | Civic | Florey | Monash |
| Average | 2014 | 10.0 | 10.0 | 9.8 | -[(a)] | - | 6.5 |
| | 2015 | 11.1 | 10.3 | 9.8 | - | 6.4 | 7.1 |
| | 2016 | 10.7 | 10.0 | 9.8 | 5.3 | 7.0 | 7.0 |
| | 2017 | 9.0 | 9.8 | 9.8 | 5.8 | 7.0 | 7.8 |
| | 2018 | 13.0 | 11.9 | 11.7 | 6.0 | 6.9 | 6.8 |
| | Average 2014–2017 | 10.2 | 10.0 | 9.8 | 5.6 | 6.8 | 7.1 |
| Max. 24-hour | 2014 | 33.5 | 32.6 | 32.2 | - | - | 28.8 |
| | 2015 | 73.6 | 76.2 | 53.1 | - | 26.2 | 32.6 |
| | 2016 | 37.3 | 29.8 | 37.9 | 19.6 | 27.6 | 39.3 |
| | 2017 | 45.6 | 31.2 | 27.9 | 42.1 | 25.3 | 34.0 |
| | 2018 | 167.3 | 163.0 | 132.9 | 34.7 | 28.0 | 30.8 |
| | Average 2014–2017 | 47.5 | 42.4 | 37.8 | 30.9 | 26.4 | 33.7 |

Notes: a) a dash indicates where data availability was less than 75% for the year.

## Table 5.2 Summary of $NO_2$ measurements at ACT stations

| Statistic | Year | $NO_2$ (µg/m$^3$) | |
|---|---|---|---|
| | | Florey | Monash |
| Average | 2014 | 9.7 | 9.7 |
| | 2015 | 9.9 | 8.8 |
| | 2016 | 9.6 | 8.2 |
| | 2017 | 10.2 | 9.2 |
| | 2018 | 9.5 | 8.1 |
| | Average 2014–2018 | 9.8 | 8.8 |
| Max. 1-hour | 2014 | 92.4 | 129.3 |
| | 2015 | 67.7 | 65.7 |
| | 2016 | 73.9 | 78.0 |
| | 2017 | 75.9 | 86.2 |
| | 2018 | 80.0 | 80.0 |
| | Average 2014–2018 | 78.0 | 87.8 |

The following observations have been made:

- The figures show that, for both $PM_{10}$ and $PM_{2.5}$, there was very little variation in the average concentration by hour of the day, and little variation by day of the week. On the other hand, there was a seasonal influence on concentrations. $PM_{10}$ concentrations were typically highest in autumn, whereas $PM_{2.5}$ generally peaked in winter.

- The Civic station generally had higher $PM_{10}$ concentrations but lower $PM_{2.5}$ concentrations than the Florey and Monash stations. $PM_{2.5}$ at Florey and Monash was especially high compared with Civic during winter. This is attributed to the difference in setting of the Civic station (Canberra CBD) compared with the Florey and Monash stations (residential) and the influence of domestic wood heater emissions. It is noted that ACT Health commissioned a study in 2009 (Bridgman 2009) investigating the air quality of the Tuggeranong Valley (within which the Monash station is located). This report found that domestic wood heating during winter months significantly influenced particulate matter concentrations experienced in the area. The influence of domestic wood heater emissions in the ACT monitoring datasets is considered highly relevant for Cooma.

- For $PM_{10}$, annual mean concentrations in 2018 were markedly higher than, and in some cases significantly[6] different from, those in previous years. Maximum 24-hour concentrations in 2018 were much higher than those in previous years. The increase in $PM_{10}$ concentrations in 2018 is linked to the extensive drought conditions across NSW during the year (OEH 2019).

- For $PM_{2.5}$, the differences between 2018 and the other years were less pronounced. In terms of annual mean concentrations, the result for Civic in 2018 was higher than, and significantly different from, the results for previous years. However, at Florey the annual mean in 2018 was lower than, but not significantly different from, the means in 2016 and 2017. At Monash the annual mean $PM_{2.5}$ concentration in 2018 was lower than in most other years. For maximum 24-hour $PM_{2.5}$ concentrations, the results for 2018 were broadly representative of those for previous years, notwithstanding that the values for the Civic station were quite variable from year to year.

- For $NO_2$ the annual mean concentrations at the Florey and Monash stations varied little from year to year and were well below the impact assessment criterion of 30 $\mu g/m^3$. Maximum 1-hour concentrations were also well below the impact assessment criterion of 246 $\mu g/m^3$.

Based on the analysis undertaken, it was considered that the concentrations in 2017 were representative of concentrations in previous years, and therefore suitable for use in the air quality assessment. Table 5.2 shows average values for the period 2014–2017. $PM_{10}$ concentrations in 2017 were similar to, or lower than, the four-year average, whereas $PM_{2.5}$ concentrations in 2017 were similar to or higher than the four-year average. Annual average and maximum 1-hour concentrations of $NO_2$ in 2017 were representative of the longer-term average.

6 A multiple comparison test (Student-Newman-Keuls - SNK) was used to test the differences between the annual mean $PM_{10}$ concentrations in different yeas. For the Monash station the SNK test showed that the mean $PM_{10}$ concentration in 2018 was significantly different from the mean concentrations in all other years. For the Florey station the means in 2015 and 2018 were significantly different from those in the other years. For the Civic station, where $PM_{10}$ was more variable, the annual mean concentrations in all years were significantly different.

While there are differences in the local emission source characteristics at Cooma relative to Canberra (ie higher urban development in Canberra vs higher agricultural practices in Cooma), the concentrations measured at the ACT stations are likely to be higher than they would be at Cooma. For example, the measurements at the ACT stations are influenced by anthropogenic emissions from human activity that is on a much larger scale than that at Cooma. According to the 2016 census, Canberra has a population of around 400,000, whereas the population of Cooma is around 7,000. Based on analysis presented by the NSW OEH (OEH 2017 and 2018), increased particulate matter concentrations across the NSW monitoring network coincide with regional scale events, such as dust storms and bushfire/hazard reduction burn events. Consequently, elevated concentrations associated with regional scale events recorded by the ACT monitoring stations will be representative of conditions at Cooma.

For additional context, the measurements in the Snowy Mountains by Tadros et al. (2018) showed a four-year average $PM_{2.5}$ concentration of 3.3 $\mu g/m^3$. Although the comparison is not a direct one, this is substantially lower than the long-term average concentration at the ACT station (5.6–7.1 $\mu g/m^3$) and reflects the remoteness of the Snowy Mountains station.

It is therefore considered, based on the analysis above, that the use of ACT Government air quality monitoring data is appropriate for representing ambient air quality conditions at Cooma.

## 5.5 Assumed background concentrations

### 5.5.1 $PM_{10}$ and $PM_{2.5}$

As noted in the previous section, the data from the ACT stations in 2017 were used to define background concentrations of $PM_{10}$ and $PM_{2.5}$ for the assessment.

For each pollutant, a 'synthetic profile' of background concentrations was defined using the data from the three ACT stations. This took the form of a time series of 24-hour average concentrations during 2017. For each day of 2017, the value in the synthetic profile was taken to be the *average* value across the three ACT stations. Some gap filling was required for January 2017, as there were no data for the three stations. The values for each day in this month were defined as a mean for the corresponding day between 2014 and 2016.

The synthetic profiles for $PM_{10}$ and $PM_{2.5}$ are shown in Figure 5.5 and Figure 5.6 respectively. The corresponding 24-hour air quality criterion for each pollutant is also shown in each figure. In addition, some key summary statistics for the two profiles are presented in Table 5.3.

Concentrations of $PM_{10}$ and $PM_{2.5}$ in the synthetic background datasets developed are below the applicable impact assessment criterion throughout the 2017 calendar year. For the $PM_{2.5}$ dataset, concentrations are elevated (greater than 20 $\mu g/m^3$) during mid-June and in September. The elevated concentrations in June are associated with the influence of domestic wood heater emissions, while the September peak was coincident with extensive hazard reduction burns across NSW.

### 5.5.2 $NO_2$

To convert predicted concentrations of $NO_x$ to $NO_2$, the ozone limiting method (OLM) prescribed in Section 8.1.2 of the NSW EPA Approved Methods for Modelling (EPA, 2016) has been applied. While further detail relating to this approach is presented in Section 7.2, the OLM requires background concentrations of $NO_2$ and ozone ($O_3$).

Similar to the approach undertaken for $PM_{10}$ and $PM_{2.5}$, a 'synthetic profile' of background concentrations was defined using the data from the ACT air quality monitoring stations. For each hour of 2017, the value in the synthetic profile was taken to be the *average* value across the ACT stations (two for $NO_2$ and three for $O_3$).

The synthetic profiles for $NO_2$ and $O_3$ are shown in Figure 5.7 and Figure 5.8 respectively. The corresponding 1-hour air quality criterion is also shown in each figure. In addition, some key summary statistics for the two profiles are presented in Table 5.4.

It can be seen from these figures that the recorded concentrations of $NO_2$ and $O_3$ were well below applicable NSW EPA impact assessment criteria throughout 2017.

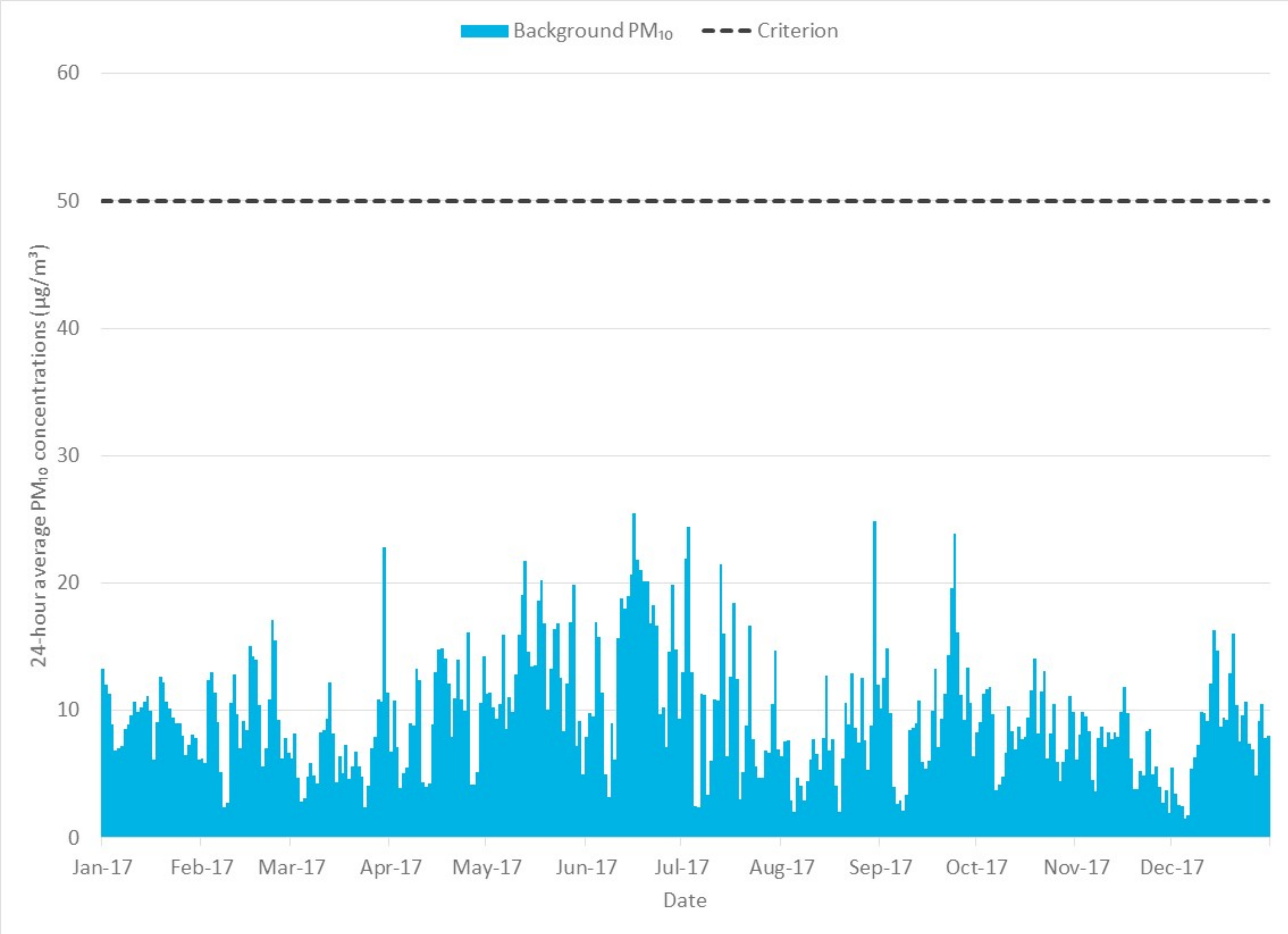



**Figure 5.5 Synthetic background profile for $PM_{10}$**

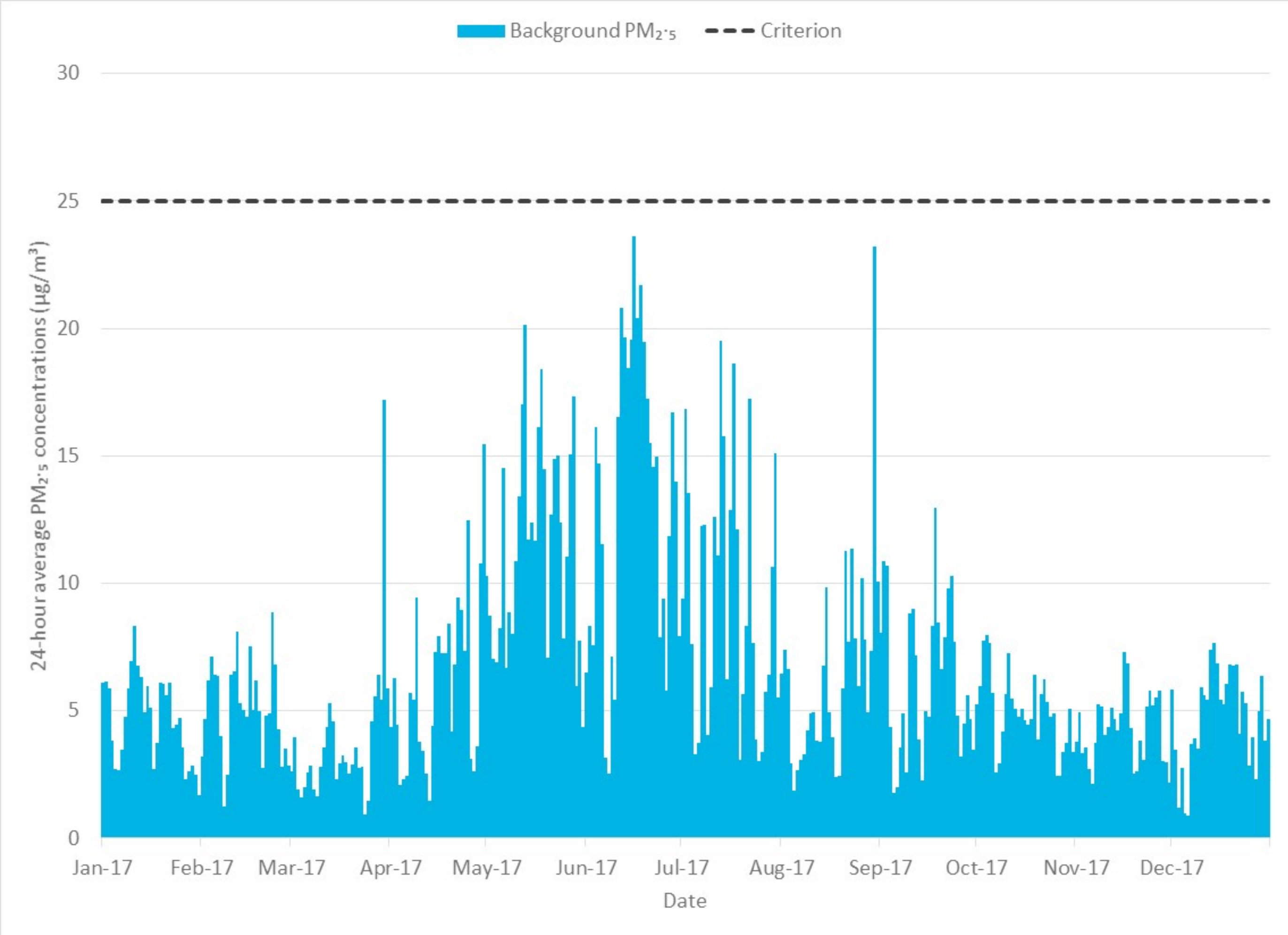



**Figure 5.6 Synthetic background profile for $PM_{2.5}$**

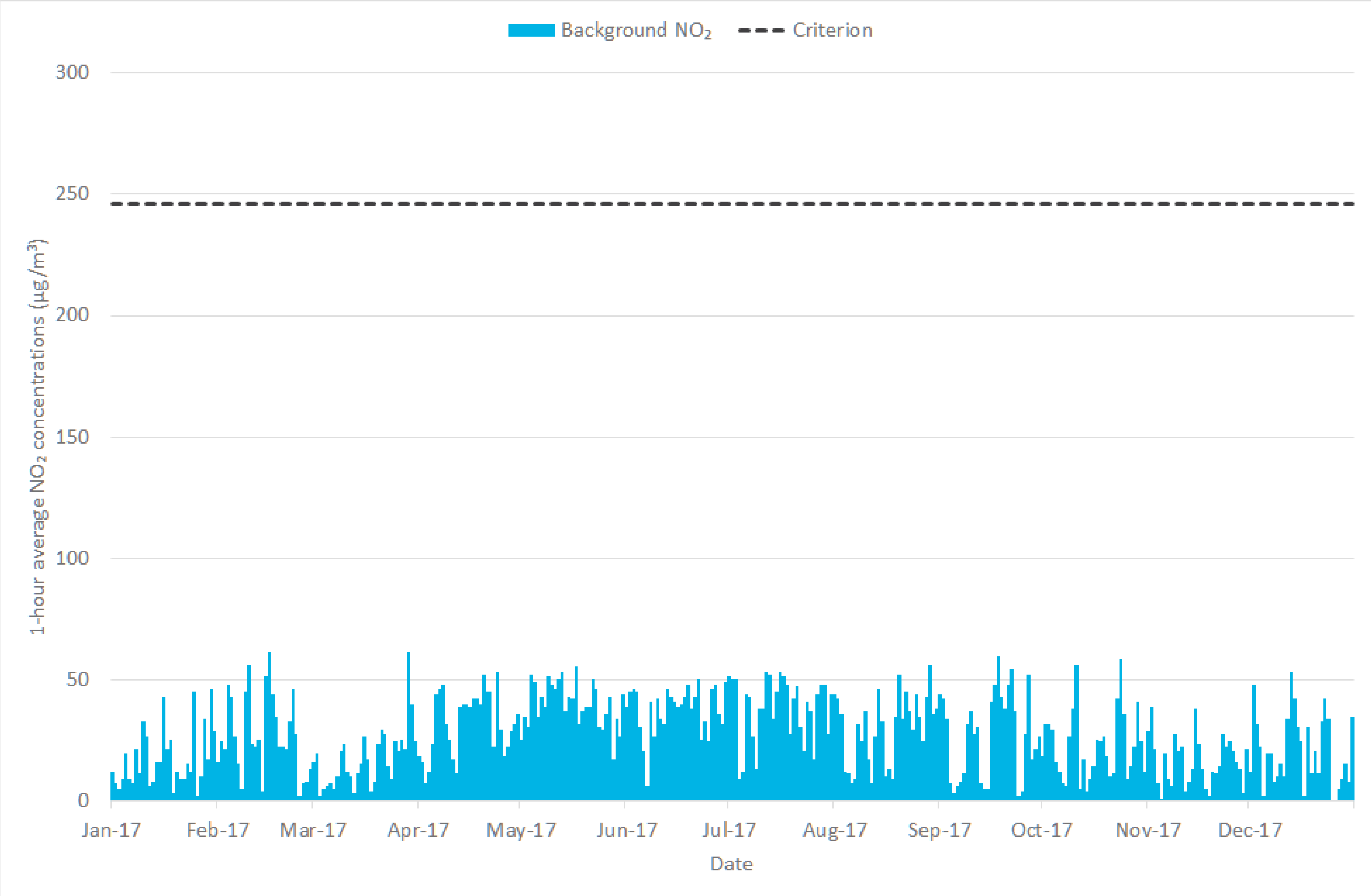



**Figure 5.7 Synthetic background profile for $NO_2$**

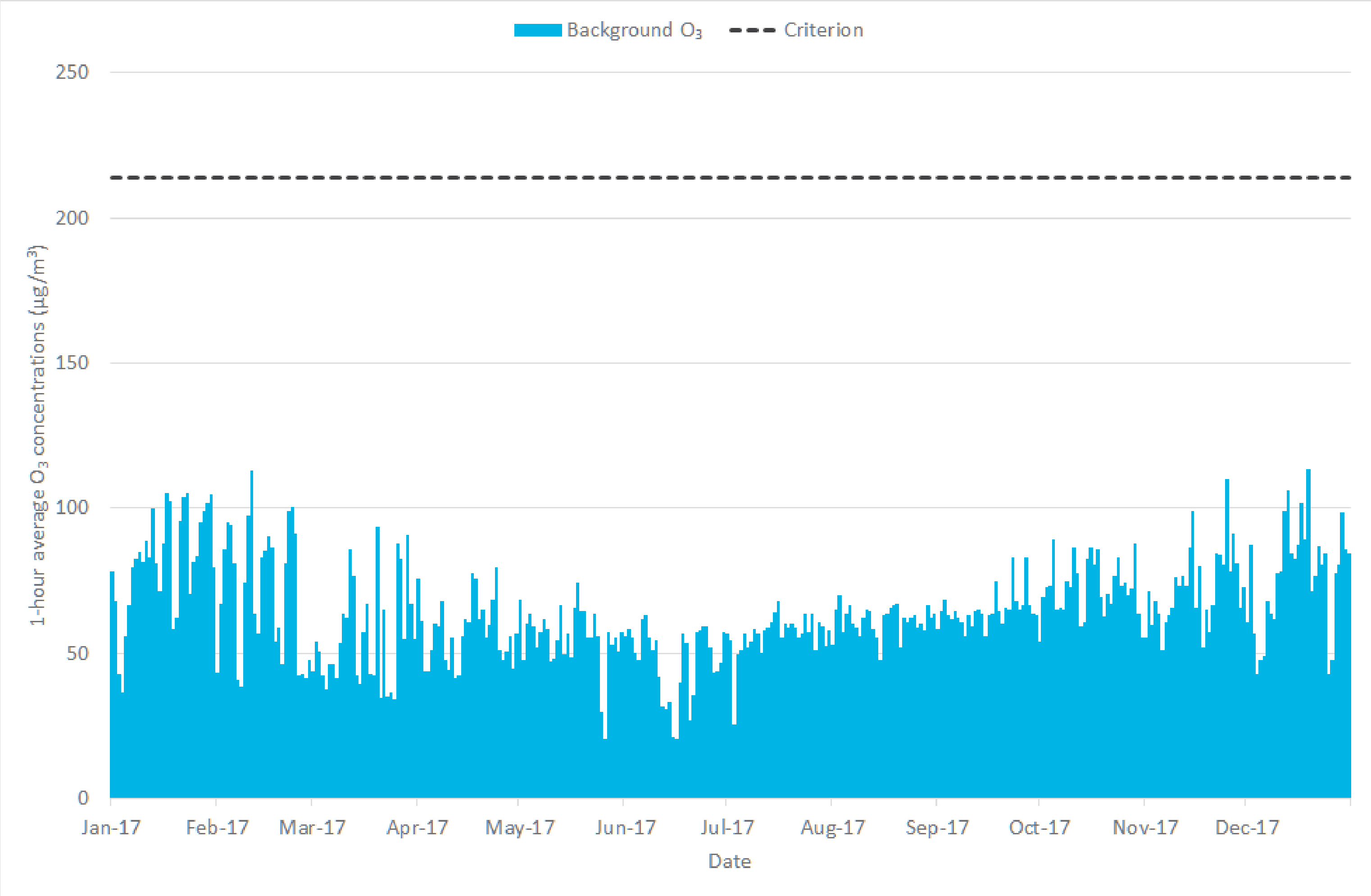



**Figure 5.8 Synthetic background profile for $O_3$**

## Table 5.3 Summary statistics for synthetic profiles – $PM_{10}$ and $PM_{2.5}$

| Statistic | 24-hour average concentration (µg/m³) | |
|---|---|---|
| | $PM_{10}$ | $PM_{2.5}$ |
| Maximum | 25.4 | 23.6 |
| 2nd highest | 24.9 | 23.2 |
| 3rd highest | 24.4 | 21.7 |
| 99th percentile | 23.2 | 20.5 |
| 98th percentile | 21.6 | 19.6 |
| 90th percentile | 16.0 | 13.5 |
| 75th percentile | 11.9 | 7.9 |
| Median | 8.9 | 5.5 |
| Mean | 9.5 | 6.7 |
| Days with $PM_{10}$ >50 µg/m³ | 0 | - |
| Days with $PM_{2.5}$ >25 µg/m³ | - | 0 |

## Table 5.4 Summary statistics for synthetic profiles – $NO_2$ and $O_3$

| Statistic | 1-hour average concentration (µg/m³) | |
|---|---|---|
| | $NO_2$ | $O_3$ |
| Maximum | 61.6 | 113.7 |
| 2nd highest | 61.6 | 113.1 |
| 3rd highest | 59.5 | 110.2 |
| 99th percentile | 47.2 | 92.8 |
| 98th percentile | 43.1 | 86.0 |
| 90th percentile | 27.7 | 65.9 |
| 75th percentile | 15.4 | 54.7 |
| Median | 5.1 | 39.5 |
| Mean | 9.9 | 38.5 |

# 6 Emissions inventory

## 6.1 Construction phase emissions

As detailed in Section 2.1.1, the construction of the proposed segment factory would involve some relatively minor demolition, clearing and excavation works at the site. The construction phase of the proposed segment factory is short (approximately five months), with works occurring Monday to Saturday for 10 hours per day.

Construction phase emissions would principally consist of particulate matter emissions from the handling of material, movement of vehicles along unpaved traffic routes and wind erosion of exposed surfaces. An environmental management plan will be prepared by the proponent and will detail appropriate dust control methods and personnel responsibilities.

Relative to the operational phase, the construction phase of the proposed segment factory will have lower incoming and outgoing traffic movements and material handling amounts. It is expected that the construction phase will have a lower air quality impact potential than the operational phase. Construction phase emissions have therefore not been considered further in this assessment. In addition, management of asbestos during construction works is detailed in the Contamination report for the proposed segment factory.

## 6.2 Operational phase emissions

The anticipated annual material usage for 25 months of the proposed segment factory is presented in Figure 6.1. A single air pollutant emissions scenario representative of maximum 12-month production at the proposed segment factory has been configured to quantify worst-case emissions from the operational phase. As illustrated in Figure 6.1, material consumption rates are expected to peak between month 5 and 24.

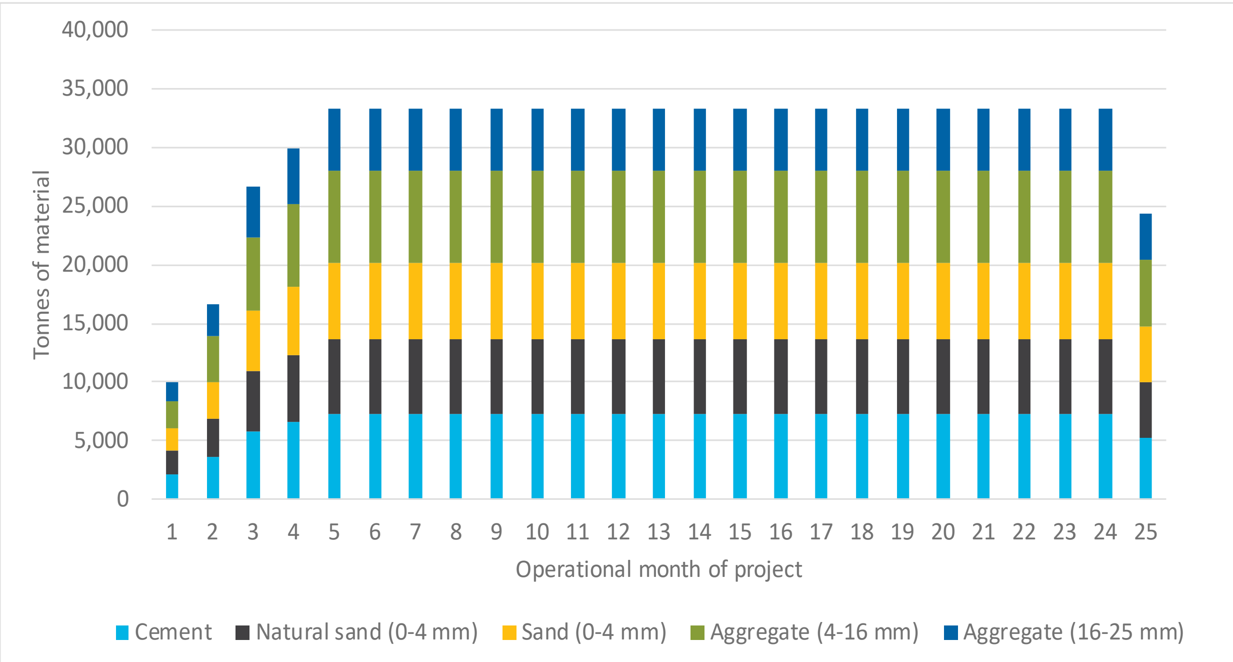



**Figure 6.1 Projected monthly material usage**

## 6.3 Sources of emissions

Sources of atmospheric emissions associated with the operation of the proposed segment factory include the following:

- the movement of trucks and forklifts on paved roads around the site (eg raw material delivery, forklift movements, segment transport truck movements);
- trucks unloading cement to storage silos on-site;
- trucks unloading sand and aggregate to bunkers on-site;
- trucks and front-end-loaders transferring sand and aggregate to the CBP hopper;
- CBP processes, including weigh hopper and central mixer loading;
- wind erosion from material storage areas;
- diesel combustion from front-end-loaders, forklifts and trucks; and
- natural gas combustion from boiler operations.

These activities are accounted for in the assessment scenario for the proposed segment factory.

## 6.4 Emissions estimates

Fugitive dust sources associated with the proposed segment factory were quantified through the application of US-EPA AP-42 emission factor equations. Particulate matter emissions were quantified for the three size fractions identified in Section 3, with the TSP fraction also used to provide an indication of dust deposition rates. Emission rates for coarse particles ($PM_{10}$) and fine particles ($PM_{2.5}$) were estimated using ratios for the different particle size fractions available in the literature (principally the US-EPA AP-42).

Emissions from fuel combustion (diesel and natural gas) were quantified from equipment.

A detailed description of the assumptions and emission factors adopted in the development of the operational emissions inventory are provided in Annexure D.

Specific activities (listed in Table 6.1) were represented by line-volume, volume and point sources which were located according to the layout of the proposed segment factory. The modelled source locations are shown in Figure 6.2.

### 6.4.1 Particulate matter emission reduction factors

In order to control particulate matter emissions from the proposed segment factory a range of mitigation measures and management practices will be implemented, including the following:

- all vehicle transport routes (trucks, forklifts) will be paved;
- all paved roads will be routinely cleaned by a street sweeper (water flushing and sweeping) as required;
- all incoming sand and aggregate will be stored in three-sided concrete bunkers; and
- the concrete batching plant processes (weigh hopper and central mixer) will be enclosed with acoustic cladding.

In order to account for these emission control methods, the following particulate matter emission reduction factors have been applied:

- paved roads wheel dust – 70% reduction for water flushing and sweeping (US-EPA 2006);
- cement silo loading – controlled emission factors applied to account for pneumatic loading of silos;
- concrete batching plant processes - 70% reduction for enclosure (NPI 2012); and
- wind erosion from material storage bunkers - 30% reduction for water breaks (NPI 2012).

### 6.4.2 Emissions summary

A summary of the annual site emissions by source type, is presented in Table 6.1 and Figure 6.3. Particulate matter control measures, as documented in Section 6.4.1 are accounted for in these emission totals.

The most significant source of emissions at the proposed segment factory is associated with the movement of vehicles (trucks and forklifts) across paved road surfaces. General CBP processes include trucks unloading cement to the storage silo, weigh hopper loading and central mixer loading. These sources have the second highest contribution to total site emissions.


Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

KEY

Site boundary
Cadastral boundary
Indicative site layout

Model source type
- Boiler (point source)
- CBP processes (volume source)

Line-volume
- Forklifts shed to yard
- Segment delivery and dispatch
- Unloading sand/aggregate to bunkers and wind erosion
- Raw material delivery
- Segment trucks in yard

Model source locations

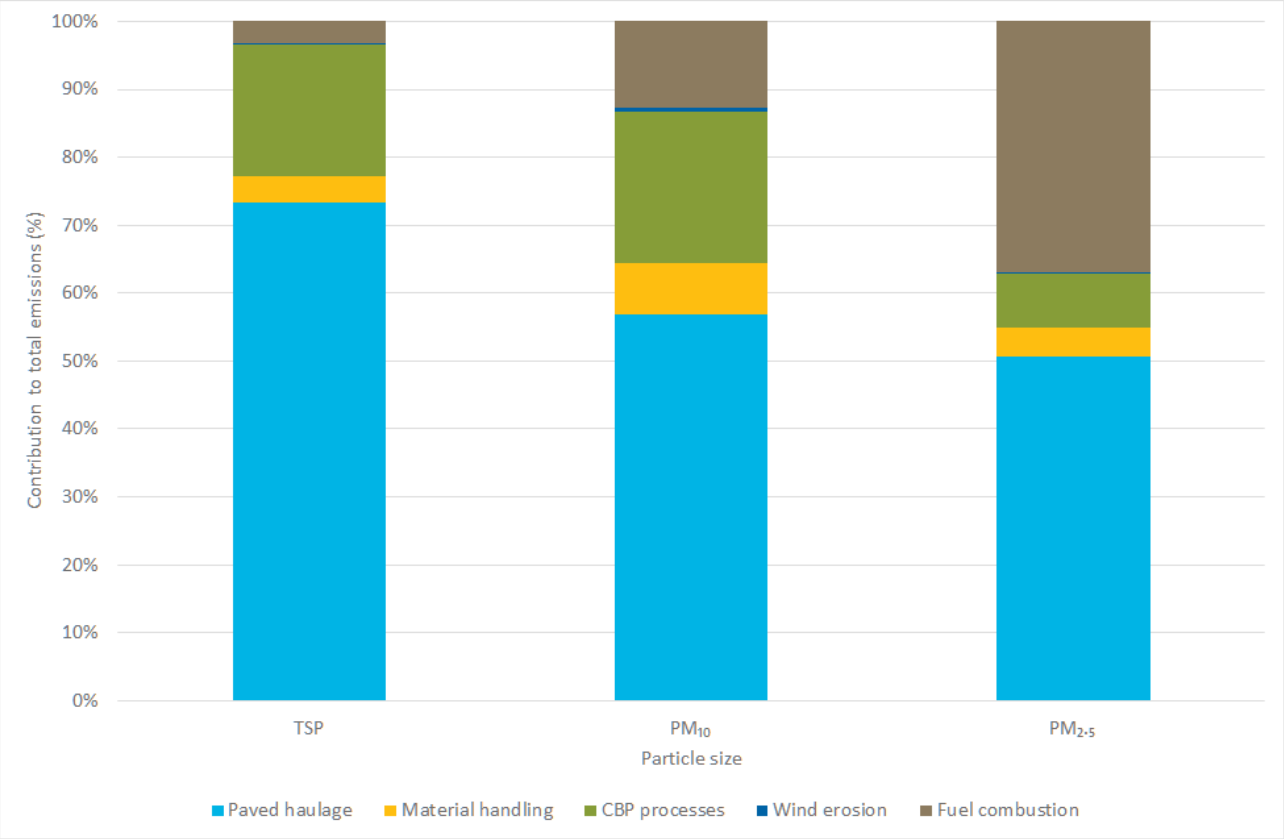
Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 6.2

A summary of the annual site emissions for $NO_x$ is presented in Table 6.2.

Further details regarding emission estimation factors and assumptions are provided in Annexure D.

## Table 6.1 Calculated annual TSP, $PM_{10}$ and $PM_{2.5}$ emissions

| Emission source | Calculated annual emissions (kg/annum) by source | | |
|---|---|---|---|
| | TSP | $PM_{10}$ | $PM_{2.5}$ |
| Raw materials trucks - paved roads | 3,797.3 | 728.9 | 176.3 |
| Trucks unloading cement to elevated storage silo (pneumatic) | 43.7 | 14.8 | 2.2 |
| Trucks unloading sand to bunkers | 72.9 | 34.5 | 5.2 |
| Trucks unloading aggregate to bunkers | 249.0 | 117.8 | 17.8 |
| Sand transfer to CBP hopper (truck and FEL) | 104.2 | 49.3 | 7.5 |
| Aggregate transfer to CBP hopper (truck and FEL) | 355.7 | 168.2 | 25.5 |
| Weigh hopper loading | 243.3 | 121.6 | 18.2 |
| Central mixer loading | 3,541.2 | 957.4 | 85.8 |
| Forklifts transporting segments from shed to paved yard | 319.3 | 61.3 | 14.8 |
| Trucks transporting segments from paved yard to storage area | 3,091.3 | 593.4 | 143.6 |
| Forklifts in stabilised soil storage area loading trucks | 249.5 | 47.9 | 11.6 |
| Segment transport - stabilised soil storage area to paved | 2,825.5 | 542.4 | 131.2 |
| Segment transport - paved roads to site exit | 4,238.3 | 813.5 | 196.8 |
| Wind erosion from storage area | 41.7 | 20.8 | 3.1 |
| Diesel combustion - FEL | 128.0 | 128.0 | 117.3 |
| Diesel combustion - Forklifts | 322.8 | 322.8 | 295.9 |
| Diesel combustion - trucks | 34.8 | 34.8 | 33.8 |
| Boiler emissions | 139.8 | 139.8 | 42.9 |
| **Total** | **19,798.3** | **4,897.2** | **1,329.6** |




## Figure 6.3 Contribution to annual emissions by emissions source type and particle size

## Table 6.2 Calculated $NO_x$ emissions

| Emission source | Calculated $NO_x$ annual emissions (kg/annum) |
|---|---|
| Diesel combustion (total site) | 17,018 |
| LPG combustion | 2,418 |

# 7 Air dispersion modelling

## 7.1 Dispersion model selection and configuration

Dispersion modelling for this assessment uses the CALPUFF modelling system, which is commonly used in NSW for applications where non-steady state conditions may occur (ie complex terrain or coastal locations) or when calm wind conditions are important (ie for odour assessment). In the absence of available upper air measurements, CALMET (the meteorological pre-processor for CALPUFF) can be run using prognostic upper air data (as a three-dimensional '3D.dat' file). Gridded upper air data were derived using TAPM[7] , which is then used in CALMET to derive an initial wind field (known as the Step 1 wind field). CALMET then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the 'hybrid' approach (TRC 2011) and is adopted for this assessment. TAPM and CALMET model settings are described in Annexure B and selected in accordance with recommendations in NSW EPA (2016) and TRC (2011). Surface observations are included in the modelling (referred to as data assimilation), discussed and described in Section 4.

In addition to the 25 individual assessment locations (documented in Section 2.3), air pollutant concentrations were predicted over a 6 km by 6 km domain featuring nested grids (a 3 km domain with 500 m resolution, a 1 km domain with 250 m resolution and a 500 m domain with 100 m resolution). Model predictions for the nested grid were used to generate concentration isopleth plots (Section 7.3).

Simulations were undertaken for the 12-month period of 2017.

[7] CSIRO's The Air Pollution Model

## 7.2 Conversion of $NO_x$ to $NO_2$

$NO_x$ emissions associated with fuel combustion are primarily emitted as NO with some $NO_2$. The transformation in the atmosphere of NO to $NO_2$ was accounted for using the US-EPA's Ozone Limiting Method (OLM) which requires ambient ozone data, as per the Approved Methods for Modelling.

Reference has been made to the synthetic hourly-varying $NO_2$ and $O_3$ concentration datasets based on concentrations recorded by the ACT Government monitoring network (see Section 5.5.2).

The equation used to calculate $NO_2$ concentrations from predicted $NO_X$ concentrations is as follows:

$$[NO_2]_{TOTAL} = \{0.1 \times [NO_x]_{PRED}\} + MIN\{(0.9) \times [NO_x]_{PRED} \text{ or } (46/48) \times [O_3]_{BKGD}\} + [NO_2]_{BKGD}$$

Where:

$[NO_2]_{TOTAL}$ = The predicted concentration of $NO_2$ in µg/m$^3$.

$[NO_x]_{PRED}$ = The AERMOD prediction of ground level $NO_X$ concentrations in µg/m$^3$.

MIN = The minimum of the two quantities within the braces.

$[O_3]_{BKGD}$ = The background ambient $O_3$ concentration – hourly varying concentration in µg/m$^3$.

46/48 = the molecular weight of $NO_2$ divided by the molecular weight of $O_3$.

$[NO_2]_{BKGD}$ = the background ambient $NO_2$ concentration – hourly varying concentration in µg/m$^3$.

The US-EPA's OLM assumes that all available $O_3$ in the atmosphere will react with NO until either all of the $O_3$, or all of the NO has reacted. A major assumption of this method is that the reaction is instantaneous. In reality, this reaction takes place over a number of hours and over distance. The OLM will therefore tend to overestimate concentrations at near-source locations.

Furthermore, the method assumes that the complete mixing of the emitted NO and ambient ozone, down to the level of molecular contact, will have occurred by the time the emissions reach the receptor having the maximum ground-level $NO_X$ concentration.

Consequently, concentrations of the $NO_2$ reported within this assessment should be viewed as highly conservative, providing an upper bound estimate of $NO_2$ concentrations from the proposed segment factory.

## 7.3 Incremental (site-only) results

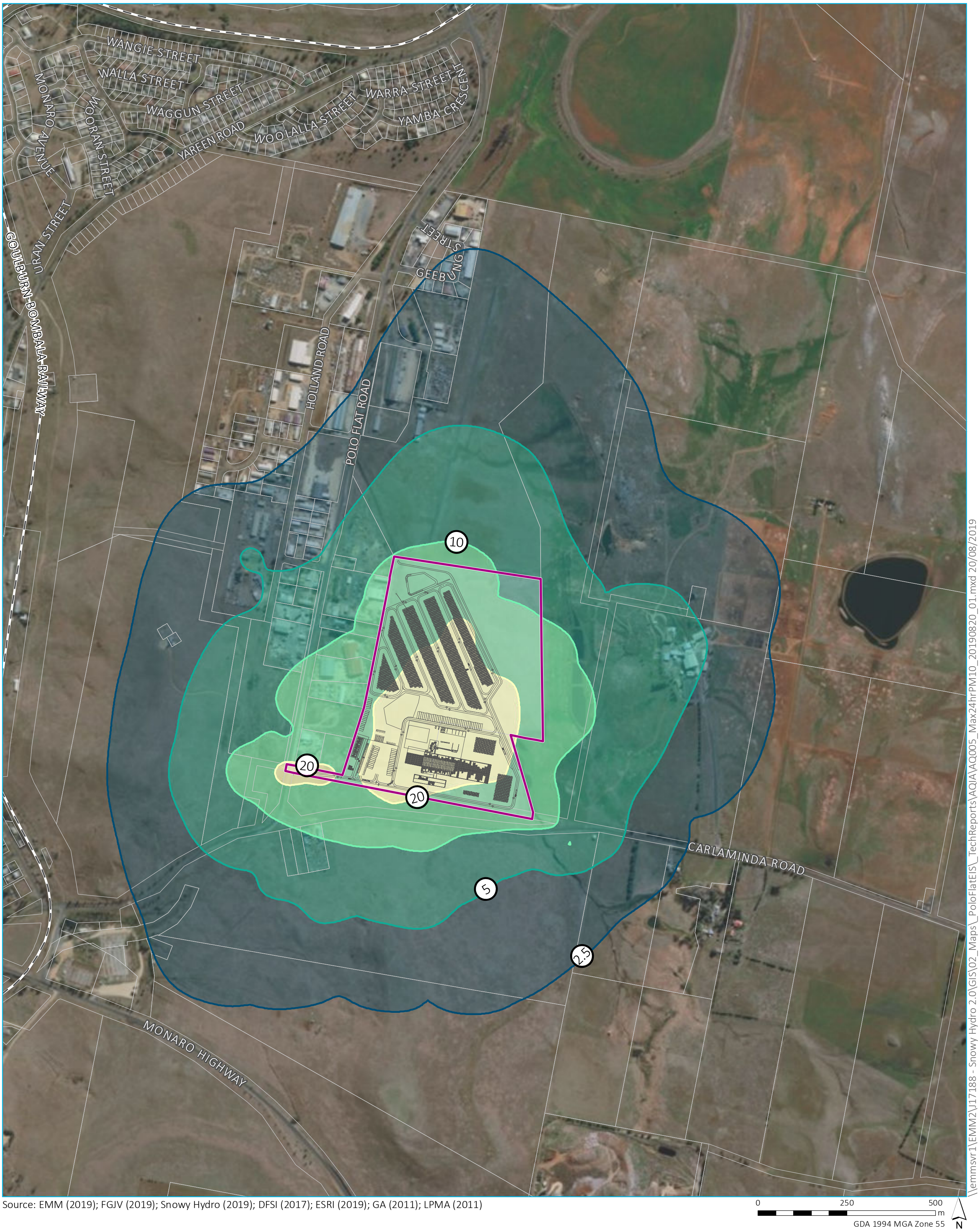
Predicted incremental TSP, $PM_{10}$, $PM_{2.5}$, $NO_2$ and dust deposition levels from proposed operations are presented in Table 7.1 for each of the assessment locations.

The predicted concentrations and deposition rates for all pollutants and averaging periods are below the applicable NSW EPA assessment criterion at all assessment locations. Except for dust deposition, the assessment criteria listed are applicable to cumulative concentrations. Analysis of cumulative impact compliance is presented in Section 7.4.

Contour plots, illustrating spatial variations in site-related incremental TSP, $PM_{10}$ and $PM_{2.5}$ concentrations and dust deposition rates are provided in Figure 7.1 to Figure 7.6 below. Contour plots for $NO_2$ have not been shown. Isopleth plots of the maximum 24-hour average concentrations presented do not represent the dispersion pattern on any individual hour or day, but rather, the maximum hourly or daily concentration that was predicted to occur at each model calculation point given the range of meteorological conditions occurring over the 2017 modelling period.

## Table 7.1 Incremental (site-only) concentration and deposition results

| Assessment location ID | Predicted incremental concentration (µg/m³) or deposition rate (g/m²/month) | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | TSP | $PM_{10}$ | | $PM_{2.5}$ | | Dust deposition | $NO_2$ | |
| | Annual | 24-hour maximum | Annual | 24-hour maximum | Annual | Annual | 1-hour | Annual |
| **Criterion** | **90** | **50** | **25** | **25** | **8** | **2** | **246** | **62** |
| R1 | 0.1 | 1.2 | 0.07 | 0.6 | 0.03 | 0.006 | 41.2 | 0.3 |
| R2 | 4.4 | 10.6 | 1.55 | 3.3 | 0.46 | 0.654 | 77.4 | 2.8 |
| R3 | 0.1 | 0.4 | 0.04 | 0.2 | 0.01 | 0.005 | 16.0 | 0.2 |
| R4 | 0.1 | 0.5 | 0.04 | 0.2 | 0.02 | 0.004 | 29.1 | 0.2 |
| R5 | 0.1 | 1.0 | 0.09 | 0.4 | 0.03 | 0.013 | 22.5 | 0.4 |
| R6 | 0.1 | 1.0 | 0.09 | 0.4 | 0.03 | 0.012 | 42.3 | 0.4 |
| R7 | 0.1 | 0.9 | 0.07 | 0.4 | 0.03 | 0.007 | 39.7 | 0.3 |
| R8 | 0.1 | 0.5 | 0.04 | 0.2 | 0.02 | 0.004 | 29.0 | 0.2 |
| R9 | 0.0 | 0.6 | 0.04 | 0.2 | 0.02 | 0.003 | 44.3 | 0.2 |
| R10 | 0.0 | 0.5 | 0.03 | 0.2 | 0.01 | 0.002 | 38.6 | 0.2 |
| R11 | 0.0 | 0.5 | 0.03 | 0.3 | 0.01 | 0.003 | 24.2 | 0.2 |
| R12 | 0.1 | 0.6 | 0.05 | 0.3 | 0.02 | 0.005 | 42.5 | 0.2 |
| R13 | 0.1 | 1.2 | 0.07 | 0.5 | 0.03 | 0.006 | 53.9 | 0.3 |
| R14 | 0.1 | 1.7 | 0.11 | 0.6 | 0.04 | 0.009 | 63.2 | 0.5 |
| R15 | 0.3 | 2.1 | 0.15 | 1.0 | 0.05 | 0.041 | 63.5 | 0.7 |
| R16 | 0.5 | 2.6 | 0.22 | 1.4 | 0.08 | 0.069 | 71.1 | 1.1 |
| R17 | 0.5 | 5.8 | 0.27 | 1.5 | 0.10 | 0.072 | 72.2 | 1.2 |
| R18 | 4.0 | 12.6 | 1.43 | 4.8 | 0.47 | 0.576 | 91.7 | 2.7 |
| R19 | 0.4 | 2.9 | 0.24 | 1.0 | 0.09 | 0.033 | 60.8 | 0.7 |
| R20 | 0.3 | 3.0 | 0.24 | 1.0 | 0.09 | 0.022 | 63.0 | 0.9 |
| R21 | 3.8 | 12.8 | 1.29 | 4.4 | 0.42 | 0.570 | 80.2 | 2.6 |
| R22 | 5.9 | 10.5 | 1.81 | 3.6 | 0.54 | 0.920 | 78.4 | 2.5 |
| R23 | 0.5 | 4.0 | 0.30 | 1.7 | 0.12 | 0.051 | 67.9 | 0.9 |
| R24 | 0.1 | 1.3 | 0.10 | 0.5 | 0.04 | 0.010 | 52.1 | 0.4 |
| R25 | 0.2 | 2.1 | 0.14 | 0.9 | 0.06 | 0.012 | 45.7 | 0.6 |




Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

KEY

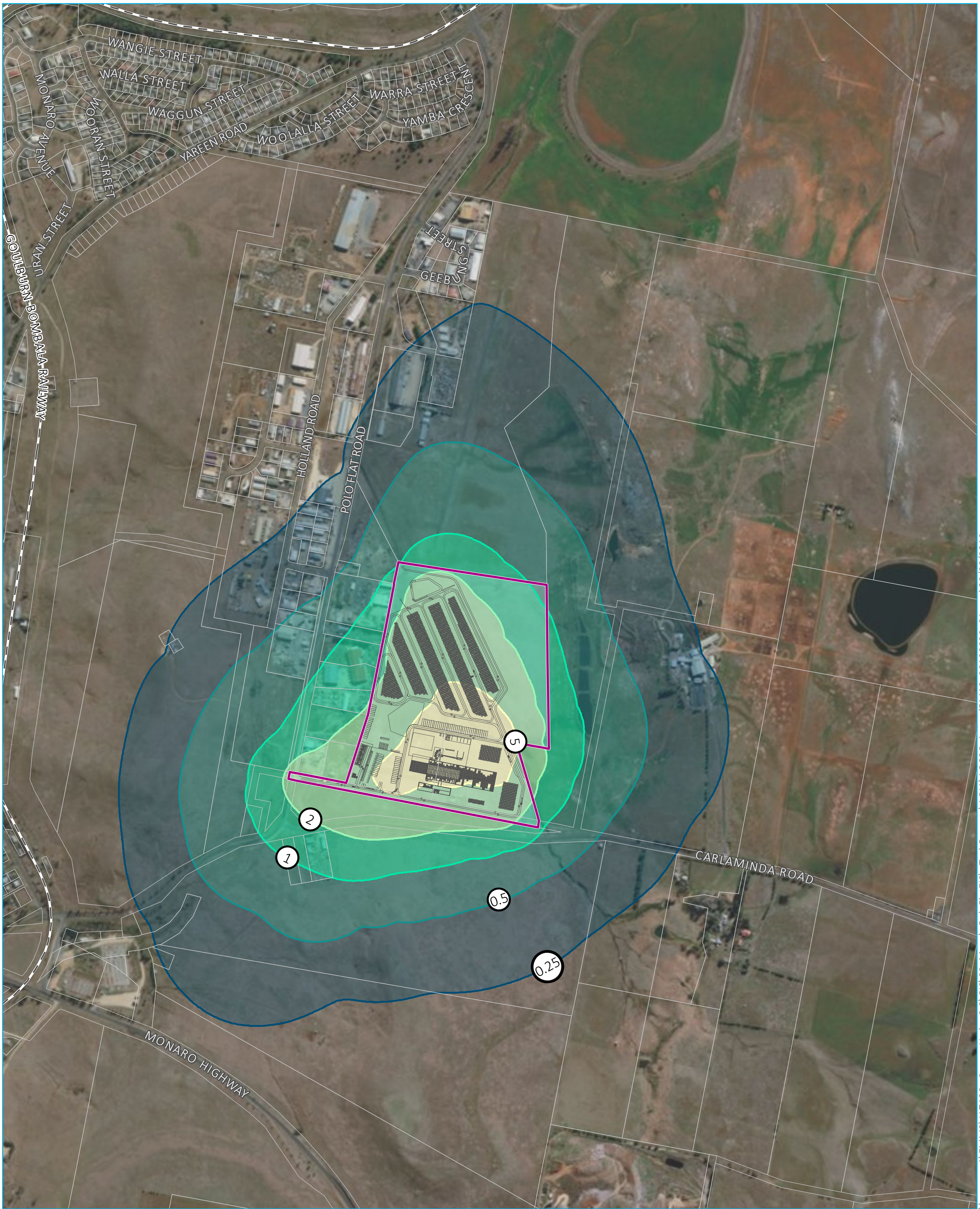
- Site boundary
- Indicative site layout
- Rail line
- Cadastral boundary

PM$_{10}$ concentration (µg/m$^3$)

- 2.5
- 5
- 10
- 20

Maximum predicted 24-hour average PM$_{10}$ concentrations – site only

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 7.1




Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

Site boundary

Indicative site layout

Rail line

Cadastral boundary

$PM_{10}$ concentration (µg/m$^3$)

0.25

0.5

1

2

5

Predicted annual average $PM_{10}$ concentrations – site only

Snowy 2.0

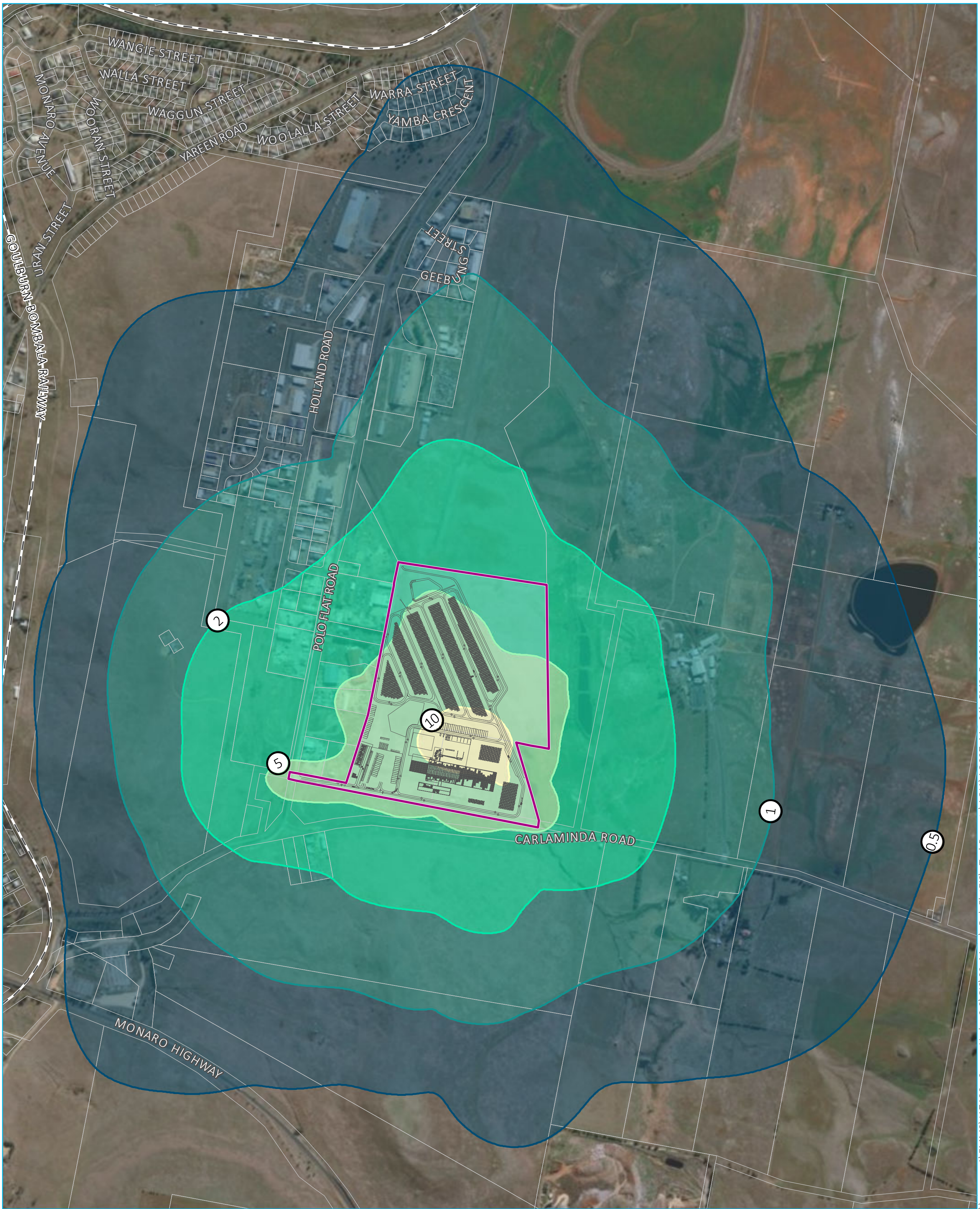
Air Quality Impact Assessment

Proposed Segment Factory

Figure 7.2

snowy 2.0

EMM creating opportunities




\\emmsvr1\EMM2\J17188 - Snowy Hydro 2.0\GIS\02_Maps_PoloFlatEIS_TechReports\AQ\AQ007_Max24hrPM2p5_20190820_01.mxd 20/08/2019

Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55

N

KEY

Site boundary

Indicative site layout

Rail line

Cadastral boundary

$PM_{2.5}$ concentration (µg/m$^3$)

0.5

1

2

5

10

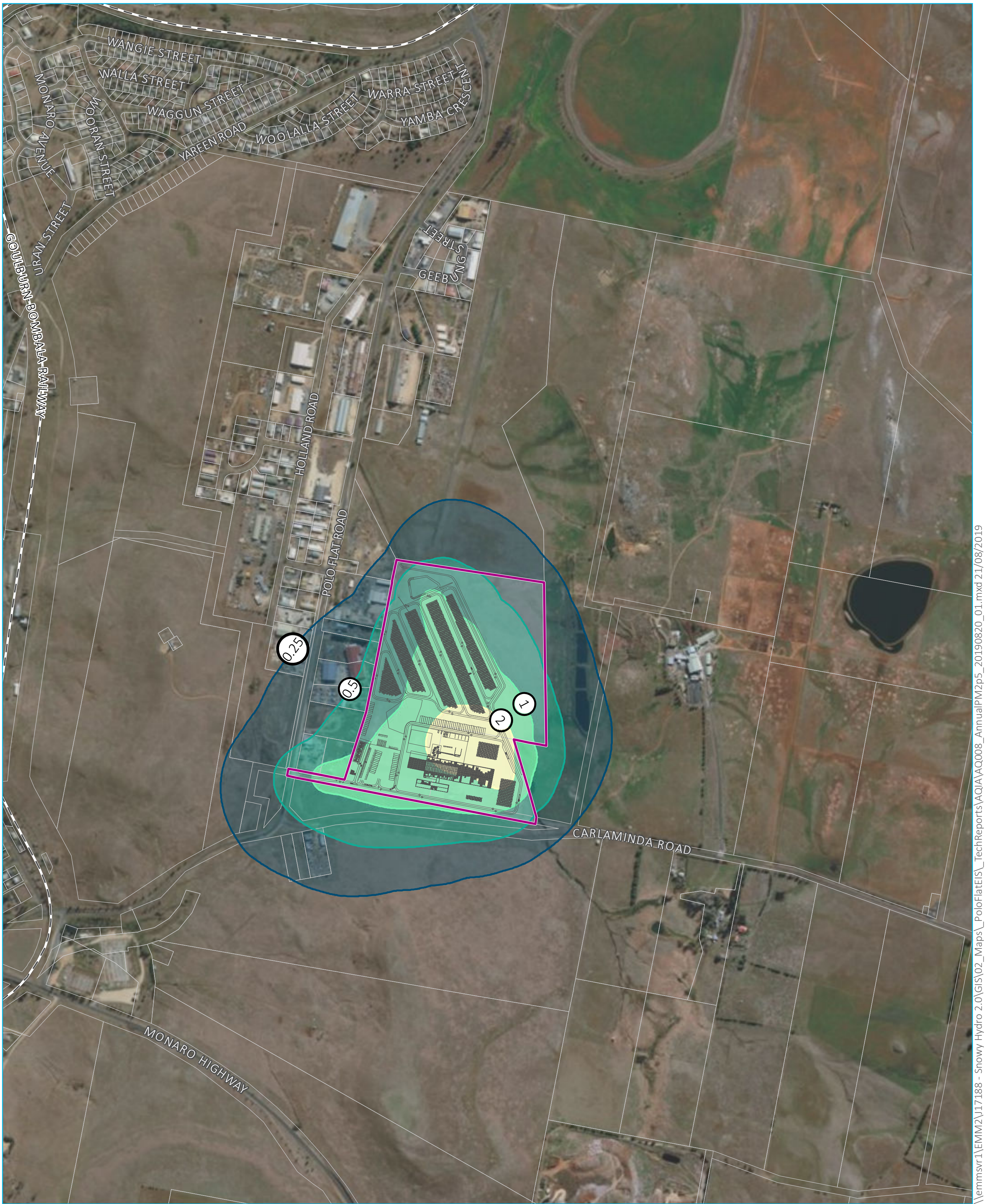
Maximum predicted 24-hour average $PM_{2.5}$ concentrations – site only

Snowy 2.0

Air Quality Impact Assessment

Proposed Segment Factory

Figure 7.3




Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55 N

KEY

Site boundary

Indicative site layout

Rail line

Cadastral boundary

PM$_{2.5}$ concentration (µg/m$^3$)

0.25

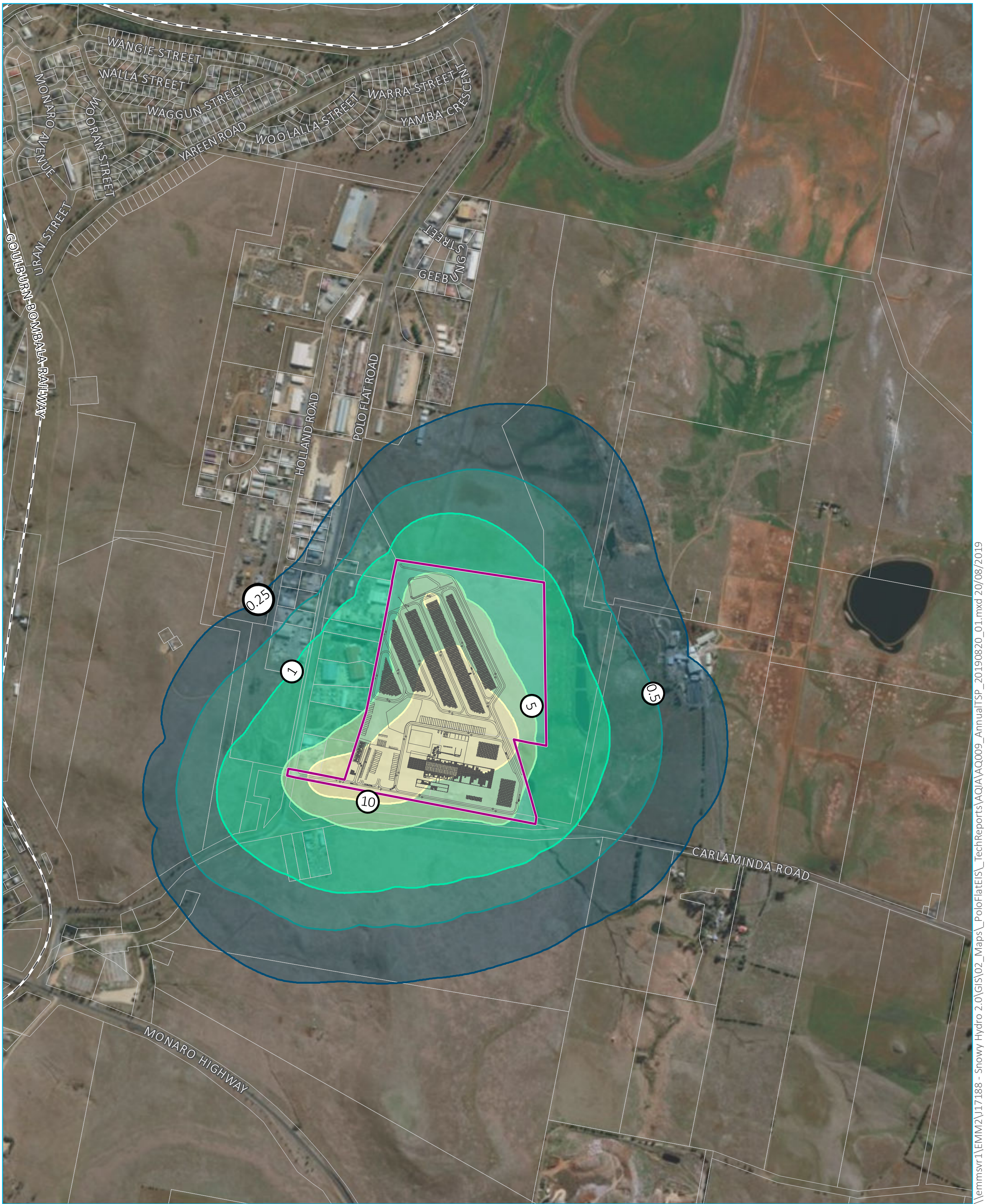
0.5

1

2

Predicted annual average PM$_{2.5}$ concentrations – site only

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 7.4




Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

0 250 500 m

GDA 1994 MGA Zone 55 N

KEY

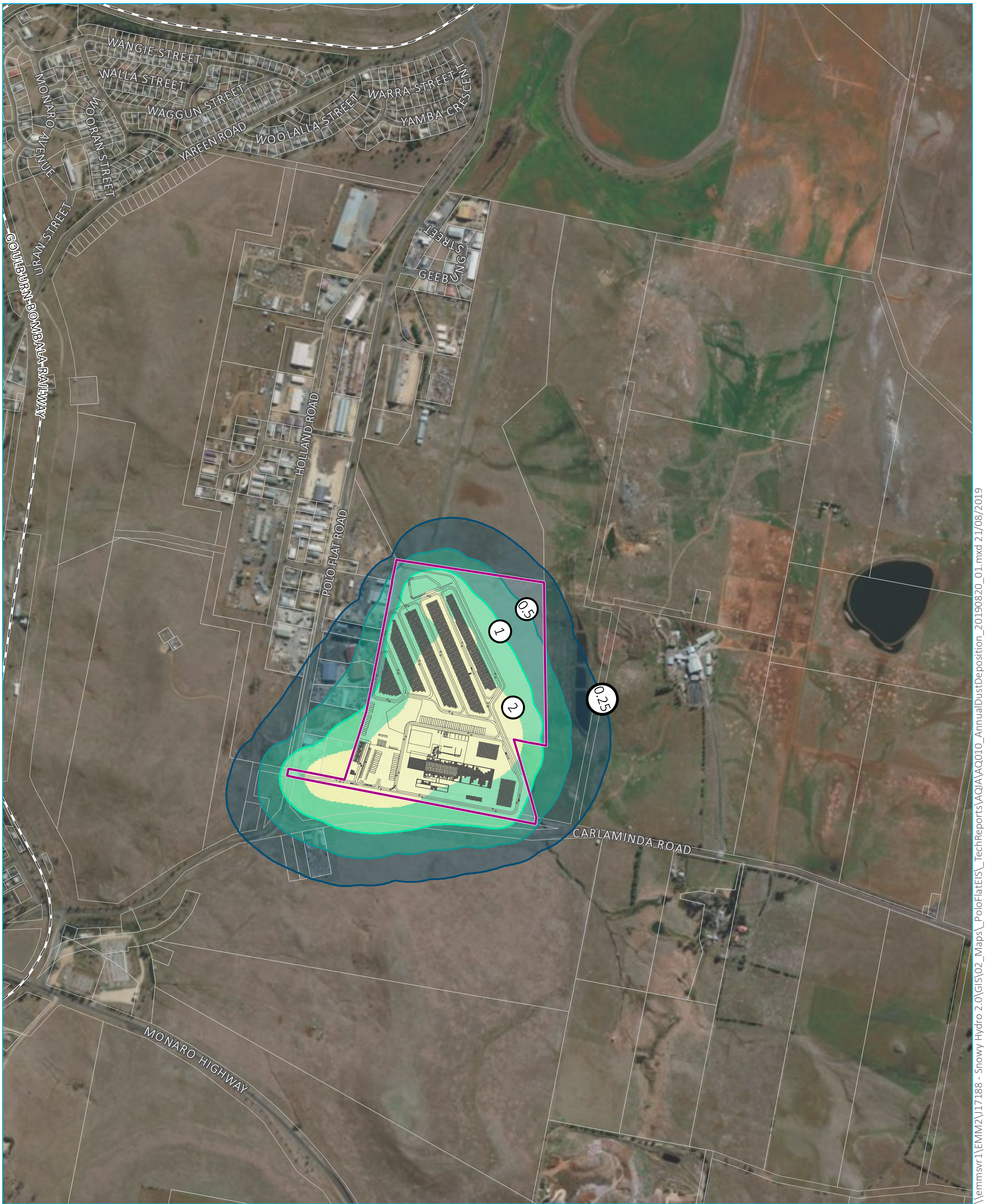
- Site boundary
- Indicative site layout
- Rail line
- Cadastral boundary

$PM_{2.5}$ concentration (µg/m$^3$)

- 0.25
- 0.5
- 1
- 5
- 10

Predicted annual average TSP concentrations – site only

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 7.5




Source: EMM (2019); FGJV (2019); Snowy Hydro (2019); DFSI (2017); ESRI (2019); GA (2011); LPMA (2011)

KEY

Site boundary
Indicative site layout
Rail line
Cadastral boundary

Deposition level (g/m$^2$/month)
0.25
0.5
1
2

Predicted annual average dust deposition levels – site only

Snowy 2.0
Air Quality Impact Assessment
Proposed Segment Factory
Figure 7.6

## 7.4 Cumulative (proposed segment factory plus background) results

Cumulative concentrations (proposed segment factory plus background) were derived following the contemporaneous assessment approach. For each pollutant and averaging period, the coincident model prediction and corresponding background value were paired together to derive a cumulative concentration at each receptor location. For example, in the case of 24-hour average $PM_{10}$, at each receptor location the background concentration on the $1^{st}$ January 2017 was paired with the model prediction on the $1^{st}$ January 2017 and repeated for the entire modelling period.

Predicted cumulative TSP, $PM_{10}$ and $PM_{2.5}$ concentrations associated with site operations are presented in Table 7.2 for each of the assessment locations. It is noted that annual dust deposition results are not shown as background data are not available. The incremental results however (see Table 7.1) were well below the impact assessment criterion.

The following points are made in relation to the presented cumulative concentrations:

- the predicted cumulative concentrations for all pollutants and averaging periods comply with the applicable NSW EPA assessment criterion at all residential assessment locations;
- compliance at all industrial receptors is predicted for all pollutants and averaging periods except for 24-hour average $PM_{2.5}$ at R18 (two days), R21 (one day) and R22 (one day); and
- where exceedance is predicted, the corresponding background corresponds to 90% or more of the cumulative concentration (ie exceedances are only predicted when the background is already elevated).

To illustrate the dominance of background concentrations to the predicted cumulative concentrations, a timeseries plot of 24-hour average cumulative $PM_{2.5}$ concentrations at industrial receptor R18 is presented in Figure 7.7. It can be seen from this figure that the two days above the NSW EPA assessment criterion coincide with the period in the dataset identified in Section 5.5.1 as strongly influenced by domestic wood heater emissions.

It is therefore considered that the operation of the proposed segment factory is unlikely to cause adverse air quality impacts to the surrounding environment.

### Table 7.2 Cumulative (proposed segment factory plus background) concentration results

| Assessment location ID | Predicted cumulative concentration (µg/m³) | | | | | | |
|---|---|---|---|---|---|---|---|
| | TSP | $PM_{10}$ | | $PM_{2.5}$ | | $NO_2$ | |
| | Annual | 24-hour maximum | Annual | 24-hour maximum | Annual | 1-hour | Annual |
| **Criterion** | **90** | **50** | **25** | **25** | **8** | **246** | **62** |
| R1 | 23.9 | 26.3 | 9.6 | 24.0 | 6.7 | 63.4 | 10.0 |
| R2 | 28.3 | 30.8 | 11.1 | 23.7 | 7.2 | 95.9 | 12.5 |
| R3 | 23.9 | 25.6 | 9.6 | 23.7 | 6.7 | 61.6 | 9.9 |
| R4 | 23.9 | 25.8 | 9.6 | 23.8 | 6.7 | 63.0 | 9.9 |
| R5 | 23.9 | 25.7 | 9.6 | 23.7 | 6.7 | 62.1 | 10.1 |
| R6 | 23.9 | 25.8 | 9.6 | 23.7 | 6.7 | 62.6 | 10.1 |
| R7 | 23.9 | 25.8 | 9.6 | 23.7 | 6.7 | 65.4 | 10.0 |
| R8 | 23.9 | 25.8 | 9.6 | 23.7 | 6.7 | 63.9 | 9.9 |
| R9 | 23.9 | 25.9 | 9.6 | 23.8 | 6.7 | 61.6 | 9.9 |
| R10 | 23.8 | 25.6 | 9.6 | 23.7 | 6.7 | 61.6 | 9.9 |
| R11 | 23.8 | 25.6 | 9.6 | 23.7 | 6.7 | 61.6 | 9.9 |
| R12 | 23.9 | 25.6 | 9.6 | 23.7 | 6.7 | 61.6 | 10.0 |
| R13 | 23.9 | 25.7 | 9.6 | 23.7 | 6.7 | 64.6 | 10.0 |
| R14 | 23.9 | 26.6 | 9.6 | 24.1 | 6.7 | 66.3 | 10.2 |
| R15 | 24.1 | 25.5 | 9.7 | 23.6 | 6.8 | 79.8 | 10.5 |
| R16 | 24.3 | 25.5 | 9.7 | 23.6 | 6.8 | 90.3 | 10.8 |
| R17 | 24.3 | 25.5 | 9.8 | 23.6 | 6.8 | 86.5 | 10.9 |
| R18 | 27.8 | 35.2 | 10.9 | **26.8** | 7.2 | 116.0 | 12.4 |
| R19 | 24.2 | 26.5 | 9.8 | 24.0 | 6.8 | 76.2 | 10.4 |
| R20 | 24.1 | 26.3 | 9.8 | 24.0 | 6.8 | 66.1 | 10.6 |
| R21 | 27.6 | 38.2 | 10.8 | **27.5** | 7.1 | 115.8 | 12.3 |
| R22 | 29.7 | 32.9 | 11.3 | **25.8** | 7.2 | 87.7 | 12.2 |
| R23 | 24.3 | 28.1 | 9.8 | 24.7 | 6.8 | 72.0 | 10.6 |
| R24 | 23.9 | 25.7 | 9.6 | 23.7 | 6.7 | 67.5 | 10.1 |
| R25 | 24.0 | 27.2 | 9.7 | 24.4 | 6.8 | 66.0 | 10.3 |

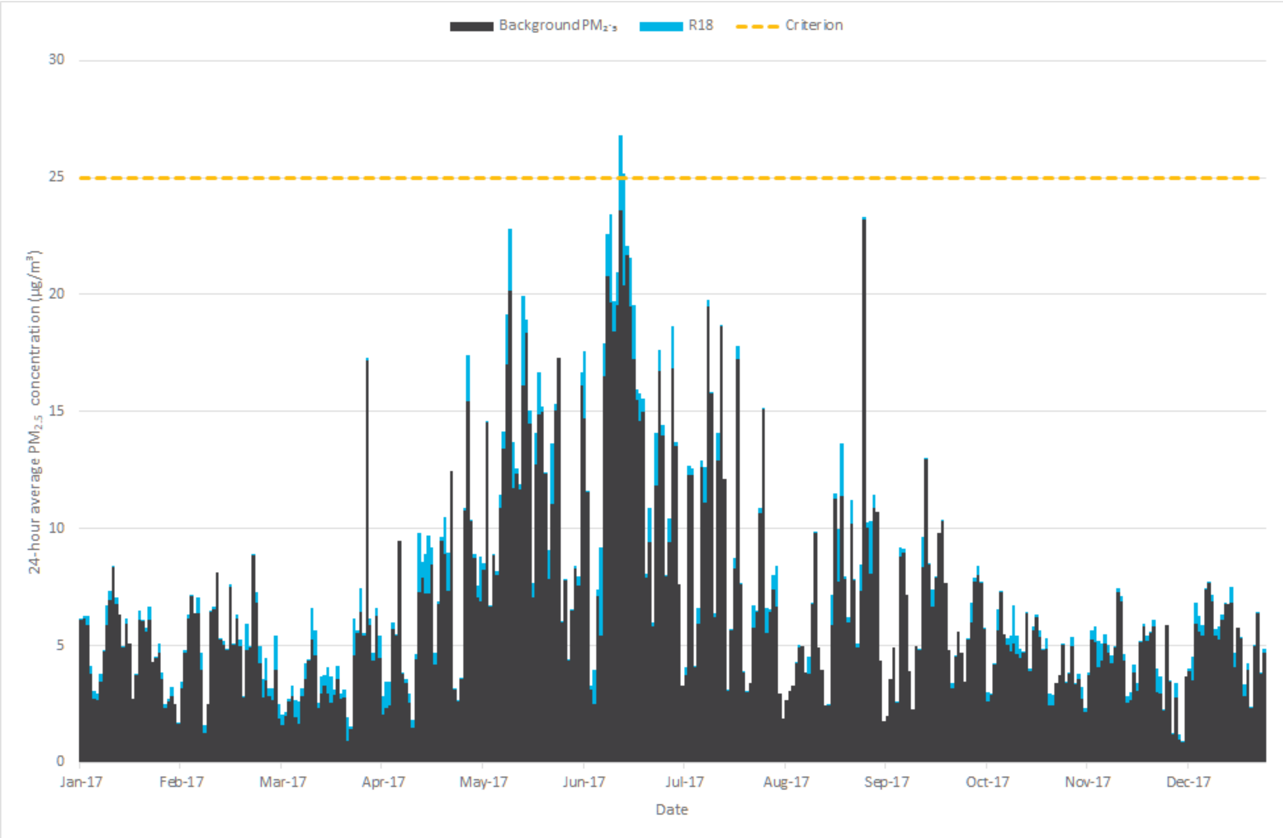



**Figure 7.7 Cumulative 24-hour average $PM_{2.5}$ concentrations – industrial receptor R18**

# 8 Greenhouse gas assessment

## 8.1 Introduction

The estimation of greenhouse gas (GHG) emissions for the proposed segment factory was based on the DEE National Greenhouse Accounts Factors (NGAF) workbook (DEE 2018). The methodologies in the NGAF workbook follow a simplified approach, equivalent to the 'Method 1' approach outlined in the National Greenhouse and Energy Reporting (Measurement) Technical Guidelines (DoE 2014). The Technical Guidelines are used for the purpose of reporting under the National Greenhouse and Energy Reporting Act 2007 (the NGER Act).

For accounting and reporting purposes, GHG emissions are defined as 'direct' and 'indirect' emissions. Direct emissions (also referred to as Scope 1 emissions) occur within the boundary of an organisation and as a result of that organisation's activities. Indirect emissions are generated as a consequence of an organisation's activities but are physically produced by the activities of another organisation (DEE 2018). Indirect emissions are further defined as Scope 2 and Scope 3 emissions. Scope 2 emissions occur from the generation of the electricity purchased and consumed by an organisation. Scope 3 emissions occur from all other upstream and downstream activities, for example the downstream extraction and production of raw materials or the upstream use of products and services.

Scope 3 is an optional reporting category (Bhatia et al 2010) and should not be used to make comparisons between organisations, for example in benchmarking GHG intensity of products or services. Typically, only major sources of Scope 3 emissions are accounted and reported by organisations. Specific Scope 3 emission factors are provided in the NGAF workbook for the consumption of fossil fuels and purchased electricity, making it straightforward for these sources to be included in a GHG inventory, even though they are a relatively minor source.

## 8.2 Emission sources

The GHG emission sources included in this assessment are listed in Table 8.1, representing the most significant sources associated with the proposed segment factory.

GHG emissions from the proposed segment factory are estimated using the methodologies outlined in the NGAF workbook, using fuel energy contents and scope 1, 2 and 3 emission factors for diesel, gasoline, LPG, and electricity use in NSW.

**Table 8.1 Scope 1, 2 and 3 emission sources**

| Scope 1 | Scope 2 | Scope 3 |
|---|---|---|
| Direct emissions from fuel combustion (diesel) by onsite plant and equipment | Indirect emissions associated with the consumption of purchased electricity | Indirect upstream emissions from the extraction, production and transport of diesel, LPG and gasoline |
| Direct emissions from fuel combustion (LPG) by boilers | | Indirect upstream emissions from electricity lost in delivery in the transmission and distribution network |

## 8.3 Activity data

Estimates of annual diesel and electricity consumption associated with the project have been provided by the proponent and estimated where required.

Annual energy consumption rates have been conservatively estimated based on the following assumptions:

- operating schedule of 365 days per year;
- a daily site-wide diesel consumption rates of 500 L per day;
- a daily natural gas consumption rate of 120 L per day by the two boilers;
- a total facility power draw of 1,100 kilovolt-amperes (kVa), converted to kilowatts (kW) through a load factor of 0.8;
- a total of 125 employees travelling up to 10 km per day to site (return trip);
- incoming raw materials to be transported from a quarry approximately 30 km south of the proposed segment factory, via 22 truck movements per day; and
- outgoing segments transported to the Main Works areas (distance of 130 km) via 60 trucks per day.

The adopted activity data (fuel and electricity) for the emission estimates is presented Table 8.2.

**Table 8.2 Annual fuel and energy consumption**

| Process | Fuel consumption (kL) or electricity use (kWh) |
|---|---|
| On-site diesel | 182.5 |
| On-site LPG | 1,051.2 |
| Employee travel fuel | 47.3 |
| Transport of raw materials to site (diesel) | 266.0 |
| Transport of segment to Main Works to market (diesel) | 3,143.1 |
| Purchased electricity | 7,708,800 |

## 8.4 Emission estimates

The following emission factors have been used to estimate GHG emissions from the proposed segment factory:

- diesel consumption on-site (Scope 1) – diesel oil factor from Table 3 of the NGAF workbook (2018);
- LPG consumption (Scope 1) - petrol factor from Table 3 of the NGAF workbook (2018);
- electricity consumption (Scope 2) – NSW Scope 2 emission factor from Table 5 of the NGAF workbook (2018);
- diesel consumption on-site (Scope 3) – diesel oil factor from Table 40 of the NGAF workbook (2018);
- LPG consumption on-site (Scope 3) – LPG factor from Table 40 of the NGAF workbook (2018);

- gasoline consumption (Scope 3) – gasoline factor from Table 40 of the NGAF workbook (2018);
- transport of product to market (Scope 3) - diesel oil factor from Table 40 of the NGAF workbook (2018); and
- electricity consumption (Scope 3) - NSW Scope 3 emission factor from Table 41 of the NGAF workbook (2018).

The estimated annual GHG emissions for each emission source are presented in Table 8.3.

The significance of proposed segment factory GHG emissions relative to state and national GHG emissions is made by comparing annual average GHG emissions against the most recent available total GHG emissions inventories (calendar year 2017[8]) for NSW (128,870 kt $CO_2$-e) and Australia (530,841 kt $CO_2$-e).

Annual average total GHG emissions (Scope 1, 2 and 3) generated by the proposed segment factory represent approximately 0.008% of total GHG emissions for NSW and 0.002% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

The contribution of the proposed segment factory to projected climate change, and the associated environmental impacts, would be in proportion with its contribution to global greenhouse gas emissions.

### Table 8.3 Estimated annual GHG emissions

| | Scope 1 (t $CO_2$-e/year) | Scope 2 (t $CO_2$-e/year) | Scope 3 (t $CO_2$-e/year) | Total |
|---|---|---|---|---|
| Diesel | 495 | - | 25 | 520 |
| LPG | 1,637 | - | 97 | 1,734 |
| Transport of raw materials to site | - | - | 37 | 37 |
| Transport of segments to Main Works | - | - | 437 | 437 |
| Employee travel | - | - | 6 | 6 |
| Electricity | - | 6,321 | 771 | 7,092 |
| **Total** | **2,132** | **6,321** | **1,373** | **9,826** |

8 http://ageis.climatechange.gov.au/

# 9 Conclusions

Dispersion modelling was completed for one operational scenario of the proposed segment factory. Atmospheric dispersion modelling was completed using the CALPUFF model system. Hourly meteorological observations from 2017, collected primarily by the BoM Cooma Airport AWS, were used as inputs into the dispersion model.

The results of the modelling show that the predicted concentrations and deposition rates for particulate matter (TSP, $PM_{10}$, $PM_{2.5}$ and dust deposition) and $NO_2$ are below the applicable impact assessment criteria at all residential assessment locations. Cumulative impacts were assessed by combining modelled proposed segment factory impacts with recorded ambient background levels. The cumulative results also demonstrated compliance with applicable impact assessment criteria at residential locations, despite a range of conservative assumptions in the emission calculations and dispersion modelling techniques. Three industrial locations were predicted to experience a maximum of two additional days over the impact assessment criterion, however these exceedance days occurred when the background was elevated and are not considered to be significant.

The operation of the proposed segment factory will require mitigation measures. These include paved roads on-site, water flushing and sweeping of paved roads, windbreaks (walls) on sand and aggregate bunkers, enclosed weigh hopper and central mixer and minimising idling of diesel equipment. These measures have been taken into account in the emissions estimation for the proposed segment factory.

A GHG assessment was also undertaken for the proposed segment factory. Annual average total GHG emissions (Scope 1, 2 and 3) generated by the proposed segment factory represent approximately 0.008% of total GHG emissions for NSW and 0.002% of total GHG emissions for Australia, based on the National Greenhouse Gas Inventory for 2017.

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US-EPA 2008, Integrated Review Plan for the National Ambient Air Quality Standards for particulate matter

US-EPA 2011a, Chapter 11.12 - Concrete Batching

US-EPA 2011b, Chapter 13.2.1 – Paved Roads

# Abbreviations

| | |
|---|---|
| ACT | Australian Capital Territory |
| AHD | Australian height datum |
| ANSTO | Australian Nuclear Science and Technology Organisation |
| Approved Methods for Modelling | *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* |
| AWS | Automatic weather station |
| BoM | Bureau of Meteorology |
| CBP | Concrete batching plant |
| $CO_2$-e | Carbon dioxide equivalent |
| CO | Carbon monoxide |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| DEE | Department of the Environment and Energy |
| EPA | Environment Protection Authority |
| EPL | Environment protection licence |
| FGJV | Future Generation Joint Venture |
| GHG | Greenhouse gas |
| kVa | Kilovolt-amperes |
| kW | Kilowatt |
| LPG | Liquid petroleum gas |
| NGAF | National Greenhouse Accounts Factors |
| $NO_x$ | Oxides of nitrogen |
| NPI | National Pollution Inventory |
| $O_3$ | Ozone |
| OEH | Office of Environment and Heritage |
| OLM | Ozone limiting method |
| $PM_{10}$ | Particulate matter less than 10 microns in aerodynamic diameter |
| $PM_{2.5}$ | Particulate matter less than 2.5 microns in aerodynamic diameter |
| $SO_2$ | Sulphur dioxide |
| TAPM | The Air Pollution Model |
| US-EPA | United States Environmental Protection Agency |
| VOC | Volatile organic compounds |

Annexure A

# Meteorological modelling and processing

## A.1 Meteorological monitoring datasets

As discussed in Section 4.2, a meteorological dataset was collated using meteorological parameters measured at the BoM Cooma Airport AWS.

Data from the BoM Cooma Airport AWS have been analysed for the period between 2014 to 2018. Data availability and analysis of inter-annual trends for this five-year period is presented in the following sections.

### A.1.1 Data availability

A summary of data availability for the BoM Cooma Airport AWS dataset for the period between 2014 and 2018 is provided in Figure A.1. The following points are noted:

- data completeness is close to 100% for all parameters for all years between 2014 and 2018. Therefore, all years meet the minimum 90% data completeness requirements for all parameters specified with Section 4.1 of the Approved Methods for Modelling (EPA 2016); and
- 2017 was chosen for assessment. It was deemed representative of meteorological conditions at this location over the five-year period.

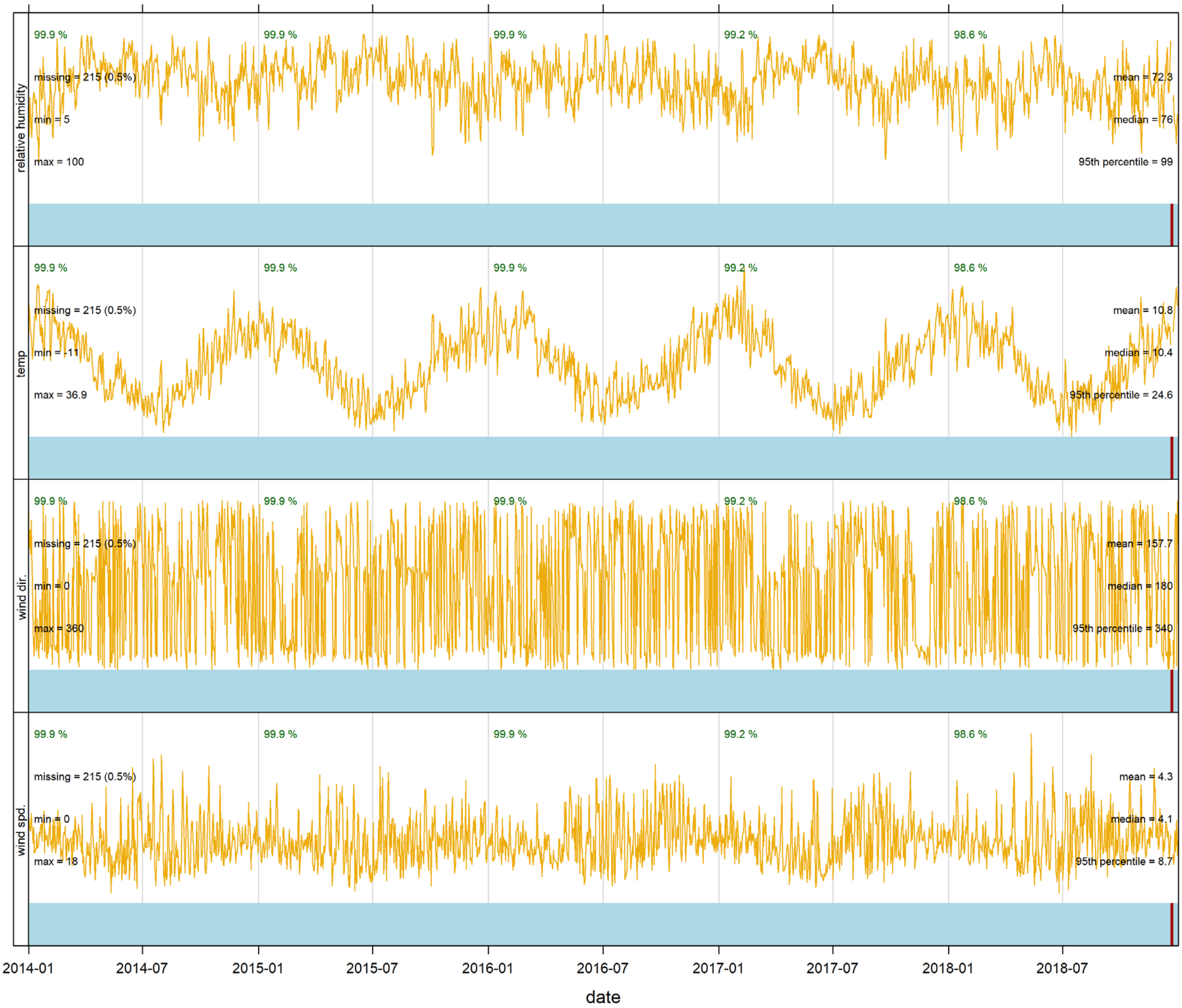



**Figure A.1 Five-year data completeness analysis plot – BoM Cooma Airport AWS – 2014 to 2018**

### A.1.2 Selection of a representative year

In order to determine the most representative year of data for modelling an analysis of inter-annual trends was conducted.

Inter-annual wind roses for the BoM Cooma Airport AWS are presented in Figure A.2.

The wind roses for the BoM Cooma Airport AWS show that the general wind directions were similar for all years, with dominant winds from the north-east and a smaller percentage of winds from the south-west and north-west. The annual average wind speeds were consistent throughout the five years ranging from 4.1 m/s to 4.4 m/s. The annual average percentage of calms was also consistent ranging from 5.9% to 8%.

Diurnal distribution of wind speed, wind direction, temperature and relative humidity for BoM Cooma Airport AWS recorded between 2014 and 2018 are shown in Figure A.3 to Figure A.6 respectively.

The inter-annual profiles for wind speed and wind direction reflect the annual consistency as shown in the wind roses for the BoM Cooma Airport AWS in Figure A.2.

The inter-annual profiles for air temperature and relative humidity were also comparable between 2014 and 2018. The 2018 dataset showed slightly higher temperatures towards the end of the day and lower relative humidity which is a potential indicator of drought conditions during the year.

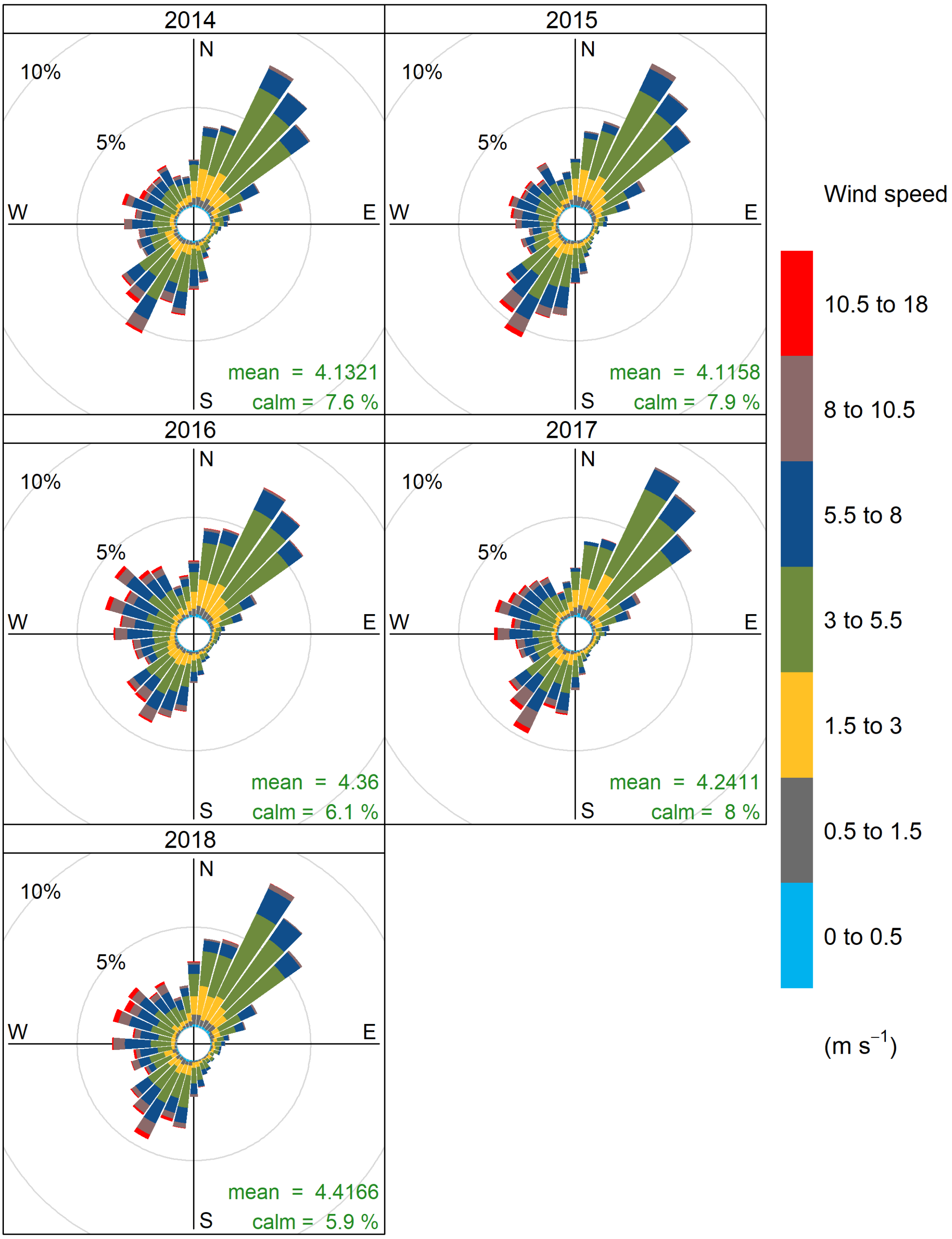



**Figure A.2 Inter-annual comparison of recorded wind speed and direction – BoM Cooma Airport AWS – 2014 to 2018**

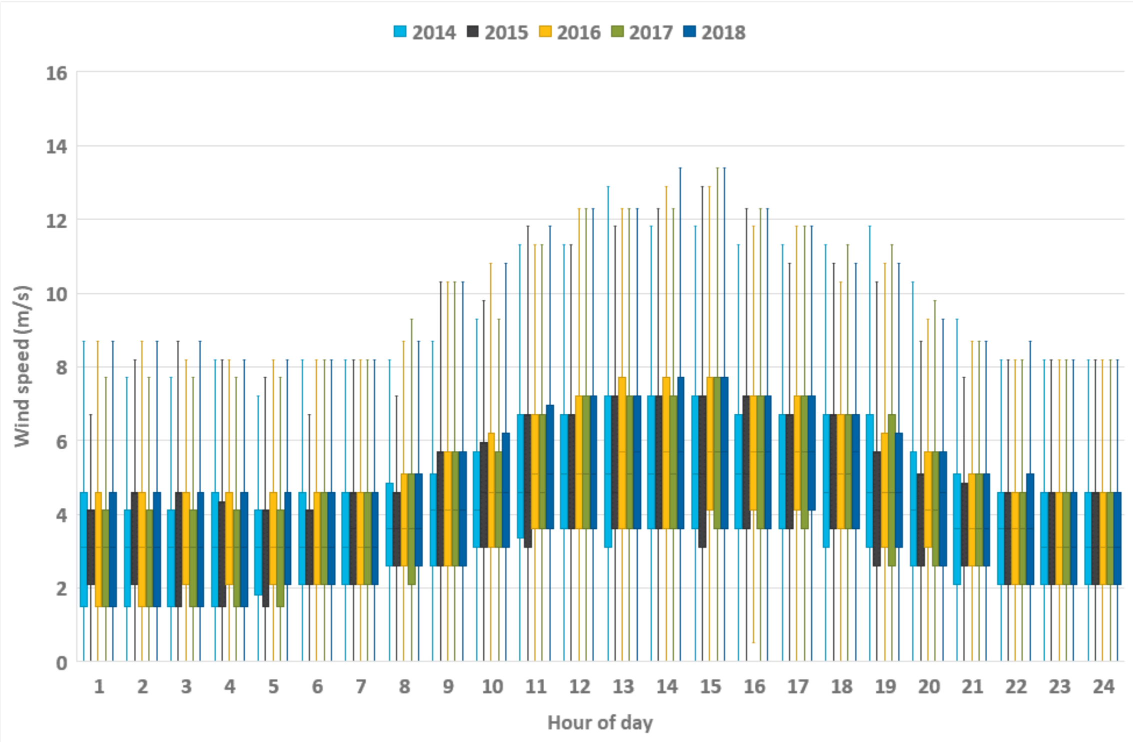



**Figure A.3** Inter-annual variability in diurnal wind speed – BoM Cooma Airport AWS – 2014 to 2018

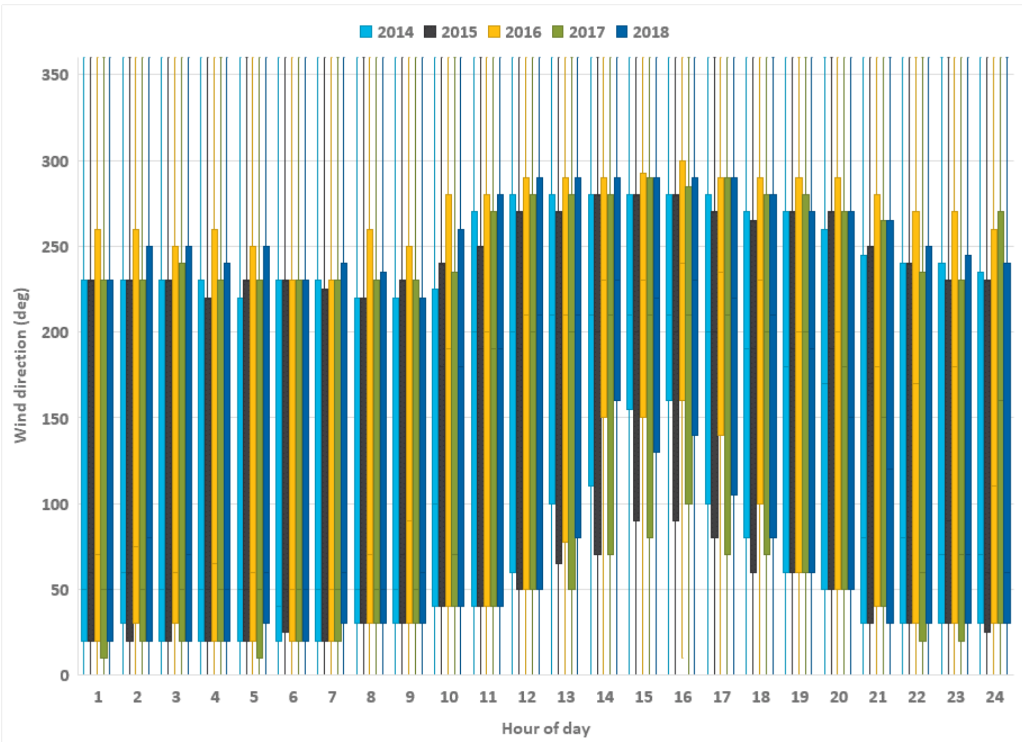



**Figure A.4** Inter-annual variability in diurnal wind direction – BoM Cooma Airport AWS – 2014 to 2018

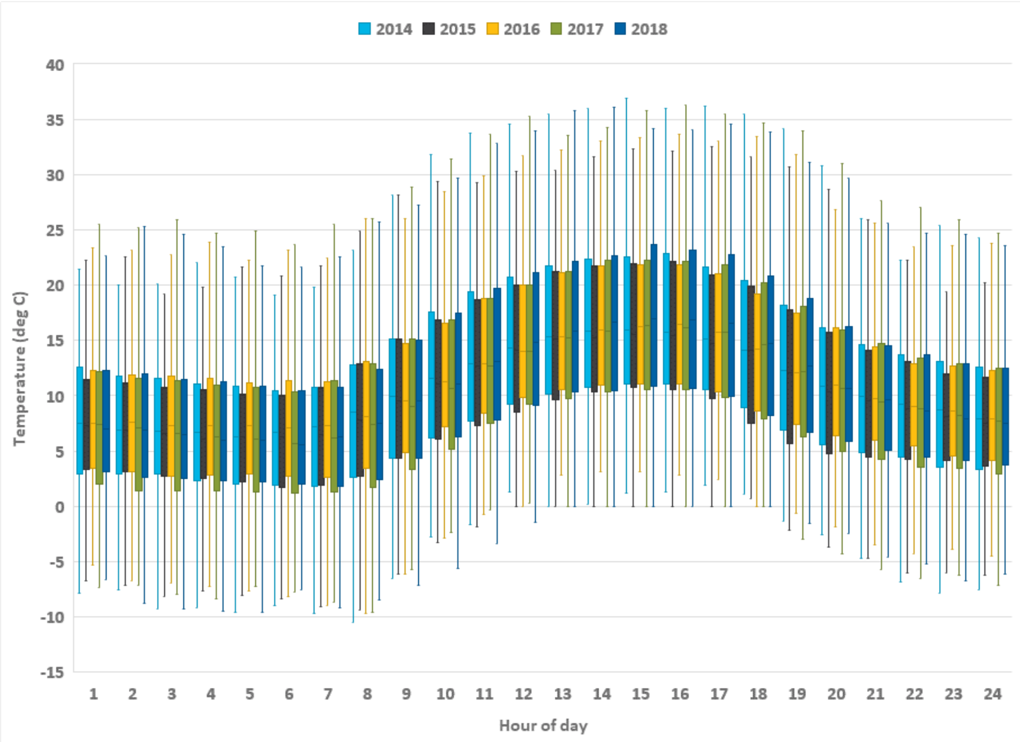



**Figure A.5 Inter-annual variability in diurnal air temperature – BoM Cooma Airport AWS – 2014 to 2018**

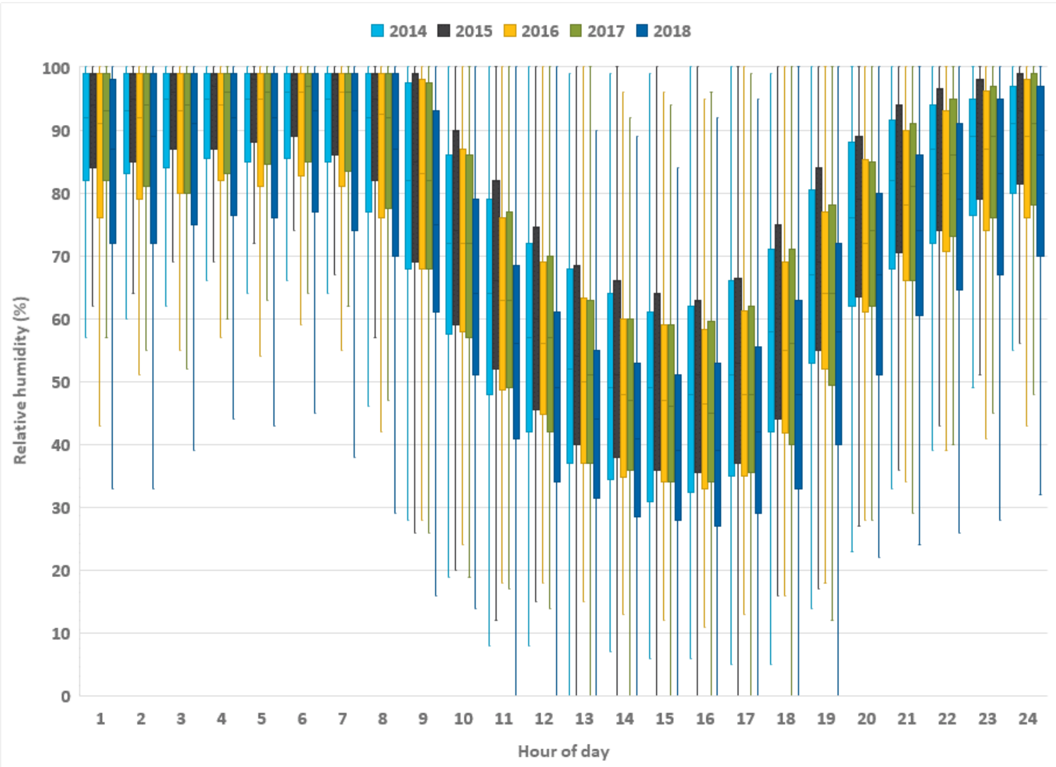



**Figure A.6 Inter-annual variability in diurnal relative humidity – BoM Cooma Airport AWS – 2014 to 2018**

## A.1.3 Seasonal and diurnal wind roses for BoM Cooma Airport AWS

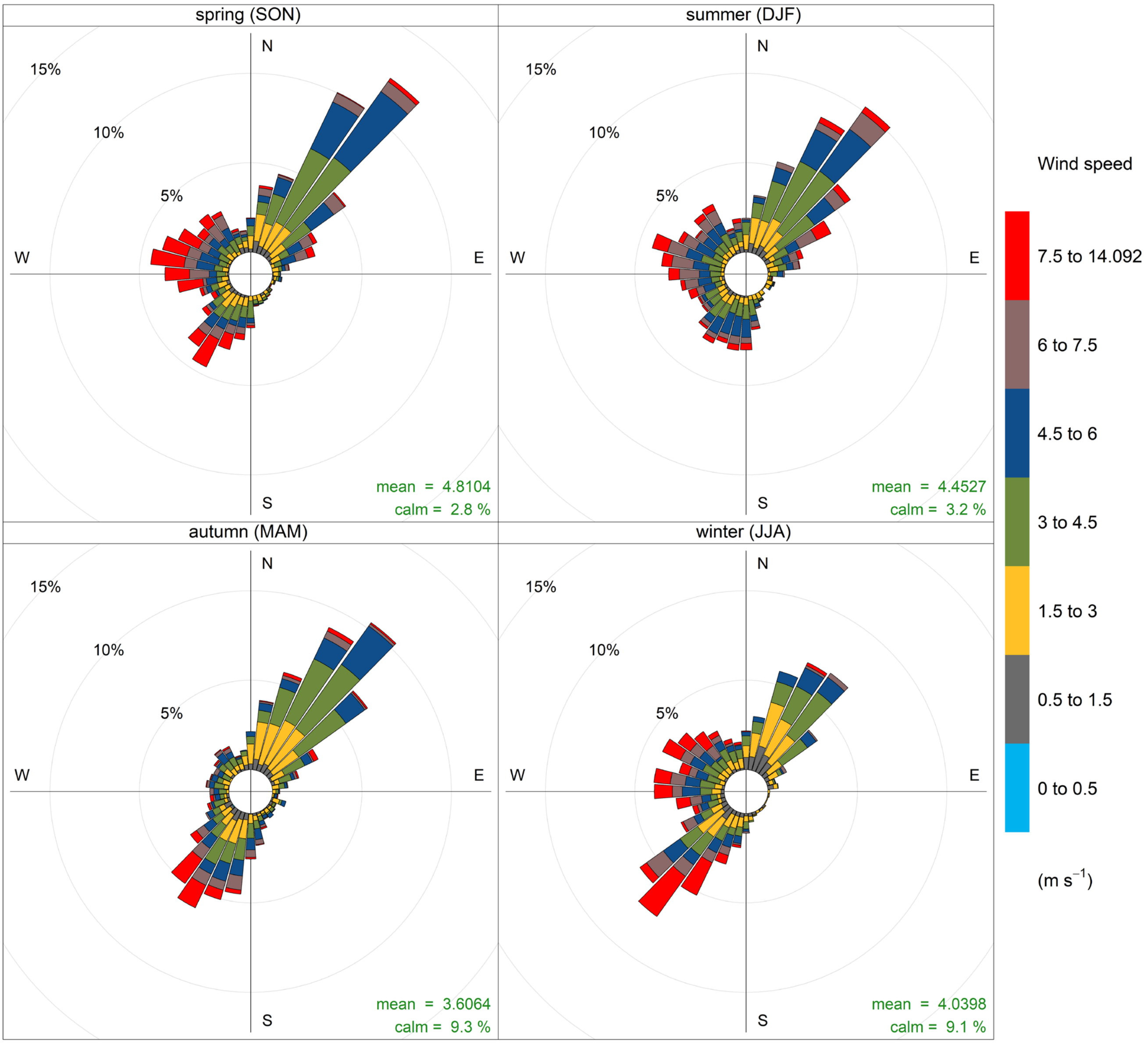



**Figure A.7 Seasonal wind speed and direction – BoM Cooma Airport AWS – 2017**

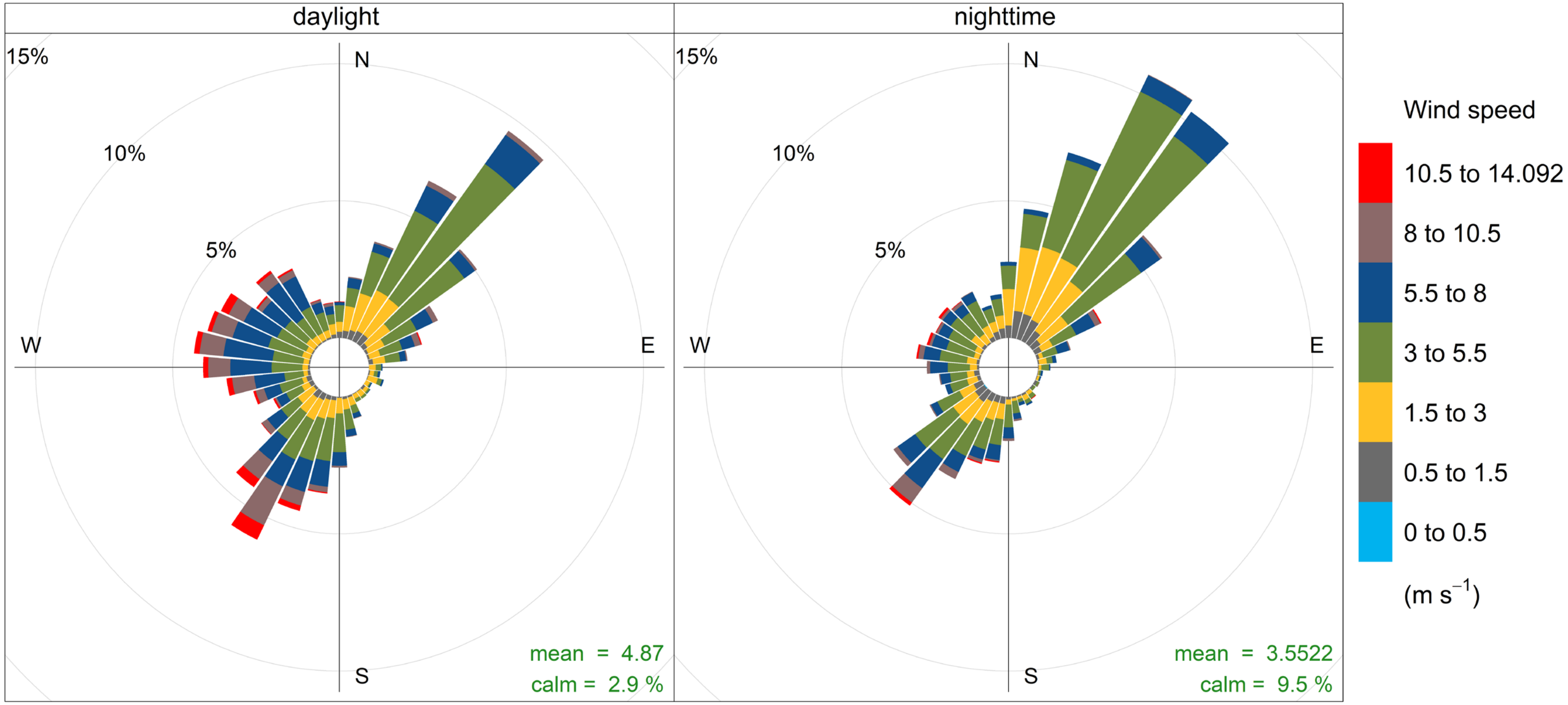



**Figure A.8 Diurnal wind speed and direction – BoM Cooma Airport AWS – 2017**

Annexure B

# Meteorological modelling and processing

## B.1 TAPM modelling

To supplement the meteorological monitoring datasets adopted for this assessment, the Commonwealth Scientific and Industry Research Organisation (CSIRO) prognostic meteorological model TAPM was used to generate required parameters that are not routinely measured, specifically mixing height and vertical wind/temperature profile.

TAPM was configured and run in accordance with the Section 4.5 of the Approved Methods for Modelling as follows:

- TAPM version 4.0.5;
- inclusion of high resolution (90 m) regional topography (improvement over default 250 m resolution data);
- grid domains with cell resolutions of 30 km, 10 km and 3 km. Each grid domain features 25 x 25 horizontal grid points and 35 vertical levels;
- TAPM default databases for land use, synoptic analyses and sea surface temperature; and
- TAPM defaults for advanced meteorological inputs.

A surface observations file was included in TAPM with meteorological data from the BoM Cooma Airport AWS.

## B.2 CALMET

The CALMET/CALPUFF model suite was chosen for this study. CALMET was used to produce 3-dimensional meteorological fields for use in the CALPUFF model.

In the absence of upper air measurements, CALMET can be run using prognostic upper air data (as a three-dimensional '3D.dat' file), which is used to derive an initial wind field (known as the Step 1 wind field in the CALMET model). The model then incorporates mesoscale and local scale effects, including surface observations, to adjust the wind field. This modelling approach is known as the 'hybrid' approach (TRC 2011) and is adopted for this assessment. TAPM was used to generate gridded upper air data for each hour of the model run period, for input into CALMET.

A CALMET grid of 50 km by 50 km was run with a resolution of 500 m. Surface meteorological data from the BoM Cooma Airport AWS were incorporated in the modelling. Cloud content and height data were also sourced from the BoM Cooma Airport AWS.

The observations at BoM Cooma Airport AWS provided the dominant influence on the derived wind field and the resultant dispersion meteorology within the model. The distance at which the observation influences the model (radius of influence) is determined by the CALMET setting 'RMAX'. The relative importance of the observation in the model (relative weighting of the Step 1 wind field and the observation) is determined by the CALMET setting 'R1'.

An RMAX of 20 km and R1 of 10 km was assigned in the model to reflect the local scale topographical influence seen in the observational data.

The detailed CALMET model options used are presented in Table B.1. These were selected in accordance with recommendations in the Approved Methods for Modelling and in TRC (2011). Surface observations were included in the modelling (referred to as data assimilation) to provide real-world observations and improve the accuracy of the wind fields.

## Table B.1 CALMET model options used

| Flag | Descriptor | Default | Value used |
|---|---|---|---|
| IEXTRP | Extrapolate surface wind observations to upper layers | Similarity theory | Similarity theory |
| BIAS (NZ) | Relative weighting given to vertically extrapolated surface observations versus upper air data | No default | -1, -0.989, -0.971, -0.937, -0.868, -0.731, -0.479, -0.089, 0.427, 1.0 |
| TERRAD | Radius of influence of terrain | No default (typically 5-15 km) | 5 |
| RMAX1 and RMAX2 | Maximum radius of influence over land observations in layer 1 and aloft | No default | 20, 40 |
| R1 and R2 | Distance from observations in layer 1 and aloft at which observations and Step 1 wind field are weighted equally | No default | 10, 20 |

### B.2.1 CALMET model evaluation

It is noted that standard practice is to exclude an observation from the model, such that model evaluation can be performed for a site that has not influenced the outcome of the model. However, in this instance, this could not be done as there was only one meteorological dataset available for the area.

Section 4.3.2 of this report presents the CALMET extracted winds at the Polo Flat site. These were compared to the meteorological data collected at the BoM Cooma Airport AWS. Whilst the CALMET extract is at a different location to the BoM Cooma Airport AWS, it was still useful to compare the two meteorological datasets to determine the performance of the model in relation to the radius of influence set in CALMET (ie a large enough radius was set to ensure that the BoM Cooma Airport AWS data were picked up at the Polo Flat site whilst incorporating terrain effects). The CALMET extract showed reasonable results when compared to the BoM Cooma Airport AWS data. Section 4.3.2 showed that the dominant wind patterns were similar between the two datasets. The annual average wind speed in the CALMET data was lower than at the BoM site and the annual percentage of calms was also lower. This also appears reasonable given the location of the CALMET extract as compared with the location of the BoM Cooma Airport AWS.

Annexure C

# Temporal patterns in the $PM_{10}$ and $PM_{2.5}$ monitoring data

## C.1 Temporal variations in the $PM_{10}$ and $PM_{2.5}$ data recorded at the Civic, Florey and Monash monitoring stations

The temporal patterns in the $PM_{10}$ and $PM_{2.5}$ monitoring data were examined using the 'timeVariation' function in the 'openair' software (Carslaw 2019). The timeVariation function examines variation in average concentrations by hour of the day, day of the week and month of the year.

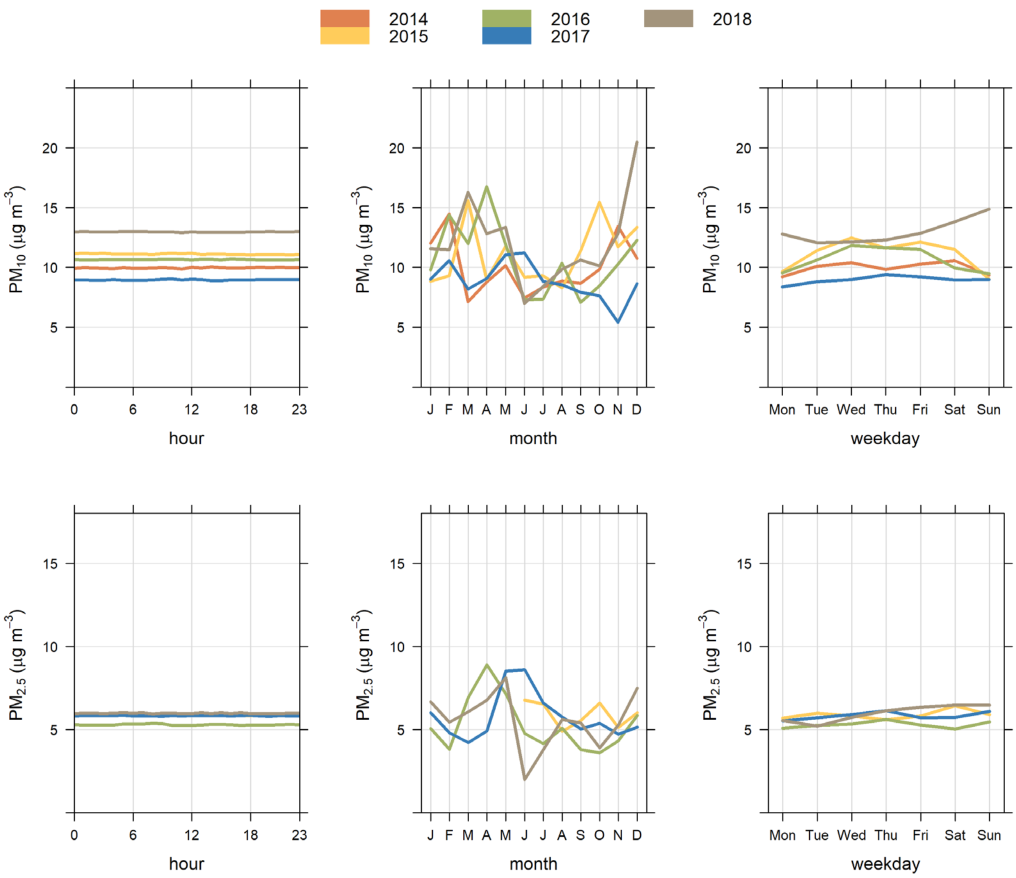



**Figure C.1 Time variation in $PM_{10}$ and $PM_{2.5}$ at the Civic station**

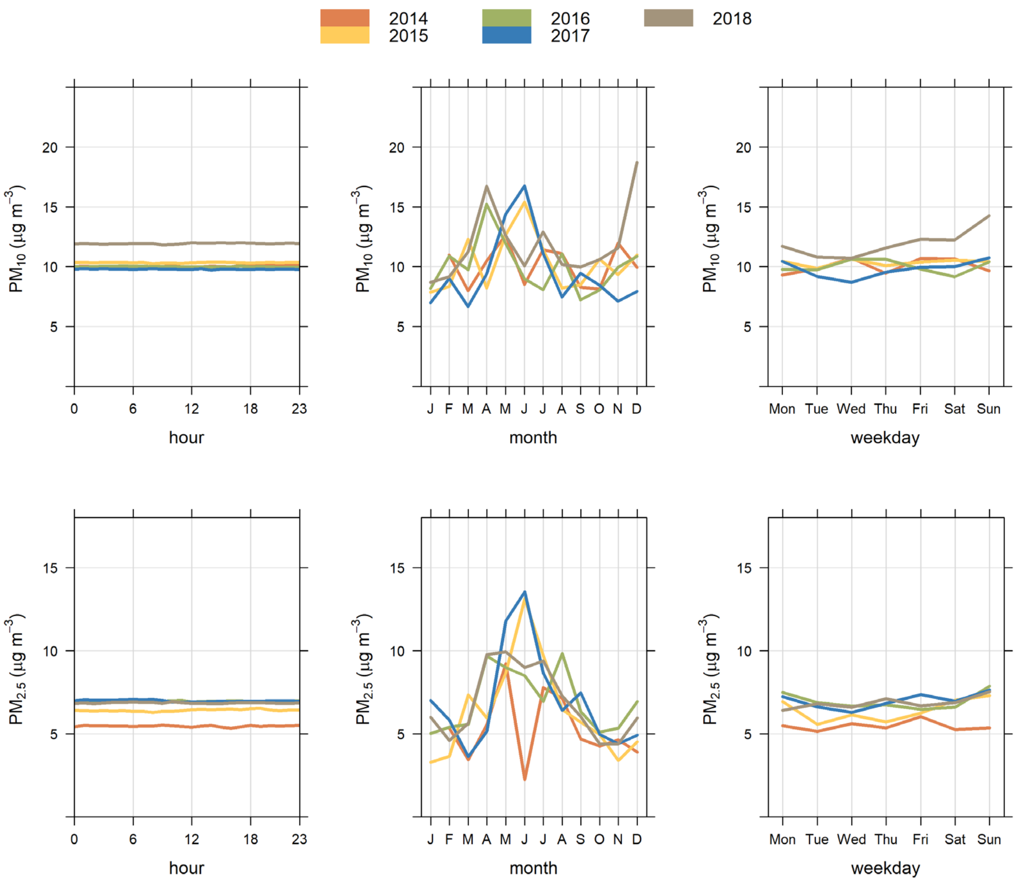



**Figure C.2 Time variation in $PM_{10}$ and $PM_{2.5}$ at the Florey station**

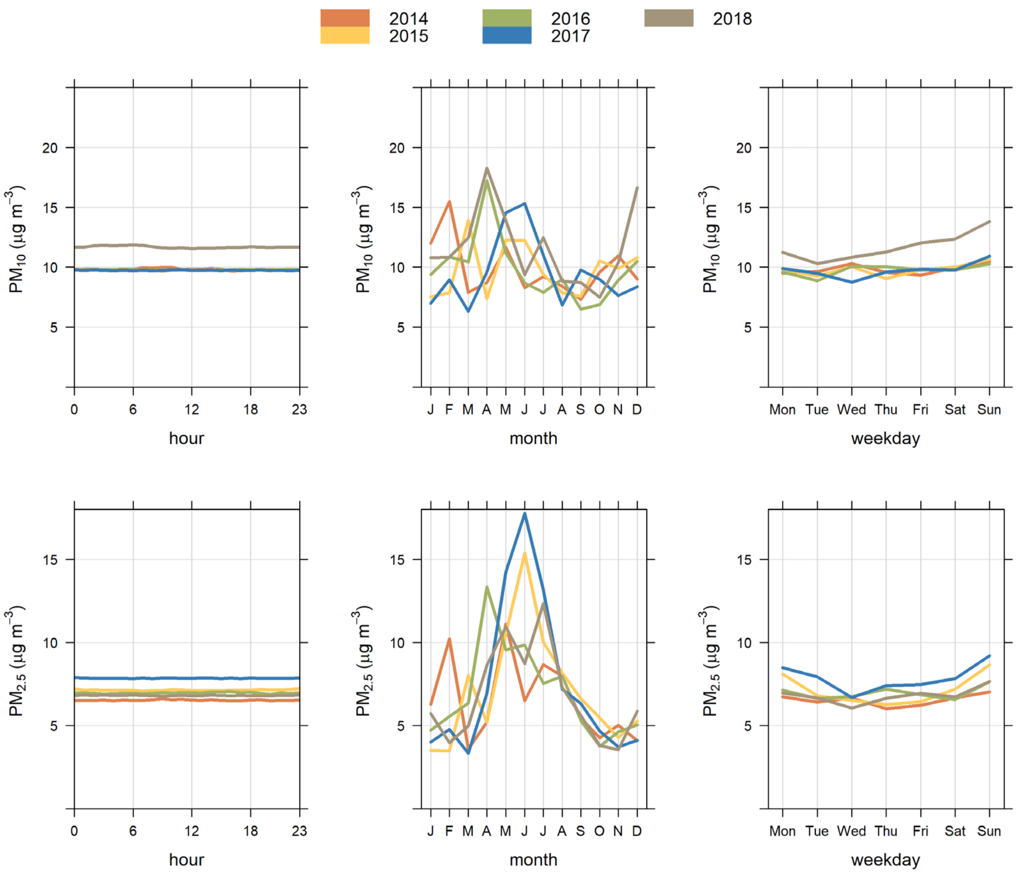



**Figure C.3 Time variation in $PM_{10}$ and $PM_{2.5}$ at the Monash station**

Annexure D

# Emissions inventory background

## D.1 Introduction

Particulate matter emissions from the site were quantified through the application of accepted published emission estimation factors, collated from a combination of United States Environmental Protection Agency (US-EPA) AP-42 Air Pollutant Emission Factors and NPI emission estimation manuals, including the following:

- US-EPA AP-42 Chapter 11.12 Concrete Batching (US-EPA, 2011a);
- US-EPA AP-42 Chapter 13.2.1 – Paved Roads (US-EPA 2011b); and
- US-EPA AP-42 Chapter 13.2.4 – Aggregate Handling and Storage Piles (US-EPA 2006).

Particulate releases were quantified for TSP, $PM_{10}$ and $PM_{2.5}$ as documented in subsequent sections.

## D.2 Sources of particulate matter emissions

Sources of particulate matter emissions associated with the site include:

- the movement of trucks and forklifts on paved roads about site (eg raw material delivery, forklift movements, segment transport truck movements);
- trucks unloading cement to storage silos on-site;
- trucks unloading sand and aggregate to bunkers on-site;
- trucks and front-end-loaders transferring sand and aggregate to the CBP hopper;
- CBP processes, including weigh hopper and central mixer loading;
- wind erosion from material storage areas;
- diesel combustion from front-end-loaders, forklifts and trucks; and
- natural gas combustion from boiler operations.

## D.3 Particulate matter emissions inventory

The emissions inventory developed for the operations at the site is presented in Table D.1.

## Table D.1 Emissions inventory

| Source name | Emission estimate TSP (kg/year) | Emission estimate $PM_{10}$ (kg/year) | Emission estimate $PM_{2.5}$ (kg/year) | Activity rate | Units | TSP emission factor | $PM_{10}$ emission factor | $PM_{2.5}$ emission factor | Unit | Parameter 1 | Unit | Parameter 2 | Unit | Parameter 3 | Unit | Parameter 3 | Unit | Reduction factor | Emission control | Emission factor source |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Raw materials trucks - paved roads | 3,797 | 729 | 176 | 16,474 | VKT/year | 0.77 | 0.15 | 0.04 | kg/VKT | 6.6 | Road silt loading (g/m²) | 0.6 | Haul distance (km) | 13,728 | Loads/year | 36 | Average weight (t) | 0.7 | Water flushing/sweeping | AP-42 13.2.1 |
| Trucks unloading cement to elevated storage silo (pneumatic) | 44 | 15 | 2 | 87,340 | t/y | 0.0005 | 0.0002 | 0.0000 | kg/t | | | | | | | | | | | AP-42 11.12 |
| Trucks unloading sand to bunkers | 73 | 35 | 5 | 153,755 | t/y | 0.0007 | 0.0003 | 0.0000 | kg/t | 3.2 | Average wind speed (m/s) | 4.2 | Moisture content (%) | | | | | 0.3 | Wind breaks from bunkers | AP-42 13.2.4 |
| Trucks unloading aggregate to bunkers | 249 | 118 | 18 | 158,122 | t/y | 0.0022 | 0.0011 | 0.0002 | kg/t | 3.2 | Average wind speed (m/s) | 1.8 | Moisture content (%) | | | | | 0.3 | Wind breaks from bunkers | AP-42 13.2.4 |
| Sand transfer to CBP hopper (truck and FEL) | 104 | 49 | 7 | 153,755 | t/y | 0.0007 | 0.0003 | 0.0000 | kg/t | 3.2 | Average wind speed (m/s) | 4.2 | Moisture content (%) | | | | | | | AP-42 13.2.4 |
| Aggregate transfer to CBP hopper (truck and FEL) | 356 | 168 | 25 | 158,122 | t/y | 0.0022 | 0.0011 | 0.0002 | kg/t | 3.2 | Average wind speed (m/s) | 1.8 | Moisture content (%) | | | | | | | AP-42 13.2.4 |
| Weigh hopper loading | 243 | 122 | 18 | 311,877 | t/y | 0.0026 | 0.0013 | 0.0002 | kg/t | | | | | | | | | 0.7 | Acoustics cladding (enclosure) | AP-42 11.12 |
| Central mixer loading | 3,541 | 957 | 86 | 87,340 | t/y | 0.135 | 0.037 | 0.003 | kg/t | | | | | | | | | 0.7 | Acoustics cladding (enclosure) | AP-42 11.12 |
| Forklifts transporting segments from shed to paved yard | 319 | 61 | 15 | 2,028 | VKT/year | 0.5 | 0.10 | 0.02 | kg/VKT | 6.6 | Road silt loading (g/m²) | 0.1 | Haul distance (km) | 20,280 | Loads/year | 25 | Average weight (t) | 0.7 | Water flushing/sweeping | AP-42 13.2.1 |
| Trucks transporting segments from paved yard to storage area | 3,091 | 593 | 144 | 20,280 | VKT/year | 0.5 | 0.10 | 0.02 | kg/VKT | 6.6 | Road silt loading (g/m²) | 1.0 | Haul distance (km) | 20,280 | Loads/year | 24 | Average weight (t) | 0.7 | Water flushing/sweeping | AP-42 13.2.1 |
| Forklifts in stabilised soil storage area loading trucks | 249 | 48 | 12 | 842 | VKT/year | 1.0 | 0.19 | 0.05 | kg/VKT | 6.6 | Road silt loading (g/m²) | 0.1 | Haul distance (km) | 8,424 | Loads/year | 46 | Average weight (t) | 0.7 | Water flushing/sweeping | AP-42 13.2.1 |
| Segment transport - stabilised soil storage area to paved | 2,826 | 542 | 131 | 8,424 | VKT/year | 1.1 | 0.21 | 0.05 | kg/VKT | 6.6 | Road silt loading (g/m²) | 1.0 | Haul distance (km) | 8,424 | Loads/year | 52 | Average weight (t) | 0.7 | Water flushing/sweeping | AP-42 13.2.1 |
| Segment transport - paved roads to site exit | 4,238 | 814 | 197 | 12,636 | VKT/year | 1.1 | 0.21 | 0.05 | kg/VKT | 6.6 | Road silt loading (g/m²) | 1.5 | Haul distance (km) | 8,424 | Loads/year | 52 | Average weight (t) | 0.7 | Water flushing/sweeping | AP-42 13.2.1 |
| Wind erosion from storage area | 42 | 21 | 3 | 0.07 | Area (ha) | 850 | 425 | 64 | kg/ha/year | | | | | | | | | 0.3 | Wind breaks from bunkers | AP-42 11.9 |
| Diesel combustion - FEL | 128 | 128 | 117 | | | | | | | | | | | | | | | | | Miscellaneous (engine specifications) |
| Diesel combustion - Forklifts | 323 | 323 | 296 | | | | | | | | | | | | | | | | | Miscellaneous (engine specifications) |
| Diesel combustion - trucks | 35 | 35 | 34 | | | | | | | | | | | | | | | | | Miscellaneous (engine specifications) |
| Boiler emissions | 140 | 140 | 43 | | | | | | | | | | | | | | | | | |
| **Total** | **19,798** | **4,897** | **1,330** | | | | | | | | | | | | | | | | | |

## D.4 Project-related input data used for particulate matter emission estimates

The material property inputs used in the emission estimates are summarised in Table D.2.

### Table D.2 Material property inputs for emission estimation

| Material properties | Value | Source of information |
|---|---|---|
| Paved road silt loading ($g/m^2$) | 6.6 | Adopted from EMM site specific sampling at a Sydney concrete batching plant |
| Sand moisture (%) | 4.17 | AP-42 S11.12, background document Table 16.1 |
| Aggregate moisture (%) | 1.77 | AP-42 S11.12, background document Table 16.1 |
| Cement moisture (%) | 0.5 | AP-42 S11.12, background document Table 18.1 |

## D.5 Diesel combustion emissions

Diesel combustion emissions were calculated using the following assumptions:

- mobile equipment emissions for the facility were based on the proposed equipment fleet specifications and US-EPA Tier 2 emission factors (as presented in Table D.3); and
- emission from road trucks were quantified through calculated annual VKT and the EPA PM Emission Factor for road trucks (EPA 2012), based on the specifications of 1996 ADR70/00.

### Table D.3 Diesel equipment fleet emissions

| Equipment type | Make/model assumed | Number | Power | Operating hours | Load factor | PM emission factor (g/kWh) | $NO_x$ emission factor (g/kWh) | Energy (kWh) | Annual emission (kg/annum) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | TSP emissions | $PM_{10}$ emissions | $PM_{2.5}$ emissions | $NO_x$ emissions |
| FEL | CAT 980 loader | 1 | 313 | 5,110 | 0.5 | 0.2 | 6.1 | 1,279,544 | 128.0 | 128.0 | 117.3 | 4,558 |
| Forklift (shed to yard) | Hyundai 250D-9 | 2 | 204 | 6,240 | 0.5 | 0.2 | 6.3 | 2,036,736 | 203.7 | 203.7 | 186.7 | 7,256 |
| Forklift (yard to truck) | Hyundai 250D-9 | 2 | 204 | 3,650 | 0.5 | 0.2 | 6.3 | 1,191,360 | 119.1 | 119.1 | 109.2 | 4,244 |

## D.6 Boiler combustion emissions

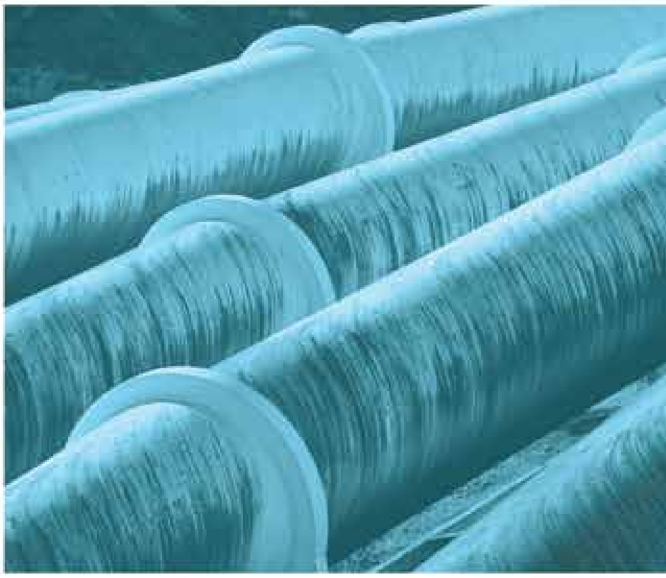
Emissions of particulate matter and $NO_x$ as a result of boiler combustion were estimated using the LPG consumption rate as provided by the proponent and emissions factors sourced from the NPI Emissions Estimation Technique for Combustion in Boilers v3.6 (NPI 2011).

Two boilers were included in the assessment and modelling inputs are provided in Table D.4. Where parameters were not known, these were estimated based on similar studies. Building wake was included in the modelling.

### Table D.4 Boiler modelling inputs

| Parameter | Boiler 1 | Boiler 2 |
|---|---|---|
| Coordinates (x,y, MGA, m) | 693106, 5987556 | 693096, 5987500 |
| Stack height (m) | 2.4 | 2.4 |
| Exit temperature (deg˚C) | 200 | 200 |
| Exit diameter (m) | 0.3 | 0.3 |
| Exit velocity (m/s) | 10 | 10 |
| LPG consumption (L/h) | 60 | 60 |
| TSP/$PM_{10}$ emission rate (g/s) | 0.002 | 0.002 |
| $PM_{2.5}$ emission rate (g/s) | 0.001 | 0.001 |
| $NO_x$ emission rate (g/s) | 0.038 | 0.038 |



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