



DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

# NSW Air Quality Monitoring Plan 2021–25

Methods for creating plans



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Cover photo: Penrith Air Quality Monitoring Station. Photo: Bradley White/DPIE.

Published by:

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ISBN 978-1-922493-75-0

EES 2021/0149

First published in December 2020; reprinted April 2021 with amendments.

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# 1. About this document

This document describes the Air Quality Monitoring Plan for NSW and the main methods and processes used to create it. It sets out the:

- scope of the plan
- key requirements and principles for air quality monitoring
- process for developing the plan
- accountabilities and governance – who does what
- quality assurance measures.

## 1.1 Purpose

The purpose of this document is to explain how the NSW Government intends to monitor ambient air quality during the next five-year period: 2021 to 2025.

The Air Quality Monitoring Plan meets the requirement of the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM), Part 4 Section 10, that each jurisdiction must have a plan setting how it proposes to monitor air quality for the purposes of this measure.

## 1.2 Target audiences

### Concerned citizens and advocates

This document is for those who wish to learn about the methods and systems used to monitor air quality in their region so they can take informed action to reduce pollutants and populations' exposure to them. It explains how certain types of pollutants, landforms and weather patterns might result in higher localised air pollution, and how nearby activities such as industry and traffic may affect amenity, and public and environmental health.

### Industry

For businesses with activities subject to air quality regulation and licensing, this document explains how the NSW Government uses industry monitoring as part of an integrated and rigorous air quality monitoring system. Monitoring helps local industry understand the community's concerns.

### NSW Government policymakers

This information can help Ministers and senior public servants to assess the adequacy of monitoring and pollution control for managing public health. Monitoring helps policymakers allocate and prioritise resources for air quality, and make decisions about the adequacy of policies, programs and regulations to manage air pollution.

### National Environment Protection Council

This plan describes monitoring in NSW for the National Environment Protection (Ambient Air Quality) Measure.

## 1.3 Plan update and review

The monitoring plan is updated annually and reviewed every five years.

**Table 1** Monitoring plan updates and reviews

Version	Release date	Purpose
Version 1.0 (original plan)	2001	Initial monitoring plan required under NEPM 1998
Major periodic reviews 2017–18	2018	To evaluate how well NSW is meeting the AAQ NEPM requirements, what is monitored for non-NEPM purposes, and where available resources could best be deployed to gather required and additional information about air quality.  The reviews identified extra monitoring requirements due to growing populations, new sources of air pollution, new technologies and specific community concerns.
Version 2.0	December 2020	Major plan update based on the 2017–18 reviews
Version 2.01	April 2021	Minor corrections
Version 2.1	December 2021	Next scheduled annual update
Version 3.0	December 2025	Next scheduled five-year review

## 2. Summary of the Air Quality Monitoring Plan

### 2.1 Scope

The plan describes the NSW Government’s monitoring methodology for ambient air quality. Monitoring covers the whole of New South Wales. Some NSW monitors are located beyond State boundaries. The way air emissions disperse is influenced by climatic and meteorological systems and patterns that do not recognise State boundaries.

#### Purpose of air quality monitoring

The primary purpose of air quality monitoring is for the protection of public health. Most routine monitoring has and will occur in regions with a high population. This Air Quality Monitoring Plan satisfies the requirements and intent of the AAQ NEPM.

The plan ensures there is adequate coverage of populated areas within a region to characterise the air quality the general population of that region is exposed to. Criteria air pollutants are monitored using a network of stations, designated as performance and trend stations. Trend stations are a particular subset of monitoring stations. These stations have monitored pollutants at the same location for more than 10 years, and capture trends in air pollution in that region over time. Performance stations, as designated in this monitoring plan, represent all other stations which either have been in place for less than 10 years, or are placed such that pollutant levels there are representative of the upper bounds which may be experienced by a portion of the population in that region. Both performance and trend stations are referred to in this plan as standard monitoring or NEPM stations, and are included in the annual NEPM compliance report for New South Wales.

The NSW regions that experience much of the State’s industry and road traffic emissions are monitored in accordance with NEPM-compliant measures. NEPM-compliant monitoring in

major cities and regional centres covers the air quality regions where approximately 78% of the 7.48 million people were resident in New South Wales in 2016<sup>1</sup>.

This includes:

- major cities of Sydney, Newcastle, Wollongong and Central Coast
- regional centres of Albury, Armidale, Bathurst, Gunnedah, Goulburn, Muswellbrook, Narrabri, Orange, Singleton, Tamworth and Wagga Wagga.

The Department of Planning, Industry and Environment undertakes a significant amount of routine monitoring outside NEPM compliance stations. This includes most prominently industry-funded networks in the Hunter Valley, and the Rural Air Quality Monitoring Network where particles are measured at large regional centres including Dubbo, Griffith, Broken Hill and Lismore.

Air quality is also monitored to gather information about specific pollution sources and assess their impact on air quality in other ways:

- The effect of industrial processes on air quality – industry-funded monitoring reports on air quality and trends due to specific pollutants generated by industry. The NSW Environment Protection Authority (EPA) may require air quality monitoring as part of licences under the Protection of the Environment Operations Act 1997 and Chapter 5A of the Protection of the Environment Operations (General) Regulation 2009.
- Early warnings of dust storms – the Rural Air Quality Monitoring Network reports on air quality (particle pollution) in regional and rural NSW, serving as an early warning system for dust storms.
- Road fleet emissions – roadside monitoring measures peak air quality levels experienced on a busy road to assess general fleet emissions.
- Air pollution and associated health risks due to incidents such as hazard reduction burns, bushfires and dust storms – incident-response monitors can be rapidly deployed to give timely access to information.

All of these stations, along with the NEPM compliance stations, form an important component of the live air quality reporting provided to the people of New South Wales.

The Air Quality Monitoring Plan comprises this document and the following schedules.

## Air Quality Monitoring Plan Schedules

### 1. Definition of regions and spatial boundaries:

- a. describes the factors considered in defining regions and spatial boundaries used in the plan
- b. identifies NSW population centres greater than 25,000 people using Australian Bureau of Statistics (ABS) significant urban areas (SUAs) and their populations at the most recent national census
- c. calculates population-based requirements for monitoring in NSW regions.

### 2. Register of NSW monitoring stations and their key attributes:

- a. maps showing locations of monitoring stations

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<sup>1</sup> NSW population 7.48 million at 2016 census. Population for top 5 SUAs Sydney 4.4m (million), Newcastle–Maitland 0.46m, Central Coast 0.32m, Wollongong 0.20m, Albury-Wodonga 0.09m. Other NEPM monitoring region SUAs are approximately 0.3m combined. Source: Australian Bureau of Statistics

- b. register of monitoring stations for the planning period, and history of monitoring station commissioning and decommissioning dates and station movements
- c. register of pollutant parameters and monitoring instruments for the planning period
- d. overall pollutant-by-pollutant analysis for NEPM compliance monitoring.

**3. Focus plans for significant urban areas in NSW:**

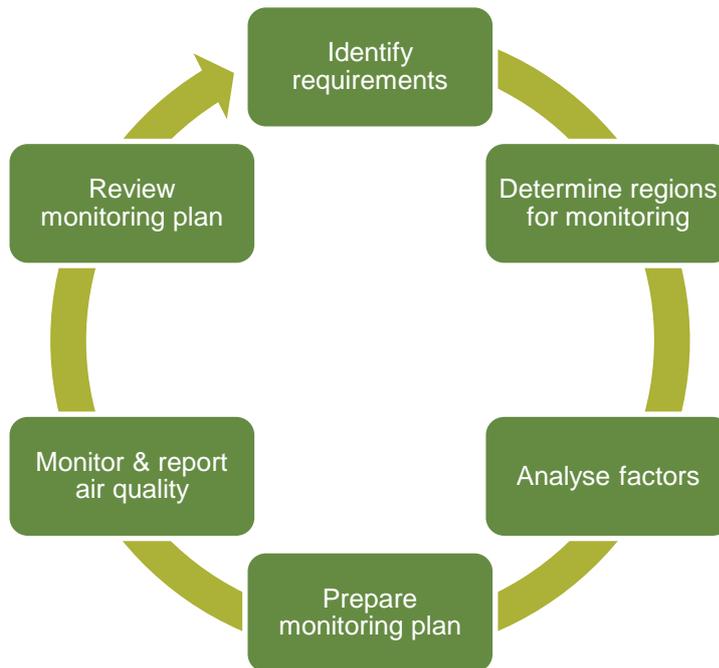
- a. detailed analysis of factors used to determine monitoring for the top five SUAs in NSW – Greater Sydney, Newcastle–Maitland, Central Coast, Wollongong and Albury–Wodonga.

### Strategic overview of air quality monitoring in New South Wales

Air Quality Monitoring in NSW: From long-term trend monitoring to integrated urban services provides a strategic overview of the evolution of air quality monitoring in NSW. (Riley M, Kirkwood J, Jiang N, Ross G, Scorgie Y 2019, 24th International Clean Air and Environment Conference.)

## 3. Method for designing air quality monitoring

The Air Quality Monitoring Plan is developed using a quality management approach of continuous improvement.



**Figure 1** Quality management cycle for air quality monitoring plans

## 4. Identifying NSW monitoring requirements

The plan describes monitoring for multiple purposes. We monitor to conform with legal requirements and to improve NSW performance against policy goals and community needs. This section covers specific monitoring requirement under the AAQ NEPM legislation (Section 4.1), guiding principles for monitoring (Section 4.2) and air quality monitoring outside the NEPM which is used to protect public health (Sections 4.3 through 4.8).



Figure 2 Summary of requirements for air quality monitoring

### 4.1 National Environment Protection (Ambient Air Quality) Measure

The NSW air quality monitoring network design is guided in part by the National Environment Protection (Ambient Air Quality) Measure (AAQ NEPM) that sets population thresholds for the likely amount of monitoring required within a certain airshed or a certain community. Its desired environmental outcome is ambient air that adequately protects human health and wellbeing – air that is safe to breathe.

The AAQ NEPM is made under the National Environment Council Acts to provide equivalent environmental protection to all Australians wherever they live. A list of key AAQ NEPM guidance documents is at Appendix A.

To ensure public health, the NSW Government characterises the air quality the general NSW population is exposed to by monitoring all legislated criteria air pollutants of interest at a network of trend stations. Trend stations capture most pollution events that might occur. Additionally, permanent upper-bound stations monitor selected pollutants to ensure that all major pollutant events are captured and reported.

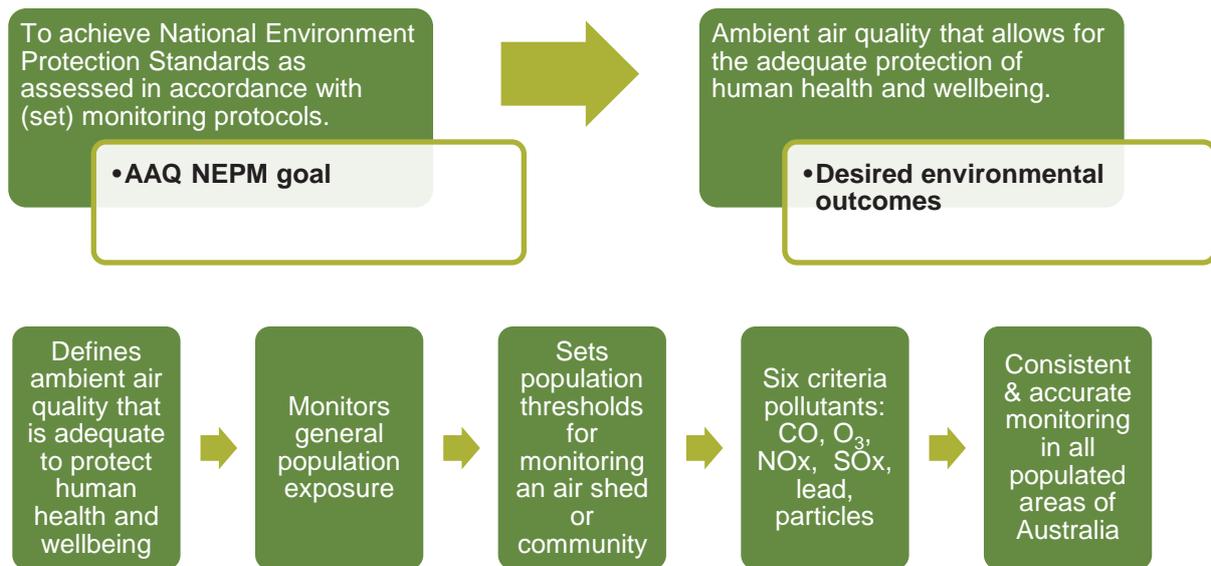


Figure 3 Key features of the AAQ NEPM

## AAQ NEPM requirements used to develop the monitoring plan

Table 2 AAQ NEPM requirements used to develop the Air Quality Monitoring Plan

AAQ NEPM requirements	Reference
<p><b>Determine regions for air quality monitoring</b></p> <p>The AAQ NEPM broadly defines 'region', allowing each jurisdiction to determine its regions and their boundaries. Guidance suggests ABS 'urban centre' population data as a transparent basis for a preliminary assessment of regions. Local knowledge of a region, airshed population, emission sources, topography and dispersion should also be considered.</p>	AAQ NEPM Peer Review Committee (PRC) Technical Paper No. 2 (2001)
<p><b>Monitor every region with a population of 25,000 or more</b></p> <p>A standard population-based calculation gives an initial estimate of the network needs of a region in the absence of detailed scientific studies and understanding of the region.</p> <p>The number of performance monitoring stations for a region with a population of 25,000 people or more must be the next whole number above the number calculated in accordance with the formula:</p> $1.5P + 0.5$ <p>where <i>P</i> is the population of the region (in millions).</p> <p>This is subject to further considerations outlined in performance monitoring stations.</p>	AAQ NEPM Clause 14
<p><b>Follow the national monitoring protocol</b></p> <p>Each jurisdiction must prepare a monitoring plan setting out how it proposes to monitor air quality for the purposes of the AAQ NEPM. Each monitoring plan must be submitted to the National Environment Protection Council.</p>	AAQ NEPM, Clause 10

AAQ NEPM requirements	Reference
<p><b>Methods of measuring and assessing concentration of pollutants</b></p> <p>To evaluate performance against the standards, the concentration of pollutants in the air:</p> <p>(a) is to be measured at performance monitoring stations</p> <p>Because the concentrations of different pollutants vary across a region, it would not be necessary or appropriate to co-locate the measuring instrumentation for all pollutants at each performance monitoring station.</p> <p>or</p> <p>(b) is to be assessed by other means that provide information equivalent to measurements which would otherwise occur at a performance monitoring station.</p> <p>These methods could include, for example, the use of emission inventories, wind field and dispersion modelling, and comparisons with other regions.</p>	<p>AAQ NEPM, Clause 11</p>
<p><b>Performance monitoring stations</b> measure the concentration of pollutants in the air to evaluate air quality against the standards and goals of the AAQ NEPM. Performance monitoring stations must be located so they measure the air quality likely to be experienced by the general population in a region. The monitoring network must provide widespread coverage of the populated area in a region.</p> <p>A performance monitoring station should be operated in the same location for at least five years unless the integrity of the measurements is affected by unforeseen circumstances. Note that in this plan, New South Wales has designated stations which have operated for less than five years as performance monitoring stations where they are planned to be monitored in that location for at least that period of time.</p> <p>Additional performance monitoring stations may be needed where pollutant levels are influenced by local characteristics such as topography, weather, or emission sources. Fewer performance monitoring stations may be needed where it can be demonstrated that pollutant levels are reasonably expected to be consistently lower than the standards in the AAQ NEPM.</p>	<p>AAQ NEPM, Clauses 11 and 13</p>
<p><b>Population average performance monitoring stations</b> are to be sited in an area with relatively low pollutant gradients, while avoiding the direct impacts of localised pollutant sources.</p>	<p>AAQ NEPM PRC Technical Paper No. 3 (2001)</p>
<p><b>Generally representative upper-bound (GRUB) performance monitoring stations</b> must be located to measure pollutants at the upper bounds of the concentrations that may be likely to be experienced within a region.</p> <p>Note: This category, according to a <a href="#">recent NEPM review</a>, may not be consistent with current best practice on population exposure, and other station definitions are sufficient. Pending possible changes, we have currently not labelled stations using this designation in our plan.</p>	<p>AAQ NEPM PRC Technical Paper No. 3 (2001)</p>
<p><b>Trend performance monitoring stations</b> are nominated to monitor and assess long-term changes in ambient air quality in different parts</p>	<p>AAQ NEPM, Clause 15</p>

AAQ NEPM requirements	Reference
of the jurisdiction. A trend station must be operated in the same location for one or more decades.	
<p><b>Performance evaluation and reporting</b></p> <p>Each jurisdiction must evaluate and report its annual performance against the AAQ NEPM goal and standards.</p>	AAQ NEPM Clause 17 and 18
<p><b>Guidelines on developing the monitoring strategy</b></p>	AAQ NEPM PRC Technical Paper No. 3
<p><b>Criteria for using screening to reduce the monitoring of any parameter</b> below that set out in Clause 14 of the AAQ NEPM</p>	AAQ NEPM PRC Technical Paper No. 4

## 4.2 NSW policies, programs and guiding principles

### Monitoring in most regions of NSW far exceeds AAQ NEPM guidance

For Greater Sydney, AAQ NEPM guidance would result in 8 monitoring stations, (based on ABS census population data from 2016). The NSW Government currently has 17 monitoring stations in Greater Sydney. There are 15 located within the ABS SUA population region, with two further stations located outside the SUA boundary but contained within the broader Greater Sydney planning region.

### Australian monitoring requirements are the strictest in the world.

In 2019, the NSW Government commissioned an independent review of its air quality monitoring network to see how other jurisdictions set population thresholds and monitoring requirements.

The review found that the population thresholds set by the AAQ NEPM were the strictest in the world. Australia requires more monitoring per head of population than any other jurisdiction or indeed any of the eight jurisdictions reviewed.

Access the full review on the [NSW Environment, Energy and Science website](#).

## NSW Air Program

Air quality monitoring is a vital element of the NSW Air Program, a major NSW Government program that has operated for more than 60 years. The program seeks to understand current air quality and its impacts, changes over time, and likely future changes. One of the program’s main outputs is supplying high-quality and fit-for-purpose data and information on air quality in New South Wales to a wide range of end users.

Immediate outcomes	Intermediate outcomes	End of program outcomes
<p>End users are aware of the significance of local air quality issues.</p> <p>Community, government and business decision-makers have access to the right information at the right time and at the right scale.</p> <p>Stakeholders are able to engage and collaborate on air quality science and management.</p>	<p>End users know how to use air quality information for risk assessments and cost–benefit analyses.</p> <p>Communities can use air quality information to take preventative action to minimise personal exposure.</p> <p>The community and policy investigators can use air quality science information in decision-making and policymaking.</p>	<p>The people of New South Wales have greater protection from air pollution.</p> <p>New South Wales amenity and quality of living is improved through having high air quality.</p> <p>New South Wales benefits from improved decisions on environmental and public health due to world-class evidence of air quality impacts.</p>

## NSW Government aims and principles for air quality monitoring

Air quality is monitored to assess if the air we breathe poses a risk to human health. Monitoring information provides evidence to the public, health professionals and policymakers when choosing short-term and long-term actions to reduce harm. Risk of harm from air pollution is a function of the number of people exposed (population), and the level of exposure to pollution hazards – pollutant types, concentrations, and durations.

**Table 3 Aims and guiding principles**

Aims of air quality monitoring	Guiding principles
Protect public health	Measure pollutants of greatest concern
Characterise regional air quality	Use scientifically sound monitoring methods
Estimate pollution exposure	Monitor in appropriate locations
Increase public awareness	Collect sufficient data to suit the defined purpose and report results transparently
Describe air quality trends	Be geographically diverse
Support air policy and program development	Provide flexibility to ensure that emerging monitoring needs can be met
Evaluate emission reduction measures and programs	Make the best use of resources
Assess new sources of pollution	Support other research activities when possible
Support research programs	Review the network periodically

## Using air quality monitoring in air quality management

Ambient air quality monitoring provides assessment of compliance with the standards set out in the AAQ NEPM. The air emissions inventory is used to identify priority sources of key air pollutants. Airshed modelling identifies areas of high population exposure to pollutants and cost-effective emissions reduction strategies are then developed to reduce the risk of harm from air pollution to human health.

### 4.3 Community needs

Monitoring must serve community needs. The NSW Government listens and learns from communities, pursuing the best outcomes and creating opportunities that benefit all. Monitoring must always be done for the sake of people’s wellbeing and the prosperity of New South Wales. The NSW EPA leads engagement activities to identify and respond to community needs. The EPA produces a range of draft policies, agreements and reports that call for community involvement, engagement and consultation.

#### Listening to the community’s requirements for air quality monitoring

In 2017, the NSW Government invited air quality stakeholders to complete an online survey to help inform the development of a clean air policy for New South Wales.

The survey results revealed that the community required:

- enhanced forecasting and air quality monitoring data available in real time
- regular comprehensive analysis and summaries
- expansion of the air quality monitoring network in Sydney and regional centres in response to population growth and industry expansion
- additional monitoring beyond NEPM compliance monitoring to increase coverage and capture local exceedances (e.g. in regional and remote communities subject to wood smoke and coal mine emissions)
- monitoring near hotspots, such as road and rail corridors, tunnel stacks and cruise ship terminals
- monitoring near sensitive locations such as hospitals and schools
- deployment of portable monitoring pods and low-cost sensors at roadsides and at various locations during bushfires and hazard reduction burns
- greater government oversight of industry air monitoring data
- development of a mobile phone app.

Survey respondents called for more monitoring stations in locations such as Lake Macquarie, Orange, Armidale, Dubbo, large regional centres on the North Coast, Western Sydney, the Northern Beaches of Sydney, and Sutherland Shire.

The survey findings are available on the [NSW EPA website](#).

At the Clean Air Summit in June 2017, the NSW Government committed to expanding the NSW air quality monitoring network to include:

- new monitoring stations in the Sydney central business district (CBD) and Parramatta CBD
- investigation of the need for monitoring in Penrith
- monitoring at a busy roadside location

- expansion of the standard air quality monitoring network in regional NSW, with additional monitors in towns along the Tablelands where wood smoke in winter is a concern for residents (e.g. Armidale, Orange and Goulburn)
- consideration of monitoring in North Coast centres, such as Coffs Harbour or Lismore, to understand air pollution in these communities better
- a new North West (Namoi) Air Quality Monitoring Network with new monitoring stations at Gunnedah and Narrabri
- integration and expansion of the Community DustWatch network into the Rural Air Quality Monitoring Network.

NSW Government Air Program scientists participate in community engagement activities and panels administered by the NSW EPA. Examples include the Lower Hunter Dust Deposition Study, the Namoi Region Air Quality Advisory Committee, the Newcastle Community Consultative Committee on the Environment, and the Upper Hunter Air Quality Advisory Committee.

Other activities include:

- The Rural Air Quality Monitoring Network is supported by 39 citizen scientists who help to maintain each station.
- There are several continuous feedback channels for the public to discuss air quality monitoring. These include
  - website feedback forms
  - [Environment Line](https://www.environment.nsw.gov.au) online, or email [info@environment.nsw.gov.au](mailto:info@environment.nsw.gov.au), or phone 131 555
  - correspondence arising from email newsletters and reports.

We encourage you to provide feedback on this plan to help inform the next scheduled update, in 2021.

## 4.4 Research and continuous improvement

Research projects and campaign monitoring give additional characterisation of air quality over a few months or years. Their scope varies but might look at air quality experienced by certain communities, focus pollutants or pollution sources. Research monitoring projects also test the efficacy of new equipment, such as lower-cost monitoring equipment.

Air quality monitoring networks measure concentrations of pollutants and other chemicals in the atmosphere which may have been generated in New South Wales or transported from outside the State. The data obtained are used by scientists and regulators to:

- evaluate and assess our air quality across the State and provide data to predict the health impacts
- assess and manage the environmental impacts of selected activities associated with emissions
- provide information about the trend in air pollution changes over the years
- determine the effectiveness of future air quality regulations
- identify new air quality concerns and raise awareness
- provide support for residents' concerns about exposure and health impacts resulting from air pollution episodes.

Researchers in the Department's Climate and Atmospheric Science Branch rely on these measurements to develop and test air quality models used for air quality forecasts, and to

understand effects of proposed regulations, new technologies, new infrastructure development, climate, and other changes in the environment.

## 4.5 Air quality incidents

Public health is the primary driver for ambient air quality monitoring. Emergency response monitors can be rapidly deployed to measure air quality experienced by people during major incidents such as the NSW ‘black summer’ bushfires in 2019–20. Four emergency response monitoring pods are available, equipped with compliance instruments. A typical configuration is: CO, NO<sub>x</sub>, SO<sub>2</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> and visibility. An aethalometer or other rack-mounted instruments can be incorporated. Responding to significant incidents, the pods can be deployed anywhere in New South Wales within 24 hours.

## 4.6 Industrial emissions and regulation

Monitoring is part of the NSW EPA’s regulation of industry. For example, in the Newcastle area, the NSW Government operates a network of monitoring stations that is funded by industry to provide information to the local community. The *Protection of the Environment Operations Act 1997* (POEO Act) is the key piece of environment protection legislation administered by the EPA. Licence conditions can include requirements for air quality monitoring.

## 4.7 Land management practices

Land management practices can have a significant effect on air quality. Monitoring in rural areas measures the effects of soil erosion, windblown dust, and bushfires. Findings are used to support improvements in land management practices.

## 4.8 Fleet emissions

A long-term roadside monitor measures peak air quality levels experienced on a busy road in Sydney. EPA air emissions inventories identify a significant portion of CO, NO<sub>x</sub>, particulates and VOCs emissions in the Sydney region are attributable to emissions from vehicles. The roadside monitor provides an indication of general fleet emissions, rather than the exposure of a particular community.

There is limited guidance on roadside monitoring in Australia and some other states have adopted approaches consistent with their wider monitoring network for roadside monitors. International jurisdictions, such as the United States and Europe, have established specific requirements for long-term roadside monitoring.

New South Wales has adopted the United States Environmental Protection Agency (US EPA) methodology for siting of a long-term roadside monitor, as much as practicable. This methodology is comprehensive and well-established. The US EPA provides guidance on roadside monitoring in Title 40 Part 58 of the Code of Federal Regulations and the *Near-road NO<sub>2</sub> Monitoring Technical Assistance Document* (Watkins N & Baldauf R 2012, United States Environmental Protection Agency, EPA-454/B-12-002).

## 5. Identifying regions for air quality monitoring

In New South Wales, air quality is primarily monitored to assess whether ambient air poses a risk to human health. When the public, health professionals, air quality managers and policymakers use monitoring evidence to support decision-making, risk of harm can be reduced. Risk of harm is a function of the number of people exposed (population), and the level of exposure – pollutant types, concentrations, and durations.

For 2021–25, air quality will be monitored and reported by air quality region. These regions correlate broadly to land-use planning regions at a higher level, often subdivided into smaller subregions to align with traditional air quality monitoring regions. This aligns air quality with spatial boundaries used for NSW Government strategic planning and reporting of other key environmental indicators – for example, modelling and projections for climate and greenhouse gas emissions.

### 5.1 Factors considered to define monitoring regions

The NSW regions for air quality monitoring and AAQ NEPM reporting are defined based on spatial boundaries, quality considerations, strategic planning regions, population data and natural systems.

#### Spatial boundaries

Spatial boundaries considered when defining NSW regions for air quality monitoring and reporting are:

- NSW Government land-use planning regions
- Bureau of Meteorology (BoM) weather forecast regions
- Greater Sydney Commission's three cities
- current air quality region definitions
- airsheds (similarity in air quality conditions)
- significant population centres, highlighted using significant urban areas (SUAs) as defined by ABS.

#### Quality considerations

Quality measures for naming regions and setting boundaries are:

- use a simple, readable presentation of region names
- use popular community identity names for locations
- distinguish geographical boundaries within and outside New South Wales
- consider the continuity of region definitions.

#### Strategic planning

NSW planning regions are an administrative boundary determined by the Department, broadly in line with population centres and human land uses. Human activities (such as burning fossil fuels for energy and transport) and land-use patterns (such as population density, travel patterns, location of polluting industries and their proximity to vulnerable types

of people such as children, and urban heat-island effect) influence air quality and its effect on the population.

Greater Sydney is the largest population and economic centre in New South Wales and Australia. The Greater Sydney Commission's strategic plans describe a metropolis of three cities – Eastern Harbour City, Central River City and Western Parkland City. For air quality purposes, these are mapped to four air quality subregions: East Sydney (Eastern Harbour), Central West Sydney (Central River), and North West and South West Sydney (Western Parkland, divided into north and south geographic areas).

## Population

This monitoring plan adopts a conservative approach and uses the upper bound of the population data as described by the SUA population data product (as defined by ABS).

Consideration of population-based monitoring for AAQ NEPM purposes is required for every region with a population of 25,000 or more. The AAQ NEPM gives a broad definition of 'region', allowing each jurisdiction to determine its regions and their boundaries. New South Wales defines regions for AAQ NEPM reporting based on AAQ NEPM requirements, population data for SUAs from the 2016 census, and the factors listed above.

ABS SUAs represent individual urban centres or clusters of related urban centres with a core urban population of over 10,000 people. They can also include related peri-urban areas and satellite development: the area into which the urban development is likely to expand, and nearby rural land. SUAs are aggregations of SA2s (ABS Level 2 statistical areas), which enables them to provide a broad range of regularly updated ABS demographic and social statistics that are not available for the urban centres and localities definitions.

The Department publishes NSW population and household projections. The Population Projection is used to provide future population estimates and hence forecasts for required number of stations in air quality regions.

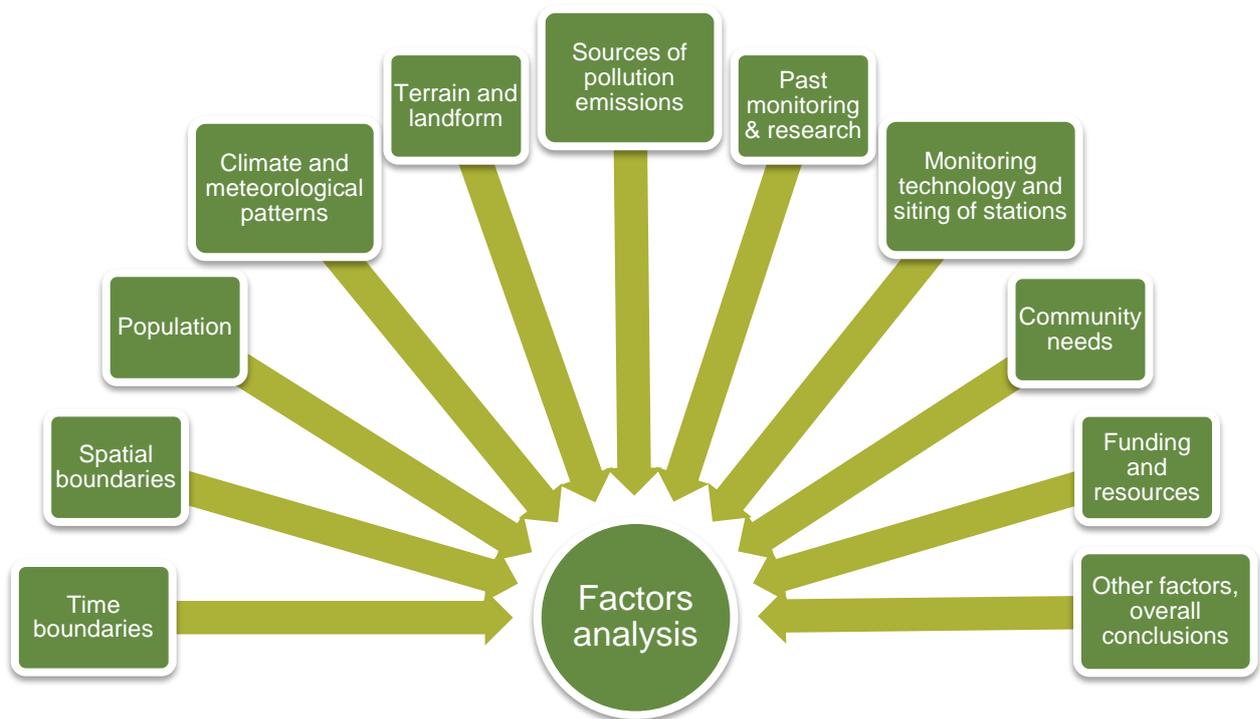
## Natural systems

Underlying atmospheric and pollution analysis is based on natural boundaries, mainly airshed which is a function of terrain, meteorology and climate. Smoke, dust and gaseous chemical pollutants are moved by thermal currents and blown by the wind. Natural convection causes hot air to rise, taking pollution with it. Landscape features such as hills and valleys are natural barriers that limit the dispersal of pollutants and can result in pollution pools with higher pollution concentrations. Winds and air movement patterns often follow a diurnal and seasonal pattern – for example, sea breezes in the afternoon. Changes to the climate mean meteorological patterns might change in future.

Regions used to develop this plan are set out in Schedule 1.

## 6. Analysing monitoring factors

Monitoring decisions in New South Wales are informed by a critical assessment of the needs of the community, looking at the sources of air pollution in that community, their likely size and the impacts on the community. All monitoring plans are prepared by analysing the following key factors.



**Figure 4** Factors considered for preparing a monitoring plan

**Table 4** Monitoring plan considerations and information sources

Factor	Considerations for analysis	Key information sources
a) Time boundaries	<p>Define time boundaries: period covered by the plan; interval for scheduled reviews; period and interval for reporting; planning horizon used in plans, policies, models, and forecasting.</p> <p>The plan covers a five-year planning period, updated annually, with a major review every five years.</p> <p>Monitoring data will be reported near-real time for most monitoring stations.</p> <p>Annual reports will be published on compliance with AAQ NEPM, and an Air Quality Statement will evaluate air quality during the past year.</p>	<p>Past air quality monitoring plans</p> <p>NSW Government strategic plans for land use, transport, and infrastructure.</p> <p>AAQ NEPM legislation and guidance.</p>
b) Spatial boundaries	<p>Define methods and data used to determine spatial boundaries for regions. Identify relationships between administrative boundaries, human geography and natural systems for air, land and water.</p> <p>Schedule 1 describes the spatial boundaries used in this plan.</p>	<p>Airshed models.</p> <p>Administrative boundaries for land-use planning and other strategic plans.</p> <p>Population centres and population density.</p> <p>ABS statistical boundaries.</p>
c) Population	<p>Calculate the AAQ NEPM requirement for population-based monitoring to assess the potential number of people</p>	<p>Population centres within the spatial boundary using ABS census data for SUAs.</p>

Factor	Considerations for analysis	Key information sources
	<p>that might be exposed to air pollution within the spatial boundaries.</p> <p>AAQ NEPM formula: population in millions x 1.5 + 0.5, rounded up to the nearest whole number.</p> <p>Schedule 1 describes the population analysis used in this plan.</p>	<p>Most recent ABS census data for SUAs.</p>
d) Climate and meteorological patterns	<p>Past and future meteorological and climate patterns, to identify how pollutants may disperse and interact within the spatial boundaries. These patterns can create conditions and locations where pollution concentrations might build up to levels hazardous to human health.</p>	<p>BoM data and information AdaptNSW Regional Climate Snapshots.</p>
e) Terrain and landform	<p>Terrain features – such as hills, valleys, and coastal proximity – influence the way air pollution moves around an airshed.</p>	<p>Terrain and topographical maps.</p>
f) Sources of pollution emissions	<p>Sources and types of pollution likely to be present in the spatial boundary are identified to assess likely presence and location of criteria pollutants. Pollution sources are considered when choosing monitoring sites that represent general population exposure, trend and upper-bound exposure.</p>	<p><u>EPA Air Emissions Inventory</u> <u>EPA Public Register of licenses</u> Local knowledge. Department of Transport data. National Pollutant Inventory. (Australian Government).</p>
g) Past monitoring, pollution trends and research studies	<p>Analyse data from past monitoring and research studies to identify trends and characterise air quality and pollution hazards. The plan might recommend future studies and monitoring to address knowledge gaps.</p>	<p>Air quality data. NEPM annual compliance reports. Annual air quality statement. State of the Environment Report. Research studies and papers.</p>
h) Monitoring technology and siting of stations	<p>Assess the technologies used to gather monitoring data, and levels of scientific rigour and accuracy of data generated when using it to analyse pollution trends. Assess whether station siting is appropriate to assess general population exposure, general upper-bound exposure and other characteristics. Monitoring plans must choose fit-for-purpose technologies.</p>	<p>Schedule 2 Monitoring stations. Register of NSW monitoring stations and their key attributes. Register of pollutant parameters and monitoring instruments.</p>
i) Community needs	<p>Identify the community's needs for monitoring and reporting. The community must have confidence in the accuracy and usability of monitoring information.</p>	<p>NSW EPA community consultation and engagement about expectations of air quality, how and where air quality is monitored, and the way in which the data is disseminated to the public.</p>
j) Available funding and resources	<p>Make the best use of resources and provide flexibility to ensure that emerging monitoring needs can be met.</p>	<p>Budgets and resources plans Human resources plans, including those for training and recruitment.</p>

Factor	Considerations for analysis	Key information sources
		Procurement strategy
k) Other factors and overall analysis	Have all factors that may affect air quality monitoring been given due consideration when preparing the plan?	Analysis, conclusions and recommendations drawn from analysis of these and the above factors.

Analysis of factors is documented as a succinct description in plain English with:

- text, charts and graphs to illustrate key observations and findings
- references and links to sources used including applicable standards and methods, datasets, charts and diagrams
- documented conclusions of analysis
- recommended actions for the planning period.

## 7. Preparing the Air Quality Monitoring Plan

The monitoring regime for the planning period is documented as a series of schedules.



**Figure 5** Monitoring regime schedules

The schedules are organised as set out in Section 2.1 of this document.

### 7.1 Illustrative geospatial maps

Where possible, maps should be dynamic and show the most up-to-date and accurate information for:

- monitoring station names, locations and types
- terrain and topology features, e.g. hills, valleys, coasts, major waterways, major roads, names of major settlements
- meteorological factors, such as wind rose diagrams
- polygons of spatial boundaries and regions used to design the plan, operate monitoring networks and report monitoring results
- polygons or shading to indicate population centres and population density.

### 7.2 Illustrative tables and lists

Where possible, tables and lists should be dynamic and show the most up-to-date and accurate information for:

- names, locations and types of monitoring stations in New South Wales and relationships to spatial boundaries

- pollutant parameters and monitoring instrumentation.

## 8. Monitoring and reporting air quality

Air quality monitoring stations contain scientific instruments that measure air pollutants accurately and continuously throughout the day. Telemetry allows data to be transmitted and reported near-real time on the Department's website.

In addition, periodic summary reports present trends and compliance with AAQ NEPM goals and standards.

Monitoring stations are maintained and operated in line with Australian Standards where applicable, and independently accredited by the National Association of Testing Authorities (NATA) to demonstrate compliance with the requirements of ISO/IEC 17025 *General requirements for the competence of testing and calibration laboratories*.

Rural Air Quality Monitoring Network stations provide indicative monitoring and are therefore not fully compliant with Australian Standards and not part of NATA accreditation.

### 8.1 Data quality objectives

Quality assurance procedures and protocols are applied to ensure the validity and integrity of air quality data acquired and reported. The primary data quality objectives are:

- precise – the data conforms to set guidelines for precision and is tested through daily calibration checks
- accurate – the data is accurate, as determined by regular multipoint calibration; accuracy depends on instrument responses remaining linear
- representative – the data collected from each site will be consistent with respect to time of day, siting and meteorological conditions
- comparable – the data will be comparable to data collected by other institutions using similar collection methods.

### 8.2 Sampling protocol

Monitoring stations in the air quality monitoring network gather data on gaseous parameters (ozone, sulfur dioxide, carbon monoxide, oxides of nitrogen), fine particles (PM<sub>2.5</sub>) and coarse particles (PM<sub>10</sub>), visibility, wind speed, wind direction, temperature and relative humidity. Solar radiation and rainfall are measured at selected stations. The instruments that measure these parameters conform to Australian and international standards, as described in Schedule 2.

In operating the monitoring program, the following measures are used to ensure that air quality and meteorological parameters are of high quality:

- siting of instruments – monitor placement is guided by requirements laid out in AS/NZS 3580.1.1 *Methods for sampling and analysis of ambient air – Guide to siting air monitoring equipment*
- instrument servicing and maintenance – key instrument components are regularly tested to diagnose and detect instrument performance drifts
- accuracy of measurements – calibration is regularly checked for gaseous and particulate air quality monitors and meteorological instruments
- logging of issues – any issues affecting instrument performance are documented to ensure that anomalous data is identified and managed through data validation.

### 8.3 Data validation procedure

Data validation procedures are implemented both in the field and after data collection, to ensure that air quality and meteorological parameters measured by the air quality monitoring network are reliable. These involve multiple steps:

- The initial stage of data validation occurs during the data acquisition phase at the monitoring station when the data logger invalidates (flags) data based on instrument alarms. These data are stored onsite in raw data files and are transmitted on an hourly basis from monitoring sites to a central file server.
- A database loading program loads the raw data file from the central file server into the corporate air quality database according to pre-defined validation and calibration rules, with the data automatically flagged as production data.
- Quality assurance staff reconcile data stored in the database using various software applications and daily reports. This occurs in consultation with field staff on a daily, weekly and monthly basis.
- End users of the data may be able to identify and report irregularities in measurements. Quality assurance staff further assess the validity of data based on the feedback.

### 8.4 Assessment against standards and goals

Air quality at NEPM-compliant sites are assessed against the standards and goals as specified in Schedule 2 of the AAQ NEPM. The standards against which air quality is assessed for gaseous pollutants are based on units of concentration in parts per million (ppm). In this report, the units of parts per hundred million (pphm) are used to make the data easier to read. Note that 1 ppm = 100 pphm. For particulate matter, the standard is based on units of micrograms per cubic metre ( $\mu\text{g}/\text{m}^3$ ).

The goal of the AAQ NEPM is to achieve the standards as assessed in accordance with the monitoring protocol within 10 years of commencement (i.e. by 2008) to the extent specified in Schedule 2 of the AAQ NEPM. The extent is expressed as a maximum allowable number of exceedances per year, for each standard.

In accordance with Clause 18 of the NEPM, for reporting compliance against PM<sub>10</sub> and PM<sub>2.5</sub> for both the one-day average and one-year average standards, jurisdictions exclude monitoring data that has been determined as being directly associated with an exceptional event. An exceptional event is defined as ‘a fire or dust occurrence that adversely affects air quality at a particular location and causes an exceedance of one-day average standards in excess of normal historical fluctuations and background levels, and is directly related to: bushfire; jurisdiction authorised hazard reduction burning; or continental-scale windblown dust’. When reporting against 1-year averages, all measured data is included in the calculated averages.

Any exceedance day deemed to be ‘exceptional’ is excluded when determining compliance with NEPM goals. Where an exceedance day is determined to be a ‘non-exceptional’ event, it is included.

**Table 5 NEPM standards and goals specified in Schedule 2 of the AAQ NEPM**

Pollutant	Averaging period	AAQ NEPM standard (max. concentration)	AAQ NEPM goal (max. number of allowable exceedances)
Carbon monoxide	8-hour rolling average	9.0 ppm	1 day a year
Nitrogen dioxide	1-hour average	12.0 pphm (0.120 ppm)	1 day a year
	1-year average	3.0 pphm (0.030 ppm)	None
Photochemical oxidants – as ozone	1-hour average	10.0 pphm (0.100 ppm)	1 day a year
	4-hour rolling average	8.0 pphm (0.080 ppm)	1 day a year
Sulfur dioxide	1-hour average	20.0 pphm (0.200 ppm)	1 day a year
	1-day average	8.0 pphm (0.080 ppm)	1 day a year
	1-year average	2.0 pphm (0.020 ppm)	None
Particles as PM <sub>10</sub>	1-day average	50.0 µg/m <sup>3</sup>	None <sup>1</sup>
	1-year average	25.0 µg/m <sup>3</sup>	None
Particles as PM <sub>2.5</sub>	1-day average	25.0 µg/m <sup>3</sup>	None <sup>1</sup>
	1-year average	8.0 µg/m <sup>3</sup>	None
Lead	1-year average	0.50 µg/m <sup>3</sup>	None

<sup>1</sup> Excluding exceptional events as defined in Section 8.4.

## 8.5 Planned reporting of air quality monitoring results

**Table 6 Reporting plan 2021–25**

Report type	Plan for 2021–25	Schedule
Current / live results by station and region	<u>Publish live air quality monitoring results</u> for NSW on the Department's website. Website improvements are scheduled for release in 2020 and 2021.	Website upgrade Part 1 November 2020 Website upgrade Part 2 March 2021 Website upgrade Part 3 July 2022
Regional seasonal / quarterly summary	Publish quarterly newsletters on the Department's website for: <ul style="list-style-type: none"> <li>Newcastle</li> <li>Upper Hunter</li> <li>North West Slopes/Namoi Region</li> <li>rural air quality monitoring.</li> </ul>	Quarterly for all publications except DustWatch report, which is monthly
NSW annual compliance with AAQ NEPM	Report annually on compliance with the goals and standard in line with AAQ NEPM guidance. Publish an annual compliance report on the Department's website.	Due to publish in second half of each calendar year for the preceding calendar year
NSW annual air quality statement	Report annually on air quality over the past year. Publish an air quality statement on the Department's website.	Due to publish in January each year for the preceding calendar year
Inventory of pollution sources	An inventory of pollution sources was published every five years but is now published as required.	To be determined

Report type	Plan for 2021–25	Schedule
NATA accreditation	Continue to maintain NATA accreditation of the monitoring facility.	Every 3 years as scheduled by NATA (e.g. next accreditation assessment will be in in 2022)

## 9. Review monitoring plans

- Monitoring plans will be updated annually with changes documented clearly and transparently.
- Monitoring plans will be reviewed and resubmitted every five years to ensure currency of population coverage and pollutant screening assumptions.
- The NSW Government will work with other jurisdictions to establish an expert review panel to investigate trends in monitoring network design and advise jurisdictions on changes to monitoring design requirements. The group may also act as a review panel for monitoring plans.

## 10. Governance

All monitoring described in this plan is managed by the Department's Climate and Atmospheric Science Branch.

Climate and Atmospheric Science Branch works with the Climate Change and Air Policy Branch within the Department's Environment, Energy and Science Group. In the NSW EPA, it works with the Regulatory Policy, Initiatives and Advice Branch and the Engagement and Public Affairs Branch.

## 11. Quality assurance

Appropriate quality assurance processes must be applied to all aspects of the air quality monitoring to ensure they align with this plan and are fit-for-purpose, rigorous, defensible and effective. The required quality assurance measures are in the framework of the Department's Climate and Atmospheric Branch Quality Management System, designed to meet ISO 9001 and ISO/IEC 17025.

- **Leadership commitment** – The NSW Government has demonstrated clear commitment to best practice air quality monitoring that meets community needs:
  - Commitments arising from the Clean Air Summit
    - Responding to public feedback, the follows commitments have been delivered:
      - establishment of the Rural Air Quality Monitoring Network, with upgrade of instruments to measure PM2.5
      - new monitoring stations along the Tablelands (Armidale, Orange, and Goulburn), and in the Namoi (Gunnedah and Narrabri)
      - new monitoring stations for the Metropolis of Three Cities, located in Penrith, Parramatta, and Sydney CBD.
    - Investigation of a long-term monitoring site on the Mid-North Coast continues, with temporary stations sited at Coffs Harbour and Port Macquarie in the meantime.
  - NSW Clean Air Strategy

It is anticipated that the NSW Clean Air Strategy will be released in 2021, following public consultation on a draft strategy.

- Acting on the recommendations of the NSW Bushfire Inquiry

We will continue to invest in air quality forecasting and alert systems, and research and policy development. We will improve the communication of evidence-based public health messaging about air quality during bushfires.

- **Effective community participation** – Early and effective participation by the public in planning and implementing air quality monitoring is an important layer of quality assurance. Public participation can result in a more effective service design and delivery by validating drafts, drawing on local knowledge and expertise for commitment and mutual understanding. Public participation assists in legitimacy and accountability for NSW Government services and actions.

NSW Government Customer Commitments, NSW Charter for Public Participation – a guide to assist agencies and promote citizen engagement (Information and Privacy Commission NSW, 2018 )

- **Peer reviewing the Air Quality Management Plan and monitoring results** – NSW Government will commission a five-yearly external peer review – for example, by engaging an independent external consultant.
- **Audit** – The Department’s Climate and Atmospheric Science Branch Quality Management System audit team will help business units and program areas ensure the monitoring plan is up-to-date, and monitoring activities (including data collection, analysis and reporting) remain on track and are implemented. This includes regular progress reporting and other independent audits of evaluation activities.
- **Reviewing the air quality monitoring function** – To ensure the quality, transparency and objectivity of air quality monitoring is maintained, the communications and engagement function, including the communications framework, communication systems, resources and capabilities, will be reviewed throughout the policy cycle. These assurance processes will be scrutinised via five-yearly expert reviews. This will ensure continuous improvement of the system using a flexible, responsive and agile approach as specified in Clean Air for NSW Consultation paper (NSW EPA and OEH 2016).

## Schedule 1: Definition of regions and spatial boundaries

The definition of an air quality region within New South Wales is based on a number of determinant factors, as outlined in Section 5.1. Within this context, the larger airsheds are defined broadly along land-use planning region definitions, with further subregions defined by airshed and population density and spread considerations.

Recently covered in a NEPM Expert Working Group (EWG) review of Australian air quality monitoring network design, the NEPM defined air quality regions in three categories:

- Type 1 – a large urban or town complex with a population of 25,000 people or more requiring direct monitoring and contained within a single airshed
- Type 2 – a region with no one population centre with 25,000 people or more but with a total population of 25,000 or more, and with significant point source or area-based emissions as to require a level of direct monitoring
- Type 3 – a region with a population of 25,000 people or more but with no significant point or area-based emissions, so that ancillary data can be used to infer that direct monitoring is not required.

The same review recommended (EWG recommendation 3) that the NEPM population threshold of 25,000 be retained as a guide for monitoring network design, and that this should use the ABS SUAs in the first case (EWG recommendation 4).

These recommendations considered the 2011 NEPM Review recommendation that the NEPM ‘remove the population threshold and formula to enable monitoring on potential population risk rather than on population size’, but noted that other major jurisdictional plans started with population threshold calculations. We have noted both recommendations, and included, where appropriate, NEPM compliance monitoring in airsheds which have population under this threshold.

**Table 7 NSW air quality monitoring regions mapped to SUA**

NSW air quality monitoring region	Significant urban areas (SUA)	2016 census population ('000s)	No. of stations by pop*	Actual number of stations**
Greater Sydney	Sydney <sup>^</sup>	4447	8	17 (+2)
Hunter	Newcastle–Maitland <sup>^</sup>	463	2	3 (+3)
Central Coast	Central Coast <sup>^</sup> and Morisset–Cooranbong	344	2	2 (1 being commissioned)
Illawarra–Shoalhaven	Wollongong <sup>^</sup>	286	1	3
North Coast	Coffs Harbour	68	1	0 (1)
North Coast	Gold Coast – Tweed Heads	60 (624) <sup>‡</sup>	2**	0 (1 in Qld)
Riverina–Murray	Wagga Wagga	54	1	1 (+1)
Riverina–Murray	Albury–Wodonga <sup>^</sup>	48 (89) <sup>‡</sup>	1**	1
North Coast	Port Macquarie	45	1	0 (1)
New England North West	Tamworth	41	1	1
Central West and Orana	Orange	39	1	1

NSW air quality monitoring region	Significant urban areas (SUA)	2016 census population ('000s)	No. of stations by pop*	Actual number of stations**
South East and Tablelands	Bowral–Mittagong	38	1	0
South East and Tablelands	Canberra–Queanbeyan	36 (432)†	2**	0 (3 in ACT)
Central West and Orana	Dubbo	36	1	0 (1)
Illawarra–Shoalhaven	Nowra–Bomaderry	36	1	0
Central West and Orana	Bathurst	35	1	1
North Coast	Lismore	28	1	0 (1)
Hunter	Nelson Bay–Corlette	27	1	0
Hunter	Taree	26	1	0
North Coast	Ballina	25	1	0
New England North West	Armidale	23	-	1
South East and Tablelands	Goulburn	23	-	1
Hunter	Forster–Tuncurry	20	-	0
Riverina–Murray	Griffith	19	-	0 (1)
North Coast	Grafton	19	-	0 (1)
Far West	Broken Hill	18	-	0 (1)
Far West	Mildura–Wentworth	6 (50)‡	1**	0 (1)
Hunter	Singleton	16	-	1 (+2)
Hunter	Muswellbrook	12	-	1 (+1)
New England North West	Gunnedah	8 (UCL)	-	1
New England North West	Narrabri	6 (UCL)	-	1
Hunter	Aberdeen	2 (UCL)	-	1

\* Based on AAQ NEPM population calculation: population in millions x 1.5 + 0.5, rounded up to the nearest whole number

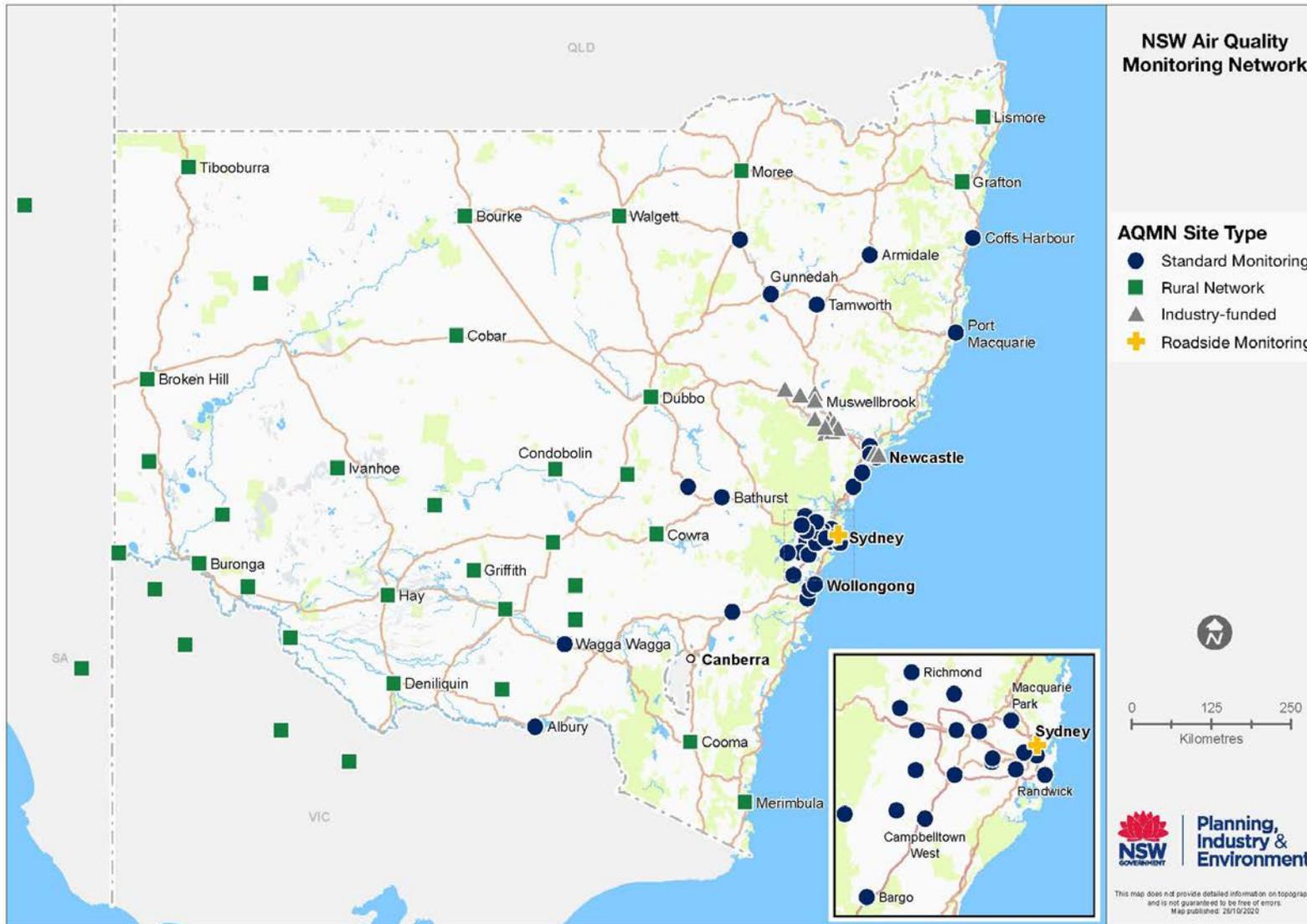
† Actual number of stations shows NEPM-compliant, inside brackets are additional non-NEPM stations (either industry, campaign or indicative particle) as of 1 January 2021 or NEPM stations located within the SUA in other jurisdictions

‡ Where SUA is in two states/territories, the NSW population is shown first outside brackets, with the total SUA population shown inside brackets. The number of stations is defined for total SUA regardless of jurisdictional borders

^ Schedule 3 of this plan describes detailed analysis of monitoring factors for five of the largest population centres in New South Wales. Albury-Wodonga was chosen as the fifth focus area as it was the largest inland region for which NSW had the largest population proportion.

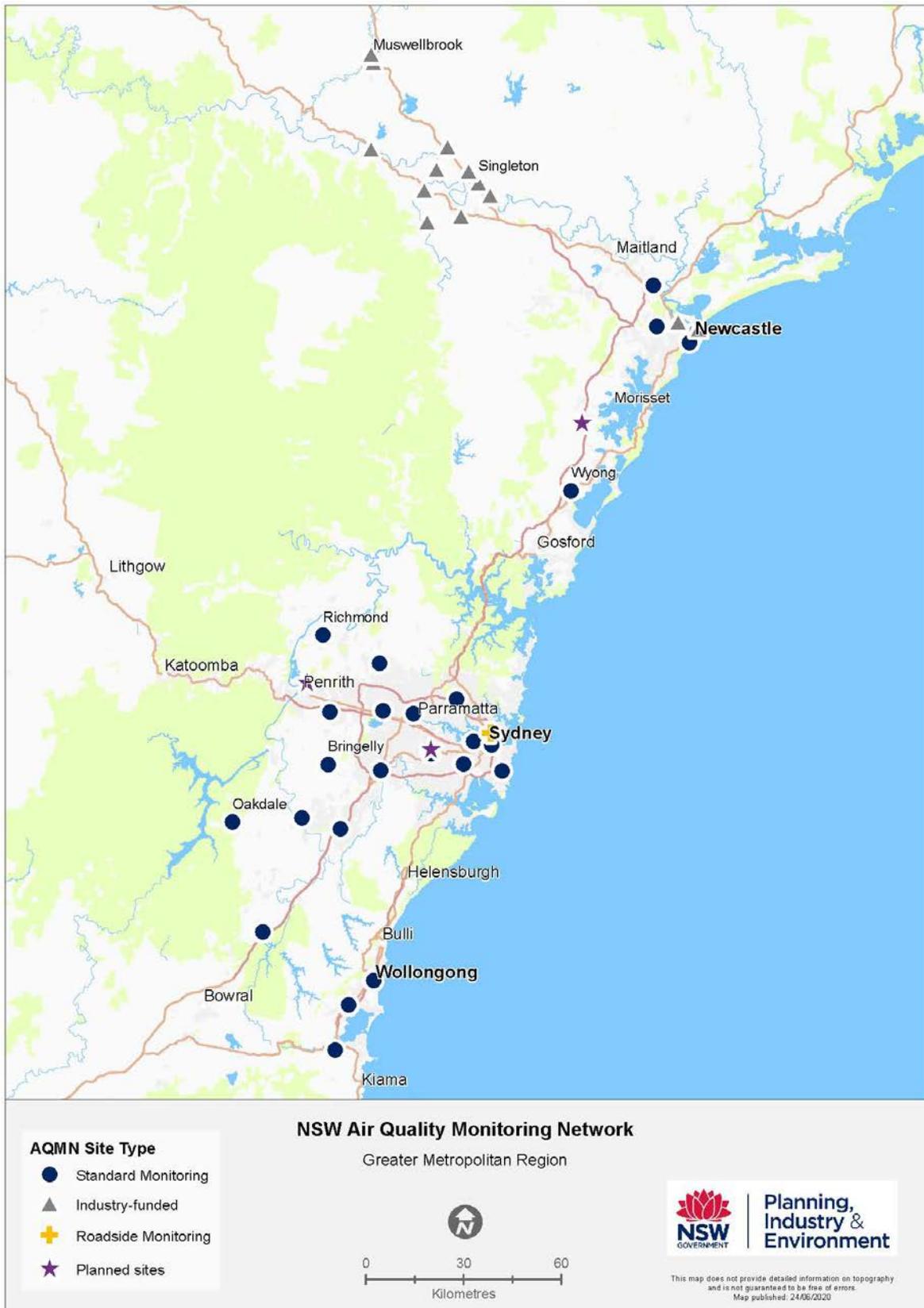
## **Schedule 2: Register of NSW monitoring stations**

## Maps of NSW monitoring stations



**Figure 6 Station locations in the NSW air quality monitoring network as of June 2020**

Note: stars indicate planned stations to be commissioned at Penrith, Lake Macquarie and Lidcombe in 2020.



**Figure 7 Station locations in the NSW Greater Metropolitan Region**

Notes: Only part of the Upper Hunter Monitoring Network falls into the Greater Metropolitan Region domain. Stars indicate planned stations as of June 2020, which have since been commissioned, at Penrith, Morisset and Lidcombe.

## Register of NSW stations and their attributes, pollutant parameters, and instruments

A list of monitoring stations with pollutant parameters and instruments can be found on the NSW Government Sharing and Enabling Environmental Data in NSW (SEED) [portal](#).

## Pollutant analysis for NEPM compliance reporting

One recommendation from the recent NEPM reviews (EWG recommendation 9), is that monitoring networks be designed to represent population exposure on a pollutant-by-pollutant basis. Long-term trend analysis of pollutant concentrations has been used in our monitoring network design.

### Analysis by current NEPM region monitoring locations

#### Particles as PM10

All stations reported as NEPM compliance stations from 2020 onwards monitor particles as PM10 as a standard parameter.

#### Particles as PM2.5

All stations reported as NEPM compliance stations from 2020 onwards, with the exception of Aberdeen, monitor particles as PM2.5 as a standard parameter.

For Aberdeen, located in the Hunter Valley, the urban area is much smaller than any other within the NEPM network. As such, local sources such as wood smoke are expected to have much smaller impact at this location than in others such as Muswellbrook. Also, PM10 annual concentrations in Aberdeen over the past decade are consistently lower than Muswellbrook. As such, it is sufficient at this stage to monitor only PM10 at Aberdeen.

#### Ozone

All stations within the Sydney, Illawarra, Central Coast and Lower Hunter regions report ozone as a standard parameter. Additionally, Goulburn and Gunnedah have monitored ozone concentrations since 2019 and 2017 respectively.

With a new ozone standard due to be implemented in 2021, screening of ozone concentrations in inland and coastal rural NEPM locations is planned for the 2020–21 summer.

#### Nitrogen dioxide

All stations within the Greater Metropolitan Region (GMR) (Sydney, Illawarra, Central Coast and Lower Hunter), as well as Muswellbrook and Singleton in the Upper Hunter, report nitrogen dioxide as a standard parameter. Additionally, Goulburn and Gunnedah have monitored nitrogen dioxide concentrations since 2019 and 2017 respectively.

Only one exceedance of the NO<sub>2</sub> standard has been noted in the past 20 years, at Goulburn in late 2019. This was due to significant bushfire impact, coincident with hourly PM2.5 concentrations greater than 2000 µg/m<sup>3</sup>. Analysis of the emission inventories shows that major sources of nitrogen oxides in the GMR are due to transport, shipping, industry and energy production, and that concentrations are typically well below the standard. As local sources in regional stations will be lower than the GMR, these can be reasonably screened as unlikely to exceed the standard.

### **Sulfur dioxide**

Sulfur dioxide is monitored at multiple locations in the GMR, as well as Singleton and Muswellbrook in the Upper Hunter. The major sources of sulfur dioxide in New South Wales occur from energy generation from coal combustion, with secondary input from industrial or transport sectors. As such, the concentrations of sulfur dioxide rarely approach or exceed national standards in almost all locations. The highest concentrations, almost always below the standards, are typically measured closer to these sources.

For regional areas outside the Upper Hunter and GMR, it is expected that without clearly identified sources close to population centres, the sulfur dioxide concentration will be lower than that measured in the GMR or Upper Hunter. As such, monitoring in major regional centres is not required.

### **Carbon monoxide**

Carbon monoxide is monitored at selected locations in the GMR only. Concentrations rarely approach the national standard, with annual maxima rarely approaching 50% of the standard, even during bushfire events. It is therefore considered unlikely to exceed the standard in regional centres and is therefore not monitored in those locations.

### **Lead**

Since the introduction of unleaded petrol in Sydney in 1986 and the phasing out of leaded petrol in 1993, lead levels in the Sydney region have declined. In 1998 the CBD peak monitoring station recorded an annual average lead concentration that was 40% of the NEPM standard. Lead levels subsequently reduced to less than 10% of the national annual standard of  $0.5 \mu\text{g}/\text{m}^3$ . Screening criteria were applied to reduce the number of stations that monitor this pollutant (i.e. based on the maximum annual average concentration being less than 65% of the NEPM standard for two to four years). As a result, the Department phased out ambient lead monitoring for the AAQ NEPM during 2004. The case for cessation of lead monitoring was approved by the National Environment Protection Council.

Lead monitoring is currently being conducted on a campaign basis in Broken Hill.

## Schedule 3: Urban areas in focus

Three-quarters of people in New South Wales live in the State's top five population centres. Detailed monitoring plans for each SUA are presented in Schedules 3.1 to 3.5.

**Table 8 Urban area monitoring regions mapped to SUA**

Schedule of this plan	Significant urban areas (SUA)	NSW land-use planning regions	2016 census population* ('000s)	% of NSW population
3.1 – Greater Sydney	Sydney	Greater Sydney	4447	59.5%
3.2 – Lower Hunter	Newcastle–Maitland	Hunter	463	6.2%
3.3 – Central Coast	Central Coast	Central Coast	320	4.3%
3.4 – Illawarra	Wollongong	Illawarra–Shoalhaven	286	3.8%
3.5 – Albury	Albury–Wodonga	Riverina–Murray	89 <sup>†</sup>	0.6% <sup>†</sup>
<b>Total</b>			<b>5564</b>	<b>74%</b>

Note: Population of NSW at 2016 census was 7,480,228<sup>2</sup>

\* The population expressed here is that contained within the SUA shown, and the air quality region referred to in the schedule may include population centres outside these urban boundaries.

<sup>†</sup> Population of Albury–Wodonga is split between NSW (48,000) and Victoria (41,000).

<sup>2</sup> [https://quickstats.censusdata.abs.gov.au/census\\_services/getproduct/census/2016/quickstat/1](https://quickstats.censusdata.abs.gov.au/census_services/getproduct/census/2016/quickstat/1)

## Appendix A: AAQ NEPM guidance documents

The National Environment Protection (Ambient Air Quality) Measure, made by the National Environment Protection Council (NEPC) on 26 June 1998, commenced 8 July 1998.

### Technical guidance papers

Technical papers on the AAQ NEPM protocol are the basis for the Peer Review Committee's assessment of jurisdictional plans, aimed at assuring the quality and national consistency of NEPM monitoring. Technical papers are advisory for jurisdictions and evolve as the science of air quality monitoring and assessment develops and as practical experience with monitoring increases.

Risk assessment approach described in Methodology for Setting Air Quality Standards in Australia, NEPC 2011

### AAQ NEPM Peer Review Committee (PRC) technical papers

Technical Paper 01, Checklist for Monitoring Plans, Peer Review Committee, May 2001 (PDF 107.72KB)

Technical Paper 02, Selection of Regions, Peer Review Committee, May 2001 (PDF 126.98KB)

Technical Paper 03, Monitoring Strategy, Peer Review Committee, May 2001 (PDF 131.97KB)

Technical Paper 04, Screening Procedures, Peer Review Committee, January 2007 (PDF 141.1KB)

The Air Pollution Model (TAPM) Phase 2 Report, Peer Review Committee, October 2002 (PDF 416.27KB)

Technical Paper 05, Data Collection and Handling (PDF 168.68KB)

Technical Paper 06, Meteorological Measurements, Peer Review Committee, May 2001 (PDF 1.82MB)

Technical Paper 07, Accreditation of Performance Monitoring, Peer Review Committee, May 2001 (PDF 131.74KB)

Technical Paper 08, Annual Reports, Peer Review Committee, September 2010 (PDF 189.21KB)

(Superseded) Technical Paper 08, Annual Reports, Peer Review Committee, October 2002 (PDF 300.3KB)

Technical Paper 09, Lead Monitoring, Peer Review Committee, May 2001 (PDF 145.26KB)

Technical Paper 10, Collection and Reporting of TEOM PM10 Data, Peer Review Committee, May 2001 (PDF 190.33KB)

Technical Paper 10 Addition: Technical Paper on Monitoring for Particles as PM2.5, March 2003

AAQ NEPM Peer Review Committee Terms of Reference, August 1999 (PDF 24.85KB)

### Further peer reviews

Review Report, National Environment Protection (Ambient Air Quality) Measure Review May 2011

Review of Monitoring Network Design – Synthesis report by the National Environment Protection Measure (NEPM) Expert Working Group Project 2 2016