NATIONAL ENVIRONMENT PROTECTION MEASURE FOR AMBIENT AIR QUALITY

MONITORING PLAN FOR NEW SOUTH WALES

JUNE 2001

This Monitoring Plan has been prepared in accordance with the protocol in Part 4 of the National Environment Protection Measure for Ambient Air Quality (1998). It describes monitoring which will be undertaken in the State of New South Wales to determine compliance with the Standards and Goals of the National Environment Protection Measure.

Summary

In June 1998, the National Environment Protection Measure for Ambient Air Quality set the desired environmental outcome for ambient air that allows for the adequate protection of human health and well-being. New South Wales has developed a Monitoring Plan to assess compliance with this Measure.

The majority of the monitoring will occur in the industrial and high population region containing Newcastle, Sydney, and Wollongong. This region contains over 60% of the 6.04 million people resident in NSW in 1996. It also contains much of the industry of the State.

NSW will characterise the air quality to which the general population is exposed in this region by monitoring all air pollutants of interest at a network of trend stations. These stations will capture the majority of pollution events that may occur from time to time, but they will be supplemented by additional permanent upper bound stations at which selected pollutants only will be monitored to ensure that all major pollutant events are captured and reported.

Campaign monitoring will be undertaken in regional centres. Initial monitoring will be in Albury, Wagga Wagga, Bathurst and Tamworth. Campaign monitoring will be used to validate and review the screening measures applied to the urban centres outside the main axis. This monitoring will also be used to assess the need for trend stations in these centres. In addition, campaign monitoring will be undertaken in the Central Coast area of the Sydney region.

In total, NSW initially intends to monitor the majority of pollutants at ten trend stations, selected individual pollutants at six additional permanent upper bound stations, and selected pollutants at four campaign stations in provincial cities.

NSW EPA has NATA accreditation for the air quality monitoring it undertakes. Annual reports will be provided summarising the monitoring results from the nominated AAQ NEPM stations, and comparing these results to the AAQ NEPM goals.

Stations nominated for AAQ NEPM Reporting purposes (by parameter)

Region	Location	Station Type performance (P), trend (T), or campaign (C)	ozone	nitrogen dioxide	PM_{10}	carbon monoxide	sulfur dioxide	lead
Sydney	Blacktown	T	X	X	X	X	X	
	Bringelly	T	X	X	X		X	
	CBD	P				X		X
	Central Coast[1]	C	X	X	X		X	
	Lidcombe	T	X	X	X	X*	X*	
	Liverpool	C	X	X	X	X	X*	
	Macarthur[2]	T	X	X	X	X	X	
	Oakdale	P	X		X			
	Richmond	T	X	X	X		X	
	Rozelle	T	X	X	X*	X		X
	St Marys	P	X					
	Woolooware	T	X	X	X		X	

* indicates parameters nominated but not currently measured
[1] – Campaign monitoring is scheduled to begin in the Central Coast in January 2004
[2] – Macarthur station scheduled for January 2003

Notes

All sites other than the CBD site meet the definition of a neighbourhood site as given section 7 of AS 2922-1987.

Trend sites are generally representative of regional population exposure and generally approximate the PRC GRUB definition (PRC 2000b).

The CBD is a peak site for motor vehicle emission impacts (CO and Pb).

Liverpool is a campaign site to be used until the Macarthur site is established.

Oakdale is an upper bound site for ozone in a rural area.

St Marys is a generally representative upper bound site for ozone that generally approximates the PRC GRUB definition (PRC 2000b).

Stations nominated for AAQ NEPM Reporting purposes (by parameter)
(continued)

Region	Location	Station Type performance (P), trend (T), or campaign (C)	ozone	nitrogen dioxide	PM_{10}	carbon monoxide	sulfur dioxide	lead
Lower Hunter	Newcastle	T	X	X	X*	X	X*	
	Beresfield	C			X			
	Wallsend	C	X	X			X	X (C)*
	Maitland[3]	T	X	X	X		X	X (C)
Illawarra	Albion Park	P	X	X	X		X	
	Warrawong	P					X	X (C)*
	Kembla Grange	P	X		X*			
	Wollongong	T	X	X	X	X	X	
Tamworth	Tamworth	C October 2000			X			
Bathurst	Bathurst	C July 2000	X		X			
Wagga Wagga	Wagga Wagga	C April 2001			X			
Albury	Albury	C June 2000			X			
Orange	Orange	C January 2004			X			
Dubbo	Dubbo	C January 2004			X			
Lismore	Lismore	C January 2004			X			

* indicates parameters nominated but not currently measured
[3] – Maitland station scheduled for January 2003
C - denotes campaign monitoring of a parameter at a site that is classified as performance or trend

Notes

All sites meet the definition of a neighbourhood site as given section 7 of AS 2922-19987.

Trend sites are generally representative of regional population exposure and generally approximate the PRC GRUB definition (PRC 2000b).

Albion Park is an upper bound site for ozone in a semi-rural area.

Kembla Grange is an upper bound site for ozone in an area where there is increasing urbanisation.

Warrawong is a locally representative site close to heavy industry. It is upper bound for sulfur dioxide.

Beresfield and Wallsend are campaign sites to be used until the Maitland site is established.

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1 Introduction

On the 26 June 1998, the National Environment Protection Council (NEPC), consisting of Commonwealth, State and Territory Ministers, made the Measure on Ambient Air Quality (hereafter referred to as the Measure), NEPC (1998). This Measure established a set of Standards and Goals for six air pollutants – carbon monoxide, photochemical oxidants (as ozone), nitrogen dioxide, sulfur dioxide, lead, particles as PM_{10} – and outlined the methods by which these pollutants are to be measured, assessed and reported.

A formal requirement of the Measure is the establishment of monitoring procedures and the commencement of assessment and reporting, in accordance with the protocols of the Measure, within three years of its commencement.

After making the Measure, the Ministers resolved to establish a Peer Review Committee (PRC) to advise on jurisdictional monitoring plans. Under its terms of reference, the PRC has two complementary roles. First, the PRC is required to advise the NEPC on the adequacy of monitoring plans submitted by jurisdictions. Secondly, it provides advice on technical issues related to the consistent implementation of the Measure's monitoring protocol. The PRC has developed a series of strategy papers that provide a basis for the preparation of individual monitoring plans (by jurisdictions) and for the assessment of monitoring plans (by the PRC).

It should be noted that the monitoring conducted as part of the requirements of the Measure may represent only a sub-set of the total ambient air monitoring program of some jurisdictions.

This Report presents New South Wales' submission on how it plans to monitor, assess and report air quality for the purposes of the Measure. The Report is structured according to the format specified by the PRC. This includes a consideration of:

- Regions to be monitored;
- Monitoring requirements of each region, including physical and demographic characterisation, emission sources, air quality, identification of pollutants not required to be monitored, and monitoring network;
- Siting and instrumentation;
- Accreditation; and
- Reporting.

The monitoring described in the NSW AAQ NEPM Monitoring Plan is only part of that which is conducted in NSW by the EPA. Other stations are operated for a variety of reasons including air quality management, scientific research, compliance monitoring, and public information. Such monitoring is listed within this report as part of data analysis used to assist in determining appropriate monitoring for each region.

NSW also requires monitoring as a condition of licence to operate for premises which are likely to be significant emitters of air pollutants. This monitoring is generally intended to measure source-related peak concentrations under specific conditions, and hence would not usually be acceptable for AAQ NEPM performance monitoring.

NSW is committed to long-term monitoring at trend sites for 50 years or more. Funding for this plan is guaranteed until June 2003. Funding beyond that date is subject to the normal budgetary processes of government.

2 Identification of regions

2.1 Background

Monitoring for AAQ NEPM purposes is required for every region with a population of 25 000 or more. The AAQ NEPM gives a very broad definition of "region", allowing each jurisdiction to determine its regions and their boundaries. The Peer Review Committee (PRC) accepted the following definition of region:

> "A **region** for the purposes of performance monitoring is a geographical area where the air quality (for a particular pollutant) is determined either entirely or in large part by the influence of a common collection of anthropogenic emissions sources."

NSW has defined regions for AAQ NEPM reporting based on the requirements of the Measure interpreted using the above definition and by referring to population data from the 1996 census. This includes considering the possibility that smaller urban centres may be sufficiently close together to generate a region with a total population greater than 25 000.

According to Clause 14(1) of the Measure:

> '*the number of performance monitoring stations for a region with a population of 25 000 or more must be the next whole number above the number calculated in accordance with the formula:*
>
> ***1.5P + 0.5***
>
> *where **P** is the population of the region (in millions).*
>
> *Additional performance monitoring stations may be needed where the 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 PRC AAQ NEPM Guideline Paper – PRC (2000b) – three types of regions were identified as follows:

Type 1 A large urban or town complex with a population in excess of 25 000 requiring direct monitoring and contained within a single airshed;

Type 2 A region with no one population centre above 25 000 but with a total population above 25 000 and with significant point source or area based emissions so as to require a level of direct monitoring; and

Type 3 A region with a population in excess of 25 000 but with no significant point or area based emissions, so that ancillary data can be used to infer that direct monitoring is not required.

Moreover, PRC (2000b) considered the ABS 'urban centre' population data to provide a transparent basis for a preliminary assessment of regions for AAQ NEPM monitoring. The PRC Paper also notes that it is important that other issues:

> '*such as local knowledge of region / airshed population, emission sources, topography and dispersion should also be considered. In applying the formula that guides the number of monitoring sites needed on the basis of population, the actual population in the affected airshed should be estimated by integrating up the ABS data as appropriate. The changes in population that can result from this integration may be substantial. In some instances it may raise the population above the lower threshold where monitoring needs to be considered. Moreover, a narrow application of the ABS population data should not be used as a justification for a lower level of monitoring than would result from a consideration of an airshed concept*'.

2.2 Urban Centres in NSW

The 1996 Census, ABS (1996), counted some 6.04 million people in NSW. Following the guidelines in PRC (2000b) and using these data, there are fifteen urban centres with populations above the AAQ NEPM threshold of 25 000. In addition there are six centres with a population between 20 000 and 25 000. These centres are listed in table 1 and shown in the map of NSW.

TABLE 1: URBAN CENTRES IN NEW SOUTH WALES, RANKED BY POPULATION

(Centres with a population greater than 20 000, ABS Census 1996)

Urban Centre	Population (000)
Sydney	3,276
Newcastle	270
Central Coast	228
Wollongong	220
Maitland	50
Wagga Wagga	43
Albury-Wodonga (NSW comp.)	41
Gold Coast-Tweed Heads (NSW component)	38
Port Macquarie	34
Tamworth	32
Orange	31
Dubbo	30
Lismore	28
Bathurst	26
Canberra-Queanbeyan (NSW component)	26
Nowra-Bomaderry	24
Coffs Harbour	22
Armidale	21
Goulburn	21
Broken Hill	21
Richmond-Windsor	21

These data reflect the way that census data are collected. In particular, although the census lists it separately, Richmond-Windsor is usually considered part of Sydney and is not separately noted on figure 1. Further, the Central Coast urban centre lies between Sydney and Newcastle. In this plan, there is no Central Coast region. Rather, the area in the Central Coast urban centre is divided between the regions associated with the urban centres of Sydney (to its south) and Newcastle (to its north).

2.3 Regions in New South Wales

Consideration of AAQ NEPM monitoring is required for each region with a population of 25 000 or more. Not all of the urban centres meeting this criterion reside in distinct airsheds. The most populated part of the state – running down the coast from the coastal plain of the Hunter River to the coastal ridge at Shellharbour – contains five of these urban centres, and one of the centres with a population between 20 000 and 25 000. Consideration of topography leads to the definition of three regions for this part of the state. These are called: Lower Hunter, Sydney, and Illawarra.

The area known as the Upper Hunter has significant emissions from coal-fired power stations. Within this area are the urban centres of Scone (3 468), Aberdeen (1 737), Muswellbrook (10 541), and Singleton (12 519). This is potentially a region containing more than 25 000 people and hence one requiring consideration of AAQ NEPM monitoring.

The topography of the area is not simple. In particular, a ridge about 10 km south of Muswellbrook separates Muswellbrook and Scone from the power stations around Lake Liddell. Singleton is some 25 km to the southeast of the lake. Indeed, the river itself flows around this ridge, running southwest from Muswellbrook to Denman where the Goulburn River joins it. It then resumes a coastal path to Singleton. Thus the area known as the Upper Hunter refers to the power stations and the nearest towns, Muswellbrook and Singleton rather than the natural river valley. The topography shows clearly that there is no region containing a population of 25 000 or more.

Further observational study is planned within the Hunter valley. NSW EPA will review the results of that work to reassess the current definition of two distinct regions in the area.

Monitoring is conducted within the area by industry. This monitoring is not suitable for AAQ NEPM purposes, but does provide information on the impacts of industry within the area. This monitoring shows that impacts from power station plumes are generally minor and local in effect.

Coffs Harbour is geographically close to Sawtell (population 13,240). Taken together these urban centres create a region with a population of 35,417. The remaining urban centres with populations between 20 000 and 25 000 are geographically distinct, with no other nearby urban centres. Further, consideration of urban centres with populations above 10 000 shows that there are none sufficiently close to others so as to constitute a region containing 25 000 people.

Thus in New South Wales there are fifteen regions in total – fourteen from the urban centres with population greater than 25 000, plus Coffs Harbour-Sawtell.

2.3.1 Sydney region

Sydney lies within its own region which has a contiguous population of around 3.8 million. The region and its population density are shown in figure 2. As can be seen from the map, the Sydney region extends from the southern boundary of the Wollondilly shire in the south to the northern boundary of the Hawkesbury and Wyong shires, and so includes the southern part of the Central Coast urban centre.

2.3.2 Lower Hunter region

Newcastle, its satellite towns, the northern parts of the Central Coast urban centre, and Maitland all lie in a single region to be termed the Lower Hunter. Maitland is some 20 kilometres to the northwest of Newcastle along the axis of the Hunter River. There are no topographic features that could lead to it being regarded as belonging to a different region. Note, however, that significant topography lies between the Hunter River and Cessnock, thus Cessnock is excluded from the region.

The coastal plain associated with the Hunter River extends south down the coast to include both Lake Macquarie and Tuggerah Lake. On this basis, the northern part of the Central Coast urban centre is included in the Lower Hunter region. This region has a population of around 460 000 people, the population density is given in figure 3.

It should be noted that the EPA is currently undertaking work intended to clarify the extent to which the Lower Hunter and Sydney airsheds are interconnected. This will be used to refine this aspect of the monitoring plan in future.

2.3.3 Illawarra region

Wollongong and Port Kembla lie in a distinct region termed the Illawarra which has a population of around 220 000 people. Population density in the region is shown in figure 4. The region is characterised by a coastal plain bounded by a steep escarpment to the west.

2.3.4 Remaining regions

All the remaining urban centres considered are located within separate airsheds and are therefore treated separately.

2.4 Region Types

Within New South Wales, the Sydney, Lower Hunter and Illawarra regions are clearly of Type 1. They are already the subject of direct monitoring and will continue to be. As discussed above, the Central Coast population centre is included in the Sydney and Lower Hunter regions at present.

The situation in the rural population centres other than these will be discussed in greater detail in Section 3. However, in summary, Wagga Wagga, Albury-Wodonga, Tamworth, Orange, Dubbo, Bathurst and Canberra-Queanbeyan are all subject to the influences of smoke generated from wood burning for domestic heating and are thus also of Type 1.

Coffs Harbour-Sawtell and Port Macquarie, while significant population centres, are both located on the coast where mild winters prevail. Thus, apart from motor vehicle emissions, neither have significant domestic, commercial or industrial sources. Both are therefore Type 3.

The situation with Lismore is not clear. While it has a relatively dispersed population and mild winters, burning for agricultural purposes may be of significance. In the absence of specific information, Lismore is classified as Type 1. This will be reviewed in light of the results of campaign monitoring of PM_{10} within New South Wales.

For the Tweed Heads area, which is contiguous with the Gold Coast, it could be argued that it falls into Type 3, and it is not proposed to undertake direct monitoring here. The region is not densely populated and has no major industrial, domestic or commercial sources. Even so, it is part of a continuous airshed with the Gold Coast which will be monitored as part of the Queensland monitoring plan. The data acquired through the Queensland monitoring will be used to infer concentrations in the subregion of Tweed Heads and review this classification.

These classifications are summarised in table 2.

2.5 Rural Population Centres with Population between 20 000 and 25 000

Formally, regions with a population of less than 25 000 need not be assessed for AAQ NEPM monitoring. NSW believes that comment should be made regarding urban centres with a population between 20 000 and 25 000.

Four of the five NSW urban centres with populations between 20 000 and the 25 000 lie within their own region. These are Nowra/Bomaderry, Armidale, Goulburn and Broken Hill. Of these, only Broken Hill has significant industrial sources of emissions. In the absence of significant industrial sources, the only parameter remaining of potential concern is PM_{10}. For Broken Hill the possible additional pollutant is lead. However, industrial monitoring shows concentrations are currently below the standard and falling as mining and associated industrial activity winds down.

Particulate monitoring (by high-volume sampler on a six-day cycle) in Nowra over a number of years has shown concentrations that never exceed the AAQ NEPM standard. Indeed, they rarely reach half the standard.

The EPA has, over a number of years, collaborated with the local council in Armidale to operate a nephelometer to measure fine particles. Armidale City Council with assistance from the EPA continues this work now. At present the population of the Armidale airshed is well below the 25 000 threshold. Should the population of Armidale grow, the need for AAQ NEPM monitoring will be reassessed.

Similarly, Goulburn currently shows a slowly declining population. The need for AAQ NEPM monitoring will be reassessed should the population increase. Broken Hill shows a strongly declining population and it is not expected that AAQ NEPM monitoring is warranted either now or in the future.

NSW does not intend to undertake AAQ NEPM monitoring in any of these centres as part of this Plan.

TABLE 2: REGIONS CLASSIFIED BY TYPE

Type1	Type 2	Type 3
Sydney		Coffs Harbour
Lower Hunter		Port Macquarie
Illawarra		Tweed Heads
Wagga Wagga		
Albury-Wodonga		
Tamworth		
Orange		
Dubbo		
Bathurst		
Canberra-Queanbeyan		
Lismore•		

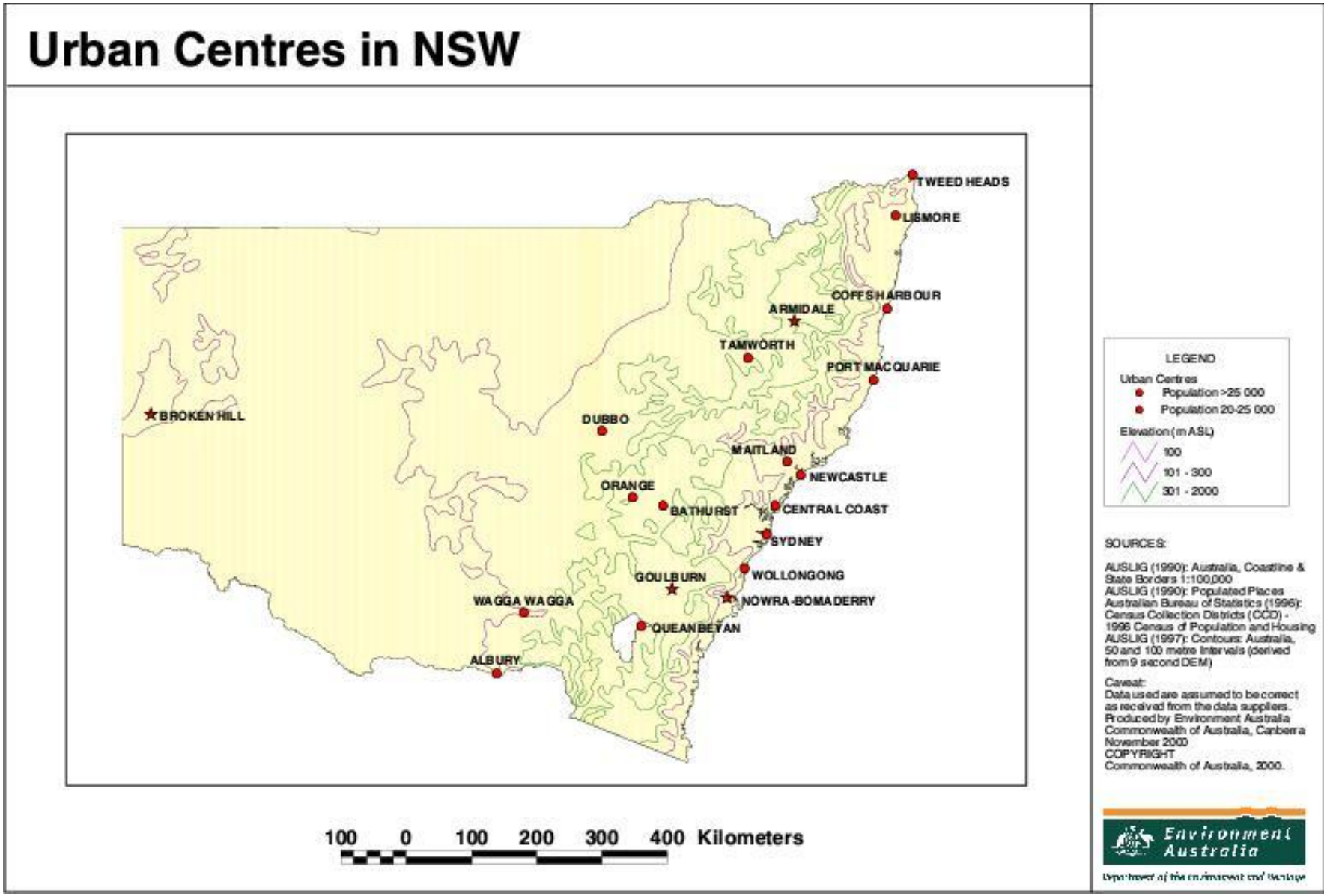


Figure 1: Location of population centres in New South Wales.

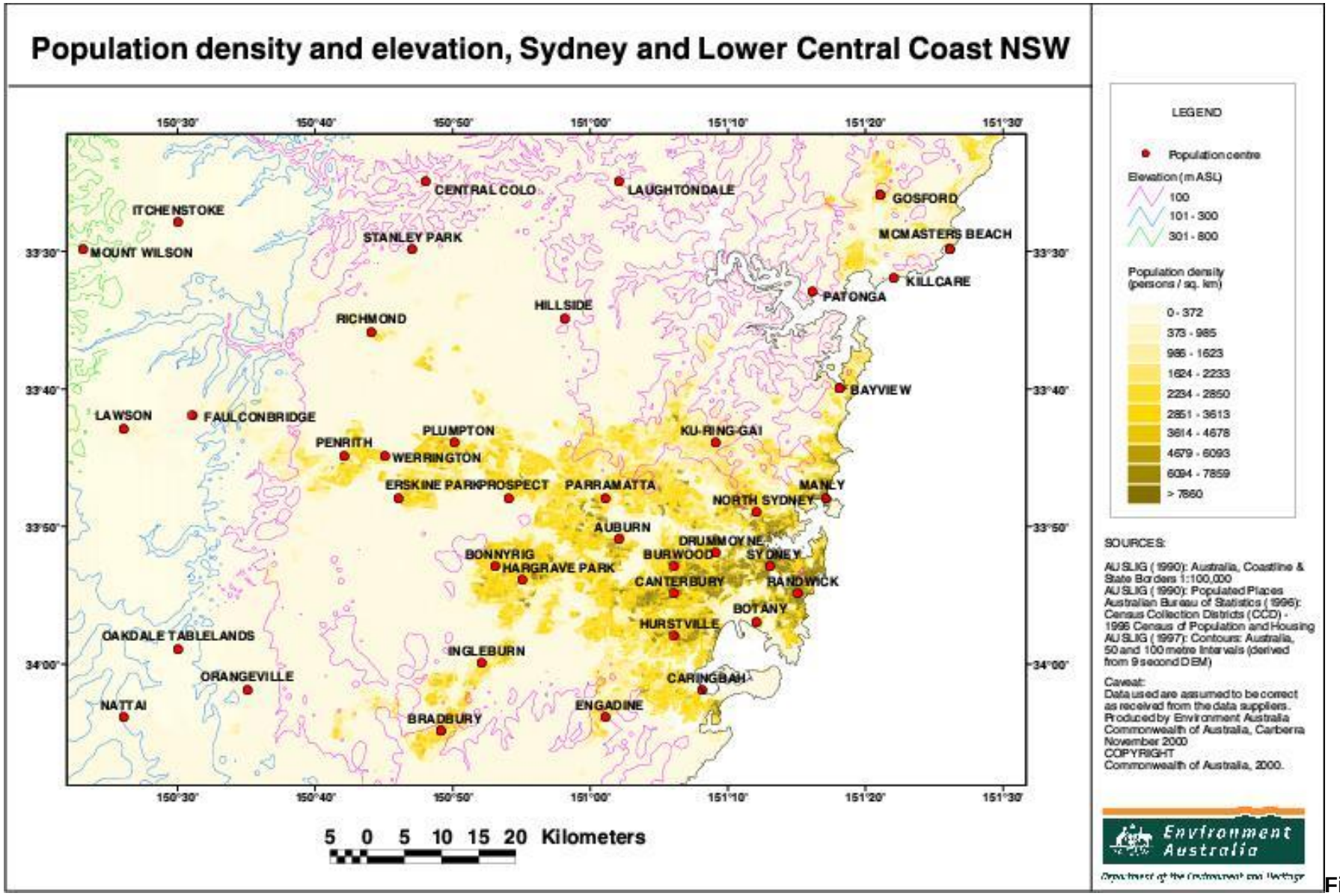


Figure 2: Population density and topography in the Sydney Region.
Place names indicate population centres.

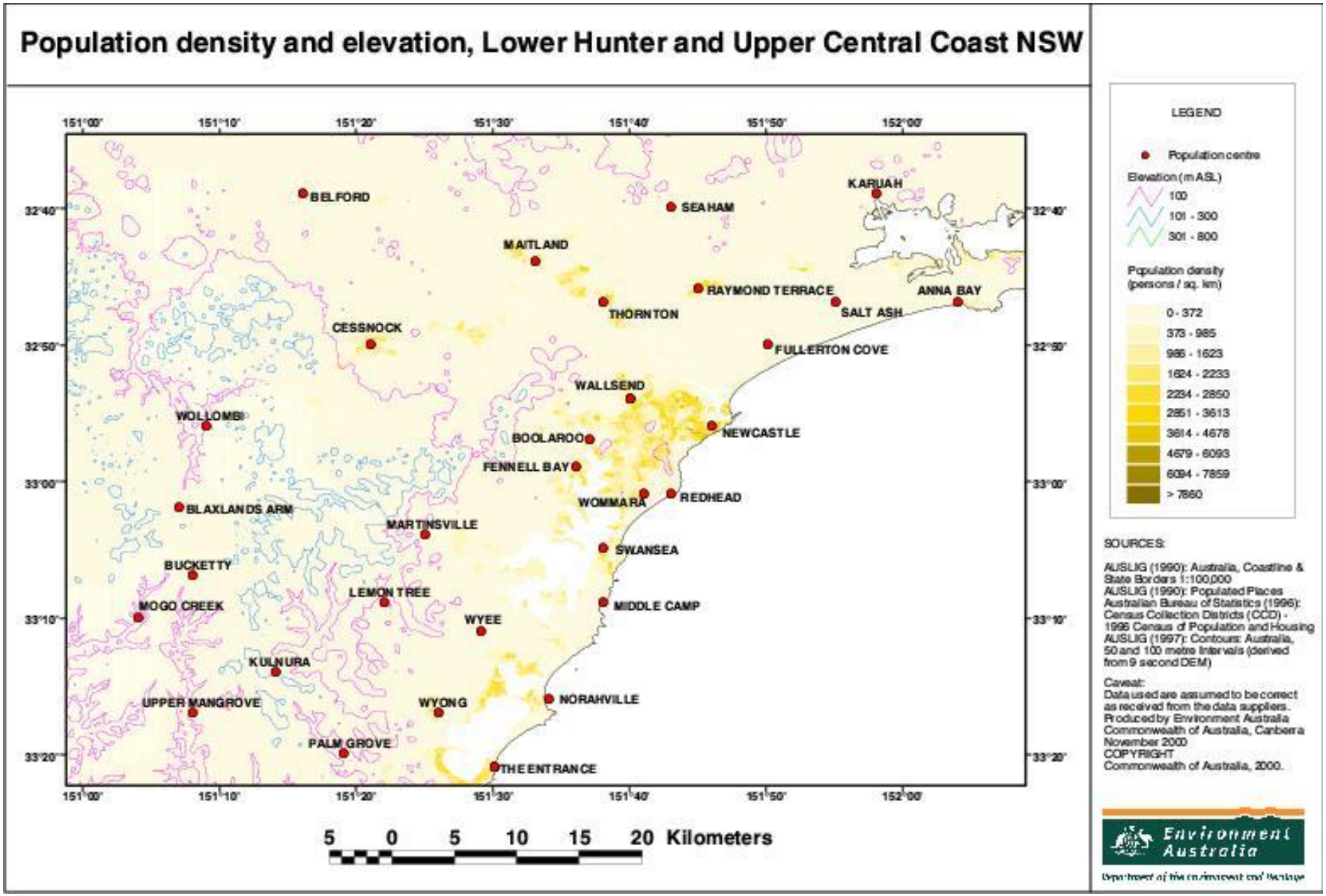


Figure 3: Population density and topography in the Lower Hunter Region.
Place names indicate population centres.

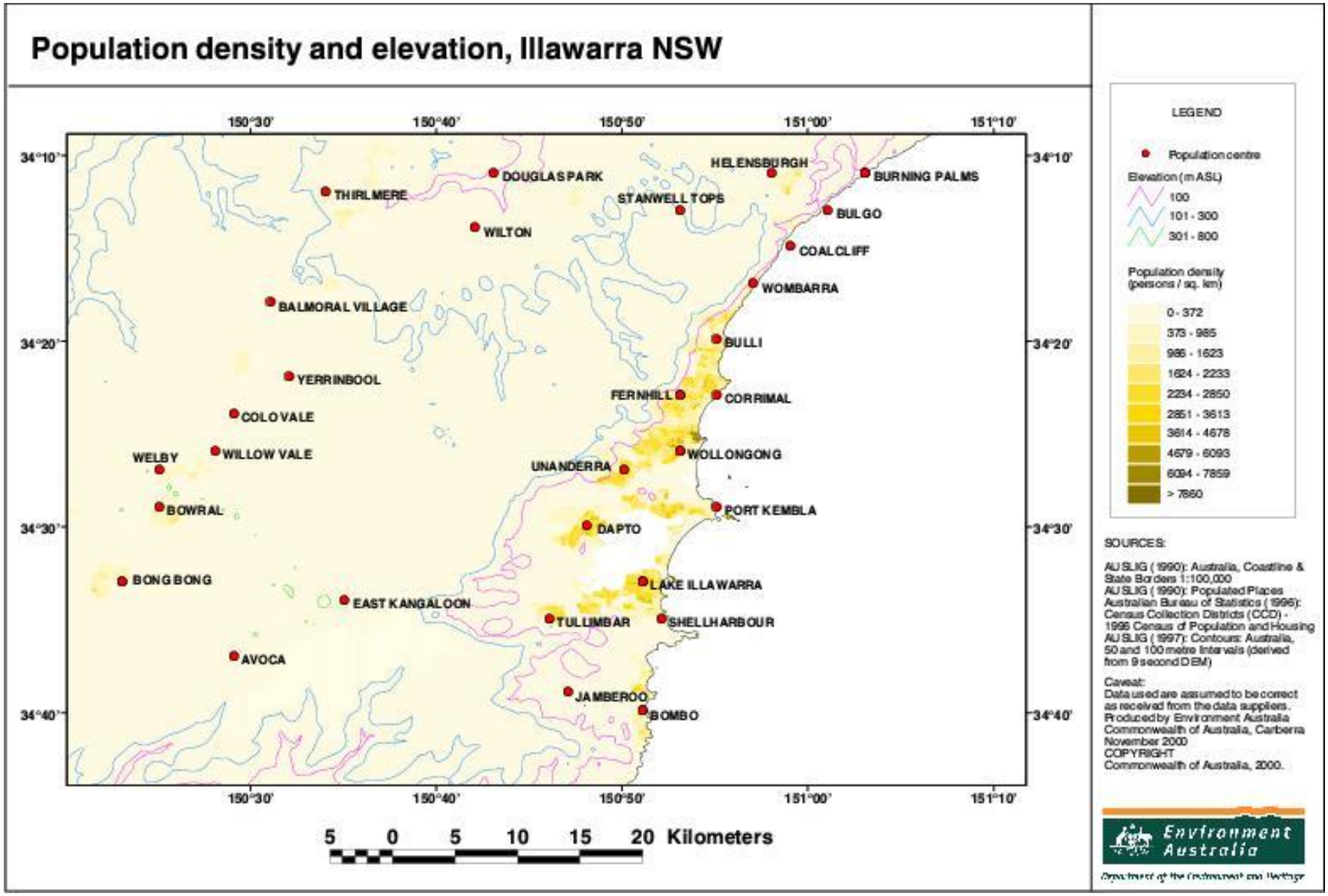


Figure 4: Population density and topography in the Illawarra Region.
Place names indicate population centres.

3 Monitoring requirements of regions

Section 2 showed that there are some eleven regions of type 1 in New South Wales. The monitoring needs of each are discussed in the following subsections. Each region is described and existing air quality data summarised. Where the existing air quality data implies a need for monitoring, this is noted within the summary. The monitoring nominated for AAQ NEPM reporting purposes is then described.

Part 4 of the Measure outlines the monitoring protocol to be followed. The AAQ NEPM is made under the NEPC Acts which aim to provide equivalent environmental protection to all Australians wherever they live. Thus the desired environmental outcome of the AAQ NEPM is ambient air quality that allows for the adequate protection of human health and well-being. The objective of the AAQ NEPM Monitoring Protocol is to provide a consistent approach to the measurement of ambient air quality experienced in populated areas throughout Australia. Ambient air quality monitoring must be conducted in a manner that provides confidence that the exposure of the general population to the six air pollutants is accurately assessed.

Clause 14 of the NEPM provides some guidance on the number of sites at which monitoring should be carried out across an airshed for NEPM purposes, and Clause 17(2a) requires jurisdictions to provide a determination of the exposed population represented by each site. This is included in the report as appendix B.

PRC (2000c) sets out PRC guidelines on developing the monitoring strategy. This paper has been used in generating the monitoring strategy within New South Wales. In addition, PRC (2000d) provides criteria for using screening to reduce the monitoring of any parameter below that set out in Clause 14 of the AAQ NEPM.

Performance monitoring under the AAQ NEPM is required to determine whether the AAQ NEPM standards and goal have been met within populated areas in a region. To achieve this adequately, it is necessary to locate some monitoring stations in populated areas which are expected to experience relatively high concentrations, providing a basis for reliable statements about compliance within the region as a whole. PRC (2000c) denotes such stations as generally representative upper bound for community exposure (GRUB) sites.

However, it is also necessary to ensure that the AAQ NEPM monitoring network provides a widespread coverage of the populated area in a region and provides data indicative of the air quality experienced by most of the population.

The monitoring networks for each type 1 region have been generated using these concepts. The plan ensures that there is adequate coverage of the populated areas. Where necessary, additional upper bound stations are nominated to ensure that higher concentrations within the region are included in the AAQ NEPM plan. This approach satisfies the requirements and intent of the AAQ NEPM.

As discussed in Section 3.1, Clause 14(1) of the NEPM gives a formula for estimating the number of performance monitoring stations to be maintained in a region. It provides an initial estimate of the network needs of a region in the absence of detailed scientific studies and understanding of the region.

Consideration for each of the eleven type 1 airsheds follows. The network in each is intended to characterise air quality to which the general population is exposed and, in addition, to ensure that the higher concentrations are captured.

3.1 The Sydney Region

3.1.1 Description of the Region

Region Boundaries

The Sydney region is a basin-like structure bound by elevated terrain to the north, west and south. Its northern coastal strip extends into and includes the southern part of the Central Coast urban centre. The weather within the region is affected by relatively complex topography which divides it into a number of sub-regions depending on prevailing synoptic conditions. The land-sea interface develops mesoscale flows which further complicate the monitoring of air quality in the airshed.

Population and Topography

The Sydney region contains the largest population in NSW (and Australia). The topography is shown in figure 5. While the population in the urban centre of Sydney was determined by the 1996 Census to be 3.3 million, the population represented by the Sydney region as defined here is estimated to be 3.8 million. Thus, on the basis of Clause 14 of the NEPM, the basic number of monitoring stations required is seven (7).

The region is essentially a large basin containing complex topography. The spatial pattern of air quality is determined by the wind regimes and how they interact with the topography. The characteristics of the sea-breeze are of importance, especially for generating elevated concentrations of ozone. For most events, the sea-breeze is a north-easterly flow.

In the west of the region is the Hawkesbury basin. This is separated from the rest of the region by the Blacktown ridge. Air quality data show that the north and south of the Hawkesbury basin have distinct patterns of pollutant concentration, largely because the sea-breeze is generally north-easterly. Thus it is useful to consider the region as having three sub-regions - east, north-west and south-west.

Emission sources

An emissions inventory was developed as part of the Metropolitan Air Quality Study (Carnovale et al, 1997). It showed that Sydney's major challenge to good air quality is the extensive use of motor vehicles to fulfil transportation needs, both domestic and commercial. Emissions from motor vehicles represent almost 80% of oxides of nitrogen; nearly half the anthropogenic reactive organic compounds; and almost 90% of carbon monoxide emitted in the airshed on an annual basis (Carnovale et al, 1997). Domestic and commercial sources are also important, constituting some 40% of anthropogenic reactive organic emissions and more than 60% of PM_{10} emissions in wintertime, mainly from the use of wood as a domestic heating source. Industrial sources are less significant. Bushfires and bushfire hazard reduction burning are also major but intermittent sources of PM_{10}.

Air Quality Monitoring History

The region has been the subject of extensive monitoring over an extended period (EPA in prep). The first measurements were made in the early 1950s. Continuous measurements have been made at a number of stations since the early 1970s. Table 3 lists the stations comprising the current monitoring network in the region, their date of establishment and the parameters currently measured there. [It should be noted that a small number of stations would have undergone minor changes in location within the same local environment at times over the last three decades. Such minor changes are not listed in the Table.] The location of monitoring stations is shown in figure 5.

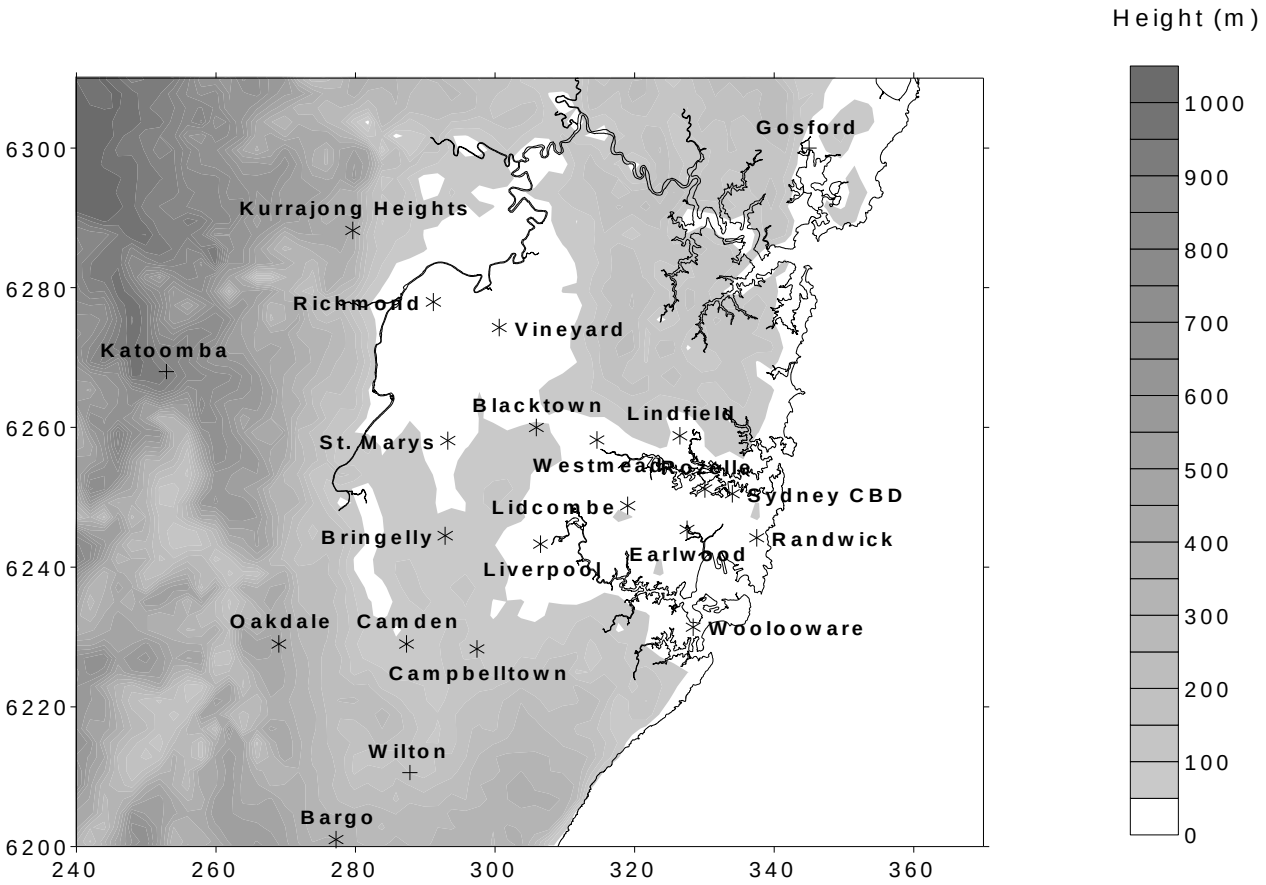


Figure 5: The Sydney Region.
Current monitoring stations are indicated by "∗".
Shading indicates height above sea level (metres).

Investigations into Air Quality

The region has been the subject of two significant scientific investigations of aspects of air quality. These are the Sydney Oxidant Study of the late 1970s and the Metropolitan Air Quality Study from 1992 to 1995. This latter study concentrated on photochemical and fine particle pollution, including development of a detailed modelling capacity tailored to the region. As part of the study a number of days were subject to extensive modelling. Together with monitoring, this modelling has enabled greater understanding of the features and distribution of events of degraded air quality in the region.

Meteorology

Sydney experiences a generally mild climate. Daily temperatures are sufficient to promote photochemical smog from October to April. While winters are mild near the coast, frosts are usual in the west of the basin, and strong temperature inversions occur.

Reduced air quality in Sydney is normally associated with a high pressure system located in the Tasman Sea producing a ridge of high pressure over the region (Hyde et al, 1997). Under these circumstances, light to moderate, local to mesoscale winds predominate, including katabatic flows and sea breezes. There is the potential for air pollutants to be retained and, possibly, recirculated in the airshed on a time scale of several to tens of hours. The detailed meteorology which leads to the distribution of each pollutant is discussed separately below.

Seasonally variable wind flow patterns exist within the Sydney airshed, with easterly surface winds dominating in the warmer months and westerly surface winds dominating in the cooler months.

General surface wind flow patterns occurring in Sydney in the morning and afternoon for both warmer (October 1997 to March 1998) and cooler (April 1998 to September 1998) months are depicted in figures 6(a) - (d).

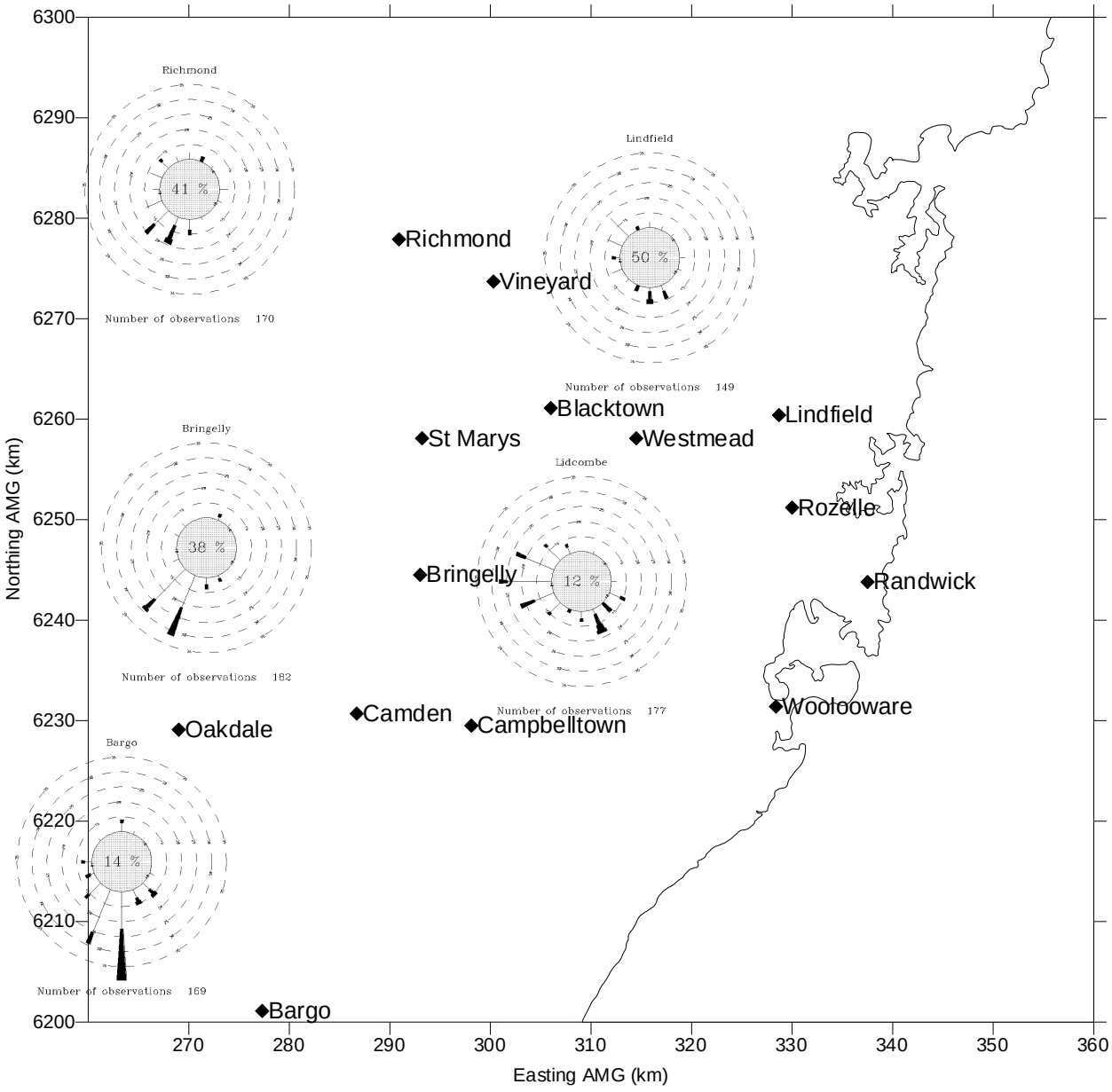
TABLE 3: MONITORING IN THE SYDNEY AIRSHED (August, 2000)

Station	Year Est.	ozone	nitrogen oxides	particles as PM_{10}		carbon monoxide	sulfur dioxide	lead	Met.
				HiVol	TEOM				
Bargo	1996	✓	✓				✓		✓
Blacktown	1992	✓	✓	✓	✓	✓	✓		✓
Bringelly	1992	✓	✓		✓		✓		✓
Camden	1989	✓(i)	✓						
Campbelltown	1976	✓(i)	✓(i)		✓				✓(i)
CBD	1970		✓	✓		✓		✓	
Earlwood	1978	✓	✓	✓	✓			✓	✓
Kurrajong Heights	2000	✓	✓				✓		
Lidcombe	1970	✓	✓		✓				✓
Lindfield	1994	✓	✓	✓	✓		✓		✓
Liverpool	1988	✓	✓		✓	✓			✓
Oakdale	1996	✓	✓						✓
Randwick	1995	✓	✓		✓		✓		✓
Richmond	1992	✓	✓	✓	✓		✓		✓
Rozelle	1970	✓	✓	✓		✓		✓	✓
St Marys	1992	✓	✓		✓				✓
Vineyard	1994	✓	✓		✓		✓		✓
Westmead	1980	✓	✓		✓	✓			✓
Woolooware	1983	✓	✓		✓		✓		✓

(i) represents an industry-operated instrument

Wind data from five stations (Lindfield, Lidcombe, Richmond, Bringelly and Bargo) were plotted to represent geographical spread throughout the airshed. Differences in wind flow patterns between the Hawkesbury basin and Liverpool basin can be seen. As shown by the plots, during the morning (prior to sunrise) calm or light winds predominate throughout the basin with local flows (katabatic drainage flows) existing. In the afternoon in the warmer months – late spring to early autumn – strong north-easterly to easterly sea breezes predominate and have been seen to extend as far south-west as Bargo. In the afternoon during the cooler period, wind flows at a station vary on a daily basis. Light sea breezes can occur in the eastern part of the basin during the late morning or early afternoon.

Figure 6(a): Morning wind rose plots for Sydney during the warmer months.
October 1997 to March 1998 (Hour 6)



- The shaded area in the centre represents calms
- Calms are winds less than 0.5 ms^{-1}
- Minimum frequency is 1%
- Frequency of circles is 5%

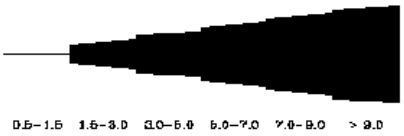
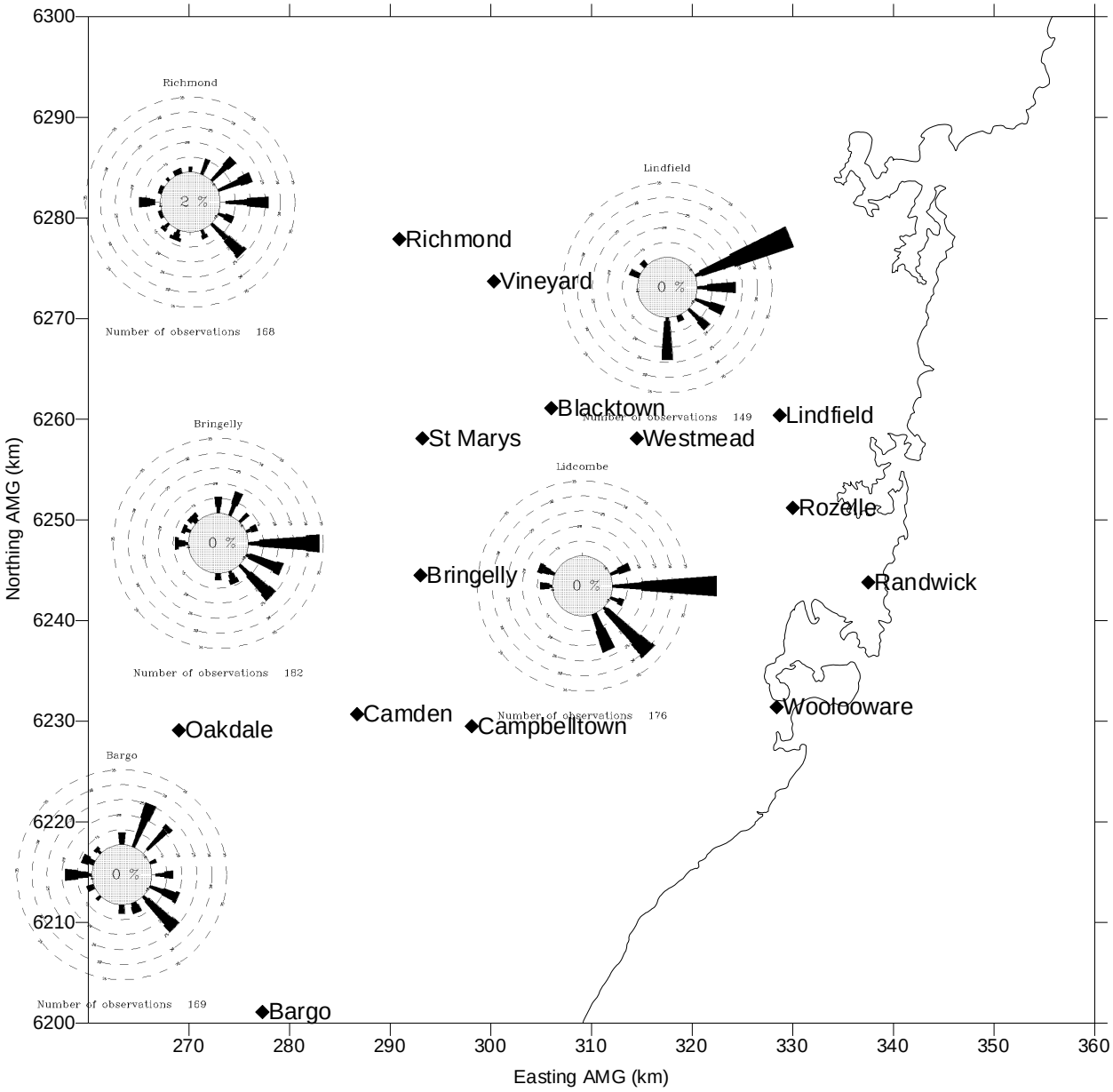


Figure 6(b): Afternoon wind rose plots for Sydney during the warmer months.
October 1997 to March 1998 (Hour 15)



- The shaded area in the centre represents calms
- Calms are winds less than 0.5 ms^{-1}
- Minimum frequency is 1%
- Frequency of circles is 5%

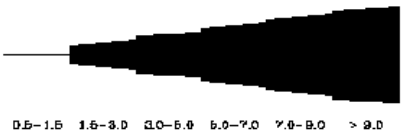
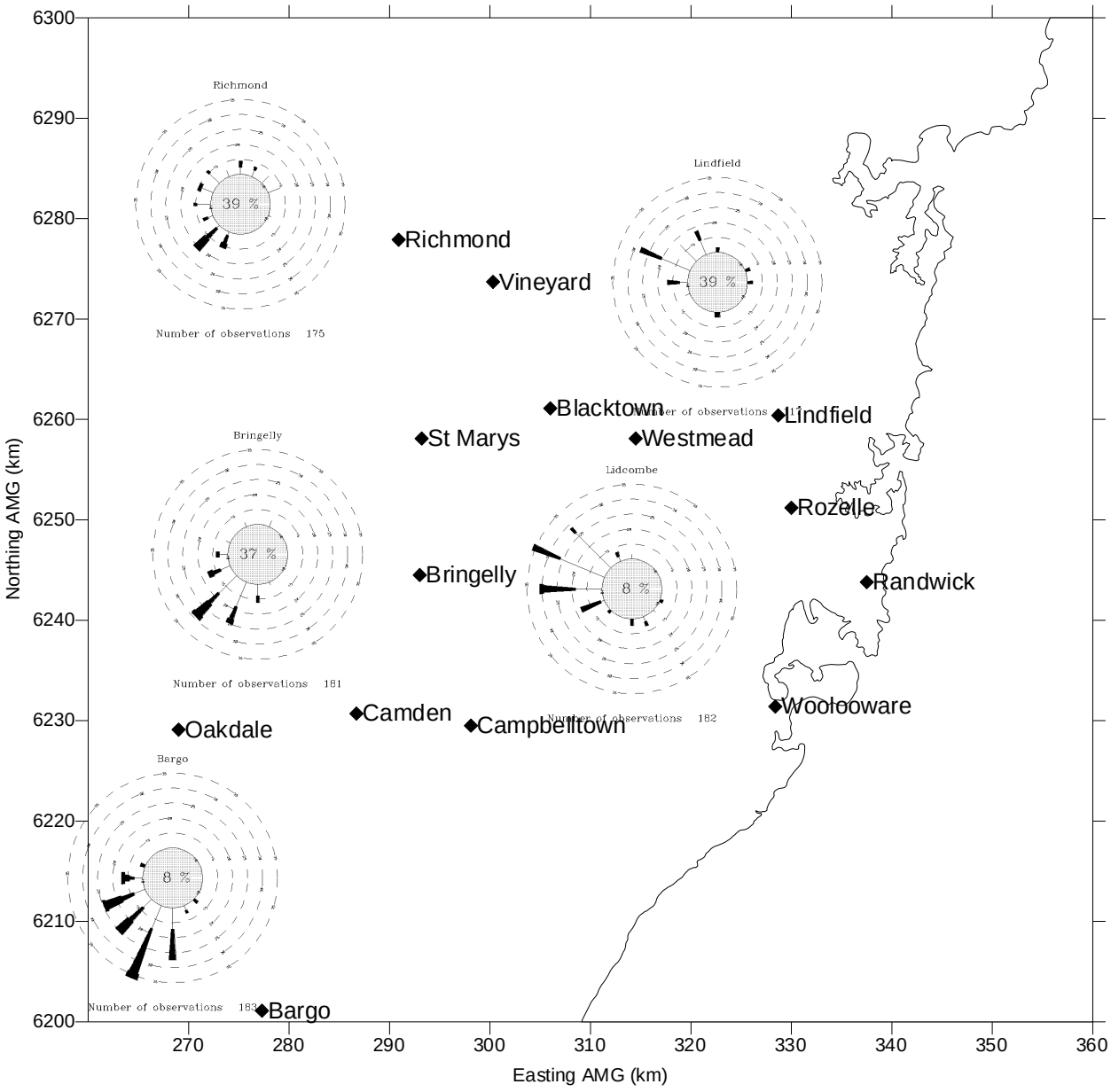


Figure 6(c): Morning wind rose plots for Sydney during the cooler months.
April 1998 - September 1998 (Hour 6)



- The shaded area in the centre represents calms
- Calms are winds less than 0.5 ms^{-1}
- Minimum frequency is 1%
- Frequency of circles is 5%

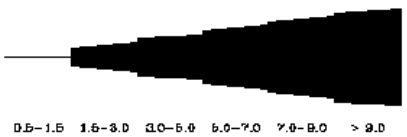
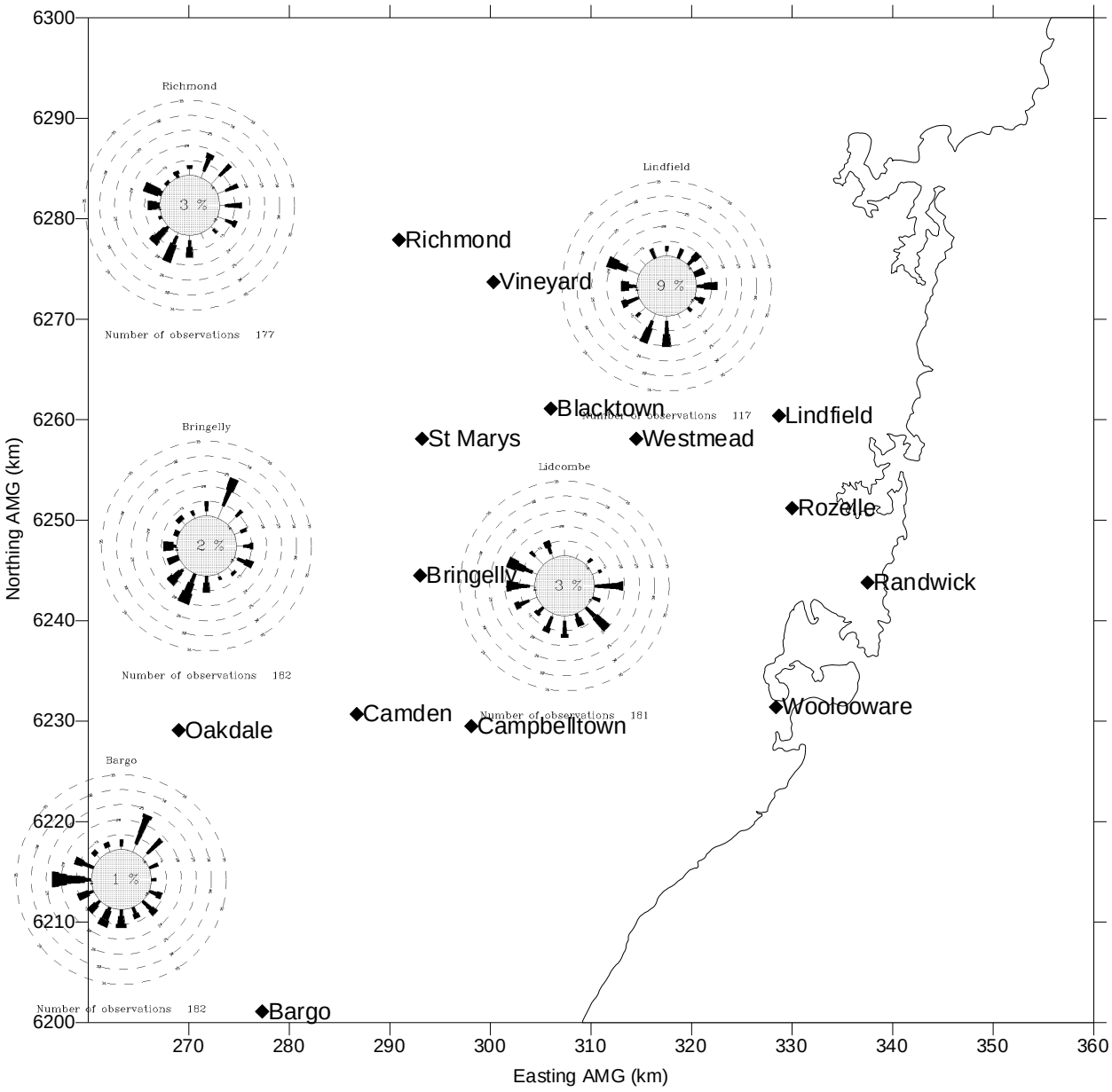
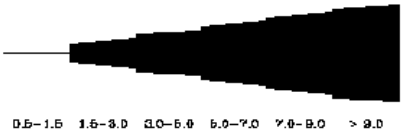


Figure 6(d): Afternoon wind rose plots for Sydney during the cooler months.
April 1998 - September 1998 (Hour 15)



- The shaded area in the centre represents calms
- Calms are winds less than 0.5 ms^{-1}
- Minimum frequency is 1%
- Frequency of circles is 5%



3.1.2 Overall Air Quality

The Sydney region is the subject of intensive continuous monitoring of air quality as shown in table 3 (above). Current monitoring (figure 7) shows that within the region, exceedences of the NEPM standard concentrations occur for one-hour ozone, four-hour ozone, daily PM_{10}, eight-hour carbon monoxide, and occasionally one-hour nitrogen dioxide. Concentrations of sulfur dioxide and lead are low.

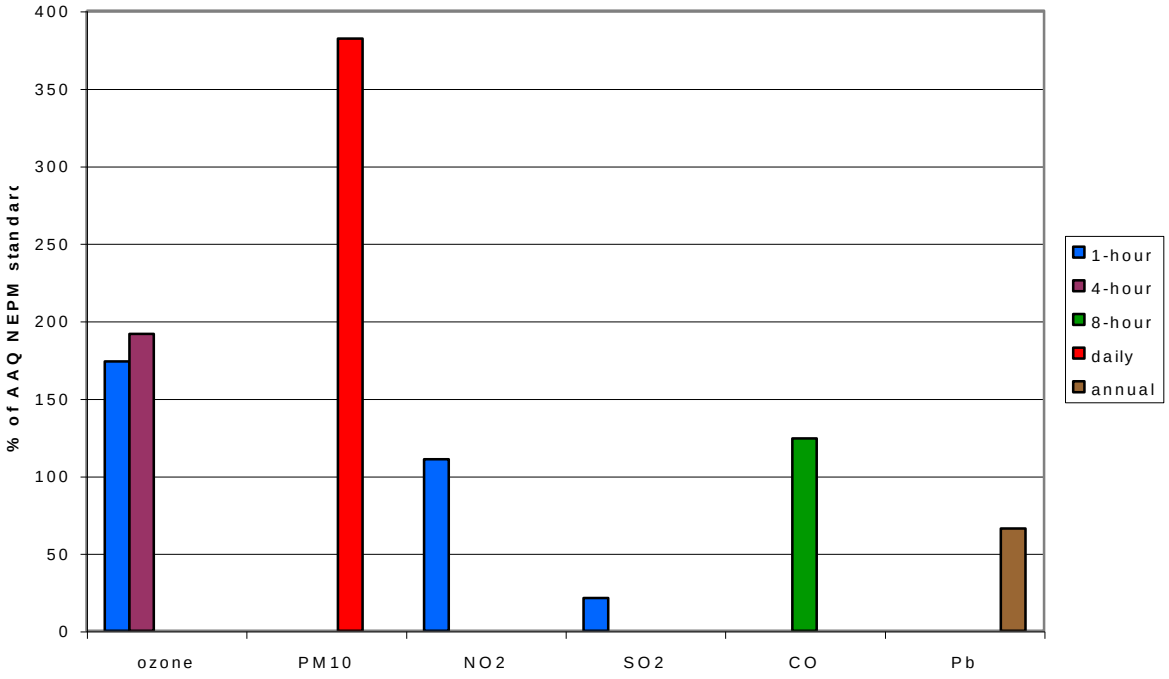


Figure 7: Maximum Concentrations as Percentages of AAQ NEPM Standards Sydney Region, 1994-1998

Concentrations of ozone greater than the AAQ NEPM standard have been recorded at all stations in the region, occurring for a variety of meteorological conditions. Elevated concentrations of PM_{10} are associated with hazard reduction burning or wildfire and have been recorded in all three sub-regions. Exceedences of the CO goal are only recorded by the peak station in the central business district. Elevated concentrations of nitrogen dioxide occur in both the warmer and cooler months. They tend to be local and are more likely in the east of the basin.

Carbon Monoxide

Carbon monoxide is not found at elevated concentrations regionally in the Sydney airshed. Rather, carbon monoxide is only elevated in specific conditions where motor vehicle traffic densities are high and the built environment reduces natural dispersion.

Carbon monoxide has been the subject of long-term monitoring at a peak station in the Sydney CBD. This station is at roadside but on the outside edge of an awning about 3 metres from ground level. The location, at the corner of George and Market Streets, is one of the busiest in the CBD. Other carbon monoxide monitoring locations were not established until the early 90s.

Concentrations of carbon monoxide have been reducing steadily at the monitoring station in the CBD as motor vehicle control technology improves (figure 8). Note that as this station is located specifically as a peak site for the impact of emissions from motor vehicles, it provides an upper bound to concentrations in the Sydney airshed. It now experiences few exceedences of the NEPM standard (figure 9).

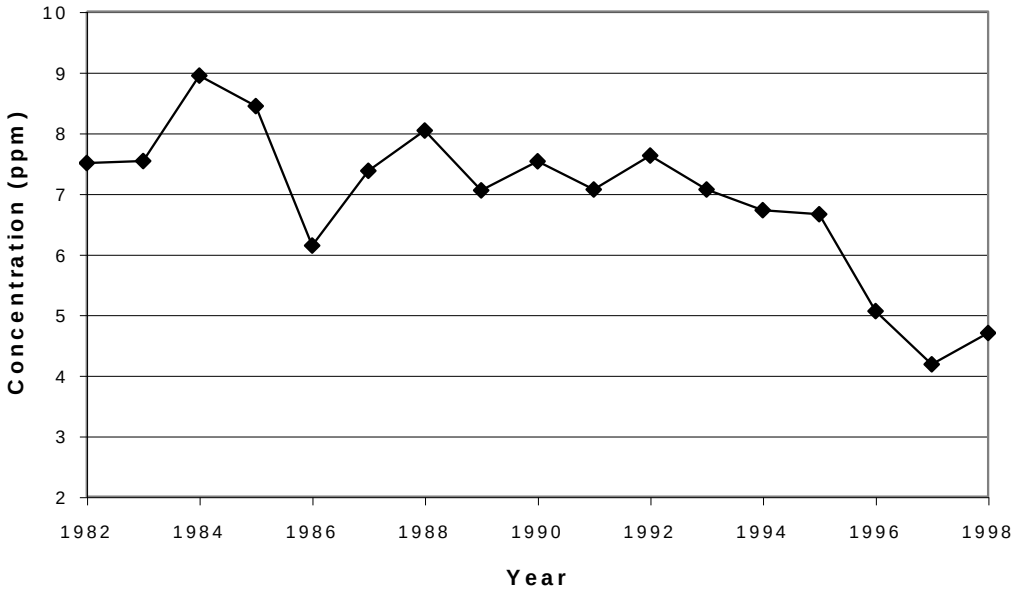


Figure 8: Annual 90th percentile concentration of 8-hour CO, Sydney CBD

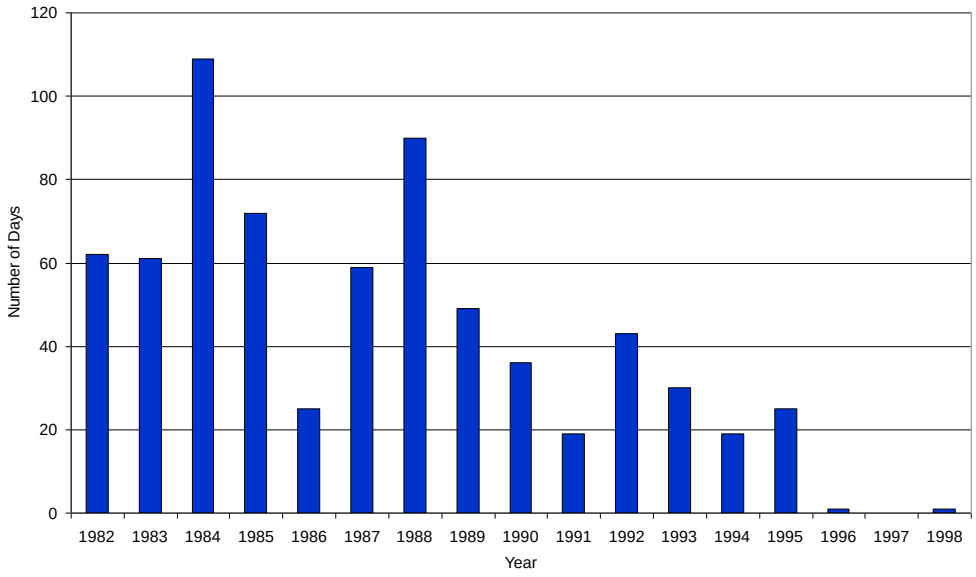


Figure 9: Number of days exceeding the NEPM 8-hour Standard for CO, Sydney CBD

(note: nearby construction interrupted operation 1996-1998)

Concentrations measured elsewhere in the Sydney region are rarely more than 50% of the standard (table 4).

TABLE 4: SYDNEY CARBON MONOXIDE CONCENTRATIONS FOR PERIOD 1993-1998

Station	Subregion	8-hour concentration (ppm)			Number of days exceeding Standard
		maximum	99th percentile	90th percentile	
Blacktown	North-west	6.7	2.6	1.2	0
Liverpool	South-west	5.9	3.3	1.5	0
Rozelle	East	6.5	3.1	1.2	0
Sydney	(peak site)	11.8	8.5	6.3	59[1]
Westmead	North-west	4.7	2.9	1.4	0

1: The number of days the 8-hour average exceeded 9ppm is 76 if considering every new day, ie. there may be some overlapping hours from the previous day. The 59 days reported in the table above is based on days when the standard is exceeded with no overlapping hours, consistent with the recommendations in PRC (2000e).

These data show that other than the CBD peak station, the maximum eight-hour average concentration of CO in any of the six years 1993-98 does not exceed 75% of the NEPM standard. The criterion for application of screening procedure B, PRC (2000d) is met and thus a reduction in the number of stations at which CO is monitored in the region is permitted under clause 14(3) of the NEPM.

CO monitoring will be undertaken for NEPM purposes at four trend stations (Blacktown, Lidcombe, Macarthur and Rozelle) and at the CBD peak station, which will serve as an upper bound stations for NEPM purposes. Until the Macarthur station is established in 2003, Liverpool data will be reported.

Ozone

Ozone episodes in Sydney occur under several different meteorological regimes and hence peak concentrations can be observed at a range of stations in the monitoring network depending on the conditions responsible for a particular ozone episode. This is demonstrated by the peak ozone concentrations observed at stations in the current network for the period 1993 to 1998, table 5.

In the Sydney region, episodes of medium to high ozone concentrations most commonly occur under the influence of a high pressure system centred in the Tasman Sea and ridging into NSW, resulting in northerly/north-westerly synoptic winds over Sydney (Leighton and Spark, 1995). Under these synoptic conditions, local conditions commonly experienced in Sydney include mesoscale flows - such as drainage flows overnight and sea breezes during the day - and warm temperatures. These days tend to be associated with warm stable air aloft, which limits mixing and the dispersion of pollutants.

On these days, peak concentrations of ozone are associated with the passage of the sea breeze across the basin. In the Sydney region sea breezes are generally north-easterly to easterly in direction, resulting in the highest concentrations of ozone being recorded at stations in the west or south-west of the airshed, figures 10(a) and 10(b). On the 3rd January 1999, the maximum hourly averaged ozone concentration of 0.11ppm occurred at Bringelly, while on the 7th January 1999, the maximum hourly averaged ozone concentration of 0.11ppm occurred at St Marys.

TABLE 5: SYDNEY OZONE CONCENTRATIONS AND EXCEEDENCES FOR THE PERIOD 1993-1998

Station	Subregion	1-hr concentrations (ppm)			No. days exceeding Standard	
		Peak	99th percentile	90th percentile	1 hour	4 hour
Bargo ∗	South-west	0.13	0.06	0.03	7	10
Blacktown	North-west	0.15	0.05	0.03	10	9
Bringelly	South-west	0.14	0.06	0.03	16	23
Earlwood	East	0.10	0.04	0.02	0	2
Lidcombe	East	0.17	0.05	0.02	8	10
Lindfield #	East	0.14	0.05	0.03	4	10
Liverpool	South-west	0.15	0.05	0.02	12	13
Oakdale*	South-west	0.15	0.06	0.03	11	15
Randwick	East	0.17	0.05	0.03	1	3
Richmond	North-west	0.13	0.05	0.03	8	12
Rozelle	East	0.12	0.04	0.02	1	1
St Marys	North-west	0.13	0.06	0.03	14	17
Vineyard #	North-west	0.13	0.06	0.03	6	10
Westmead	North-west	0.15	0.05	0.02	6	11
Woolooware	East	0.16	0.05	0.03	7	11

∗ period 1996 – 1998
period 1994 - 1998

Ozone can reach elevated concentrations over several hours prior to the arrival of the sea breeze, particularly in the west of the basin. These episodes occur under the influence of light northerly winds, and can be significant in consideration of the 4-hour ozone standard. Figure 10(c) shows the episode of the 26 February 1998, where the maximum 4-hour ozone average was 0.12ppm, recorded at Westmead. Compared to the sea breeze peaks, the particular influences that lead to these pre-sea breeze episodes are not well understood. They may be influenced by recirculation of ozone and/or precursors in drainage flows in the west of the basin. It has also been suggested that transport of precursors and/or ozone from sources outside the Sydney basin may play some part in the ozone concentrations observed during this period.

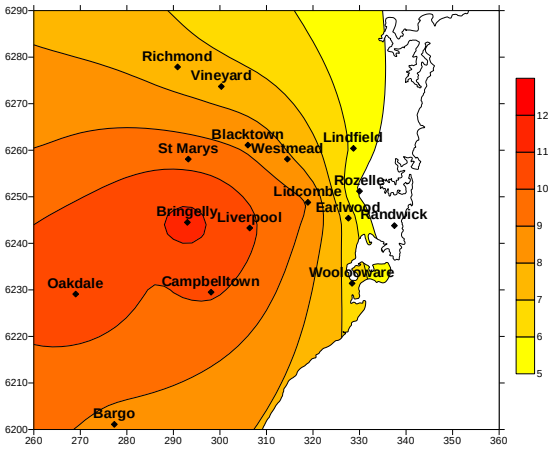
On occasion, high concentrations of ozone can also occur at the coast or in the east of the Sydney region, either in the sea breeze or under the influence of southerly winds. This can occur when precursor pollutants trapped within westerly drainage flows are carried offshore, where they react during the morning, with the resulting ozone subsequently carried back onshore by the sea breeze. On the 23 January 1998, the maximum hourly averaged ozone concentration of 0.13ppm was recorded at Lindfield, occurring under the influence of a sea breeze prior to a southerly change (figure 10(d)). Under similar conditions, on the 22 February 1998, the maximum hourly averaged ozone concentration of 0.12ppm was recorded at Woolooware (figure 10(e)).

High concentrations of ozone can also occur under the influence of south to south-easterly changes. Under these circumstances the urban plume can be carried into the northwest of the Sydney basin resulting in peak ozone concentrations being recorded in this area. An example of such an episode occurred on the 13 December 1998 and is presented in figure 10(f). The maximum hourly averaged ozone concentration recorded for this day was 0.13 ppm at Vineyard.

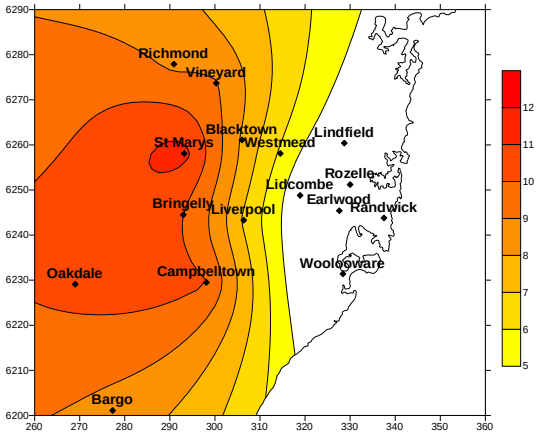
Analysis of the data shows that exceedences of the NEPM standards are most frequent in the south-west of the Sydney region. Bringelly reported the greatest number of exceedences of both the 1-hour and 4-hour standard.

Figures 10(a) to 10(f): Contours of maximum 1-hour and 4-hour ozone concentrations (pphm) for a range of days.

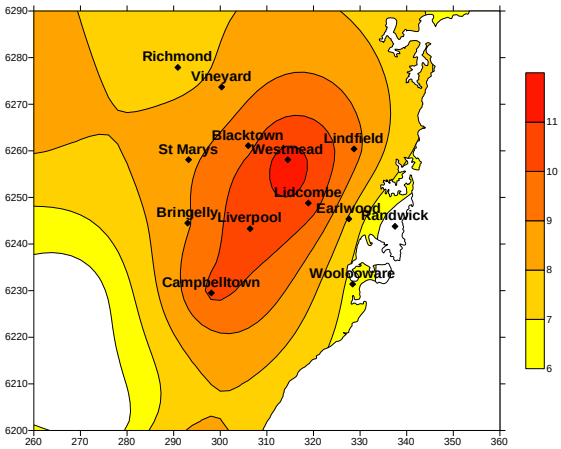
(a): 3 January 1999 - 1-hour



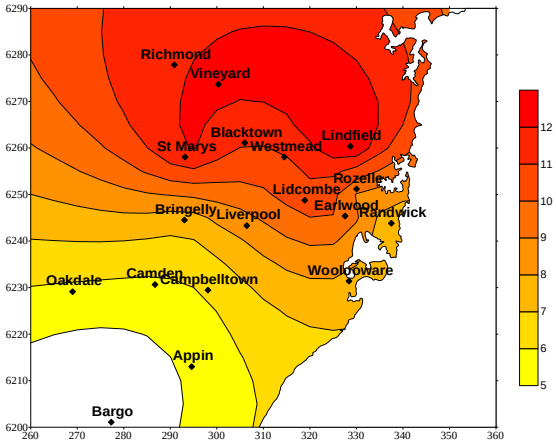
(b): 7 January 1999 - 1-hour



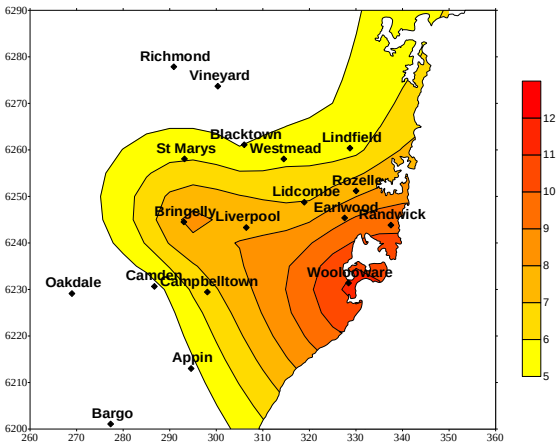
(c): 26 February 1998 - 4-hour



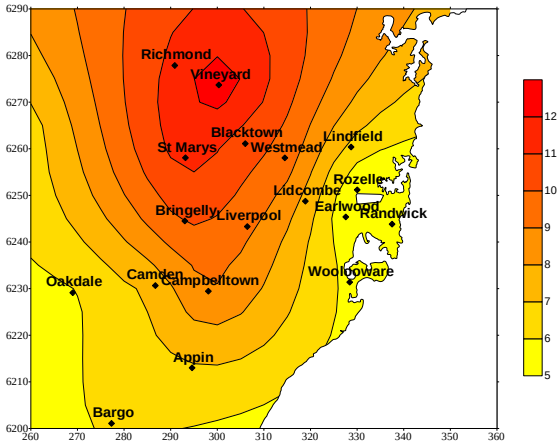
(d): 23 January 1998 - 1-hour



(e): 22 February 1998 - 1-hour



(f): 13 December 1998 - 1-hour



To capture the range of ozone events and to characterise general air quality, ozone monitoring will be undertaken at the seven trend stations (Blacktown, Bringelly, Lidcombe, Macarthur, Richmond, Rozelle and Woolooware) and at two additional upper bound stations (Oakdale and St Marys). Until the Macarthur station is established in 2003, Liverpool data will be reported. Campaign monitoring of ozone in the Central Coast subregion is scheduled to commence in January 2004.

Nitrogen Dioxide

Elevated concentrations of nitrogen dioxide can occur throughout the year in Sydney. These elevated concentrations can have significant contributions from both direct emission and production by secondary processes.

Compared to ozone, less is known about the driving influences for these elevated concentrations. Elevated concentrations tend to occur in or close to heavily urbanised areas.

During the autumn/winter period, elevated concentrations tend to occur late in the day under increasingly stable atmospheric conditions when dispersion is limited. It appears that some secondary production of nitrogen dioxide is necessary for elevated concentrations to be observed. This can occur either because during the cooler months photochemical processes do not proceed sufficiently to generate ozone, or because the limited ozone produced subsequently enables the quantitative conversion of freshly emitted nitric oxide to nitrogen dioxide (Ischtwan 1998). As both pollutants are affected by poor dispersion conditions, episodes of elevated nitrogen dioxide in winter are often associated with elevated concentrations of particulate matter.

During the summer period elevated concentrations can arise due to photochemical smog reactions and are often temporally associated with morning and afternoon peak hours.

There have been few exceedences of the 1-hour NEPM standard over recent years (table 6), but situations which lead to concentrations just below the standard occur predominantly in the central and eastern areas of Sydney. Generally, elevated concentrations are isolated, occurring at only one or two monitoring stations for any given episode.

For the period 1994-1998 there have been a total of 24 days when nitrogen dioxide concentrations were greater than 0.08 ppm, 12 occurring during the summer/spring and 12 during the autumn/winter months.

To capture the range of these events and to characterise general air quality, nitrogen dioxide monitoring will be undertaken at the seven trend stations (Blacktown, Bringelly, Lidcombe, Macarthur, Richmond, Rozelle and Woolooware). Campaign monitoring of nitrogen dioxide in the Central Coast is scheduled to commence in January 2004. Until the Macarthur station is established in 2003, Liverpool data will be reported.

TABLE 6: SYDNEY NITROGEN DIOXIDE CONCENTRATIONS FOR PERIOD 1996-1998

Station	Subregion	1-hour concentrations (ppm)			Season of maximum
		Maximum	99th percentile	90th percentile	
Bargo	South-west	0.08	0.03	0.02	Winter
Blacktown	North-west	0.10	0.04	0.03	Summer
Bringelly	South-west	0.13	0.03	0.01	Summer
Camden	South-west	0.06	0.03	0.02	Autumn
Earlwood	East	0.09	0.04	0.03	Autumn
Lidcombe	East	0.13	0.04	0.03	Summer
Lindfield	East	0.07	0.04	0.02	Winter
Liverpool	South-west	0.06	0.03	0.02	Autumn
Oakdale	South-west	0.05	0.02	0.01	Spring
Randwick	East	0.09	0.04	0.03	Summer
Richmond	North-west	0.06	0.03	0.02	Summer
Rozelle	East	0.08	0.05	0.03	Autumn
St Marys	North-west	0.07	0.03	0.02	Summer
Vineyard	North-west	0.05	0.03	0.02	Autumn
Westmead	North-west	0.11	0.04	0.03	Summer
Woolooware	East	0.09	0.04	0.02	Autumn

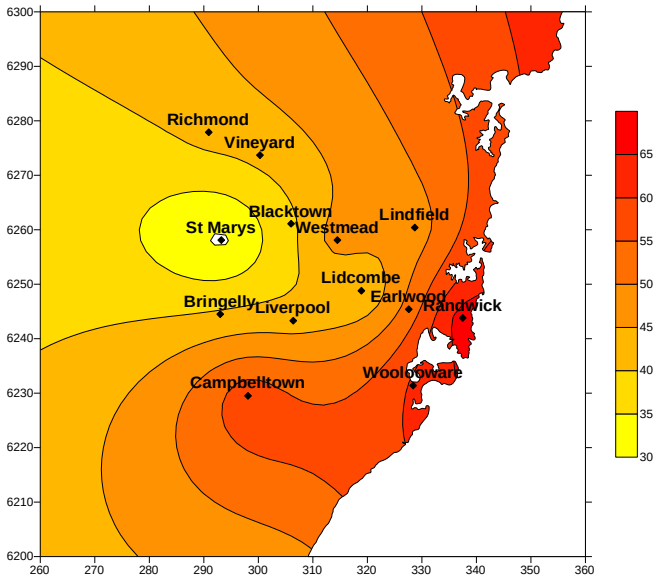
Particles as PM_{10}

Extreme episodes of particle pollution are generally associated with large-scale hazard reduction burning or wildfires. These events account for most of the exceedences of the PM_{10} standard seen in the Sydney region. The distribution of elevated concentrations of PM_{10} during these events is governed by the location of the fire and the prevailing winds on that day. The combination of these two factors means that on different occasions, all the monitoring stations in the Sydney region have recorded elevated concentrations of PM_{10}.

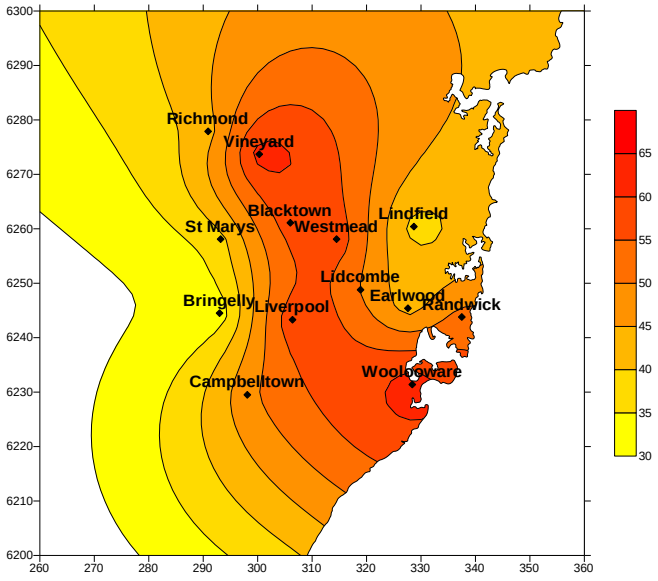
For example, figure 11(a) shows a fire-related PM_{10} event where the winds and location of the fire combined to produce peak concentrations in the east of the Sydney region. Figure 11(b) shows an event where these factors resulted in highest concentrations being observed in the north-west of the region. On some occasions fires can result in relatively localised occurrences of high particulate concentrations, figure 11(c). Occasionally dust episodes can also result in elevated concentrations of PM_{10}. These events tend to be driven by synoptic-scale rather than mesoscale winds and are hence widespread in nature, figure 11(d).

Apart from these extreme events, more moderate concentrations of particulate pollution can be observed on occasion. These events generally occur during the cooler months of the year with the highest concentrations observed during the early evening and early morning. They tend to be associated with the presence of a high-pressure system resulting in light gradient winds and stable conditions. These conditions are conducive to clear cold nights and the development of nocturnal radiation inversions and drainage flows which can result in the trapping of pollutants close to the surface and their transport within the Sydney region.

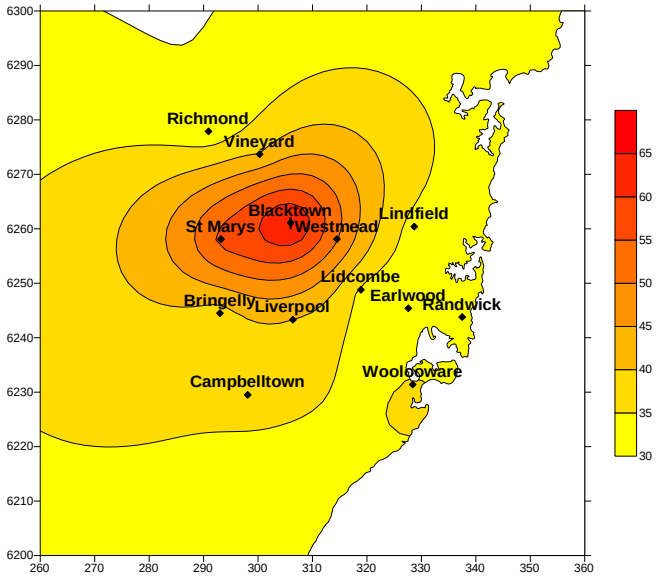
(a): 17 December 1997



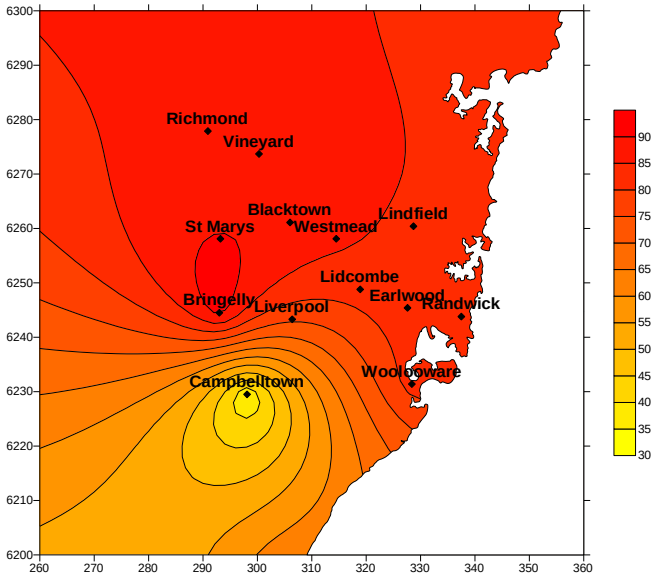
(b): 2 December 1997



(c): 23 March 1998



(d): 1 February 1996



Figures 11(a) to 11(d): Maximum 24-hour averaged TEOM - PM_{10} concentrations ($\mu g/m^3$) for a range of days and special events (bushfires)

Under these conditions, maximum particle concentrations tend to be related to emissions from morning and evening traffic peak hours and to emissions from domestic wood heating. The geographical distribution of elevated concentrations of particles tends to be dominated by local influences both in relation to sources and meteorological conditions. Areas where topography promotes the development of inversions and local drainage flows, such as local valleys and other low lying areas, are particularly prone to elevated concentrations of particles. This is especially the case where local sources of emissions are located so that their emissions become trapped within these flows.

Concentrations of PM_{10} near to or exceeding the standard concentration are widespread in the Sydney region. On the basis of measurements made using the continuous TEOM instrumentation, all stations in the network with these instruments (except Lidcombe) have shown exceedences of the standard concentration, although none have experienced more than the 5 allowable exceedences in any one year (table 7). It should be noted that the maximum values for the period 1996-1998 presented in table 7 are largely associated with summer wildfires. In particular the period includes significant wildfire events that occurred during the summer of 1997/98. Table 6 also shows that over the three-year period 1996 to 1998, the areas most affected by particle pollution were the south-west and north-west subregions.

TABLE 7: SYDNEY PM_{10} CONCENTRATIONS FOR PERIOD 1996-1998

(by TEOM)

Station	Subregion	24 hour concentrations ($\mu g/m^3$)		
		maximum (1996-1998)	2nd highest (1996-1998)	maximum 6th highest in any calender year
Blacktown	North-west	67	57	42
Liverpool	South-west	64	48	41
Randwick	East	86	68	37
Westmead	North-west	86	64	45
Richmond	North-west	86	72	42
Woolooware	East	82	63	35
Vineyard	North-west	63	62	44
Campbelltown	South-west	59	49	37
Lindfield	East	84	48	36
St Marys	North-west	57	49	37
Earlwood	East	52	49	39
Bringelly	South-west	92	68	37
Lidcombe	East	50	46	38

Clearly, elevated concentrations of PM_{10} occur in all parts of the Sydney region. A wide geographic coverage is therefore needed to represent the various events. To capture the range of these events and to characterise general air quality, PM_{10} monitoring will be undertaken at the seven trend stations (Blacktown, Bringelly, Lidcombe, Macarthur, Richmond, Rozelle and Woolooware) and at one additional upper bound station (Oakdale). Until the Macarthur station is established in 2003, Liverpool data will be reported. Campaign monitoring of PM_{10} in the Central Coast is scheduled to commence in January 2004.

Sulfur Dioxide

Sydney does not experience elevated regional concentrations of sulfur dioxide. There are only a few industrial premises emitting significant quantities, the remainder of the emissions coming from motor vehicles (especially diesel-powered motor vehicles). The largest of the few industrial premises are the two oil refineries in the Sydney metropolitan area. Measurements over many years have confirmed that sulfur dioxide is not detected at concentrations even approaching the NEPM standards.

To date, monitoring has shown low concentrations of sulfur dioxide throughout the Sydney region. During the period 1995 to 1998, regional sulfur dioxide concentrations were well below 65% of the NEPM standard (table 8). This meets the criteria for Screening Procedure B in table 1 of PRC (2000d). Thus fewer than the population-required 7 monitoring stations may be nominated for

the Sydney region. Further, for other regions with no industrial sources, these data provide a basis for reducing SO_2 monitoring.

Nevertheless, to characterise general air quality, SO_2 monitoring will be undertaken at six trend stations (Blacktown, Bringelly, Lidcombe, Macarthur, Richmond and Woolooware). Until the Macarthur station is established in 2003, Liverpool data will be reported. Campaign monitoring of sulfur dioxide in the Central Coast is scheduled to commence in January 2004.

TABLE 8: SYDNEY SULFUR DIOXIDE CONCENTRATIONS FOR PERIOD 1996-1998

STATION[1]	Average of monthly maximums	1 hour concentrations (ppm)		Months of valid data over 3-year period[2]
		maximum	2nd highest	
Randwick	0.02	0.04	0.03	32
Lindfield	0.02	0.04	0.03	28
Woolooware	0.01	0.03	0.03	34
Blacktown	0.01	0.02	0.02	28
Vineyard	0.01	0.02	0.02	35
Richmond	0.01	0.02	0.02	31
Bargo	0.01	0.01	0.01	27
Bringelly	0.01	0.01	0.01	33

1 Stations ranked on basis of measurements made during period Jan 1996 to Dec 1998
2 Some stations were not operational until some number of months into 1996

Lead

The CBD lead monitoring station has been located at the corner of George and Market Streets for many years and has consistently recorded lead concentrations higher than any others measured in the Sydney airshed. The monitor is located at the roadside, on the outside edge of an awning about three metres above ground level. Up until the introduction of unleaded petrol, concentrations consistently exceeded standards.

Following the introduction of unleaded petrol, substantial progress has been made in reducing concentrations of lead in the air. Even the CBD station now measures lead concentrations that are less than 40% the NEPM standard, table 9. Indeed, particularly at the other two regional lead stations in Sydney, samples recording lead concentrations below the detection limit are an increasingly frequent occurrence. Hence on the basis of the historical data and the siting of the monitor, the CBD station can be considered an upper bound site for the monitoring of lead.

TABLE 9: LEAD IN THE SYDNEY REGION

ANNUAL AVERAGES FOR THE PERIOD 1990-1998

	Annual average lead concentrations (µg/m^3)								
STATION	1990	1991	1992	1993	1994	1995	1996	1997	1998
Sydney CBD	0.69	0.75	0.64	0.47	0.33	0.25	0.24	0.23	0.18
Earlwood	0.35	0.68	0.57	0.34	0.43	0.19	0.06	0.14	0.09
Rozelle	0.18	0.36	0.33	0.27	0.20	0.09	0.05	0.07	0.05

The data above show that for the four years 1995 to 1998, no station reported an annual average of more than 65% of the goal, 0.33 (µg/m^3). Thus the criteria of Screening Procedure B, table 1 of PRC (2000d) are satisfied. The Sydney region has no large industrial source of lead emissions. As allowed by the recommendations on lead monitoring, PRC (2000i), monitoring may cease when concentrations are less than ten percent of the standard.

Consequently, it is intended to monitor lead only at the Rozelle trend station and at the CBD upper bound station.

3.1.3 Proposed AAQ NEPM Assessment Scheme

As noted above, the population of the Sydney region requires at least seven monitoring stations according to the formula in Clause 14(1) of the AAQ NEPM. Monitoring stations have been selected for the region to ensure that there is adequate coverage of the population, and that the higher concentrations will be captured by the network.

Two trend stations have been selected from each sub-region with an additional trend station on the coast to represent the particular conditions there. These will characterise general air quality and frequently will pick up individual pollutant events. This approach ensures that there is adequate coverage of the populated areas and of the broad differences in pollutant distribution within the region. The choice of stations in each region was made to optimise both population coverage and representation of the occurrences of higher pollutant concentration. The description of pollutant distribution presented in the previous subsection was an important consideration in choosing these stations. Further, that description showed that three additional stations are needed to capture the highest concentrations occurring in the region.

For the north-west sub-region, Blacktown and Richmond are nominated. This gives good geographic coverage and captures the high concentration events for nitrogen dioxide and PM_{10}. In the south-west Bringelly and Macarthur are nominated. The Macarthur site does not yet exist, but is nominated based on the industry monitoring at Camden and Campbelltown. Until this site is established, the existing Liverpool station will be used and it is nominated as a campaign monitoring station. In the eastern sub-region, Lidcombe and Rozelle are nominated. To represent the coast, Woolooware is nominated. These seven trend stations provide a geographic spread and capture a range of the high concentration events.

A station in the Central Business District is nominated as a peak station to capture the impact of motor vehicle emissions (carbon monoxide and lead). Additional stations are needed to capture particular events. Highest concentrations of ozone are recorded at Oakdale. This station is on the edge of the Sydney basin in a sparsely populated area. However, the highest concentrations in the region are an important measure of progress to the goal. Similarly, the St Marys station captures events missed by the trend network.

Campaign monitoring will be undertaken in the Central Coast, in the northern part of the Sydney region. This is scheduled to commence in January 2004. The outcome of this monitoring will determine whether there is a need to establish a trend station in this area.

The monitoring network for the Sydney region is shown in figure 12 and summarised in table 10 which lists all the stations noting the parameters measured at each.

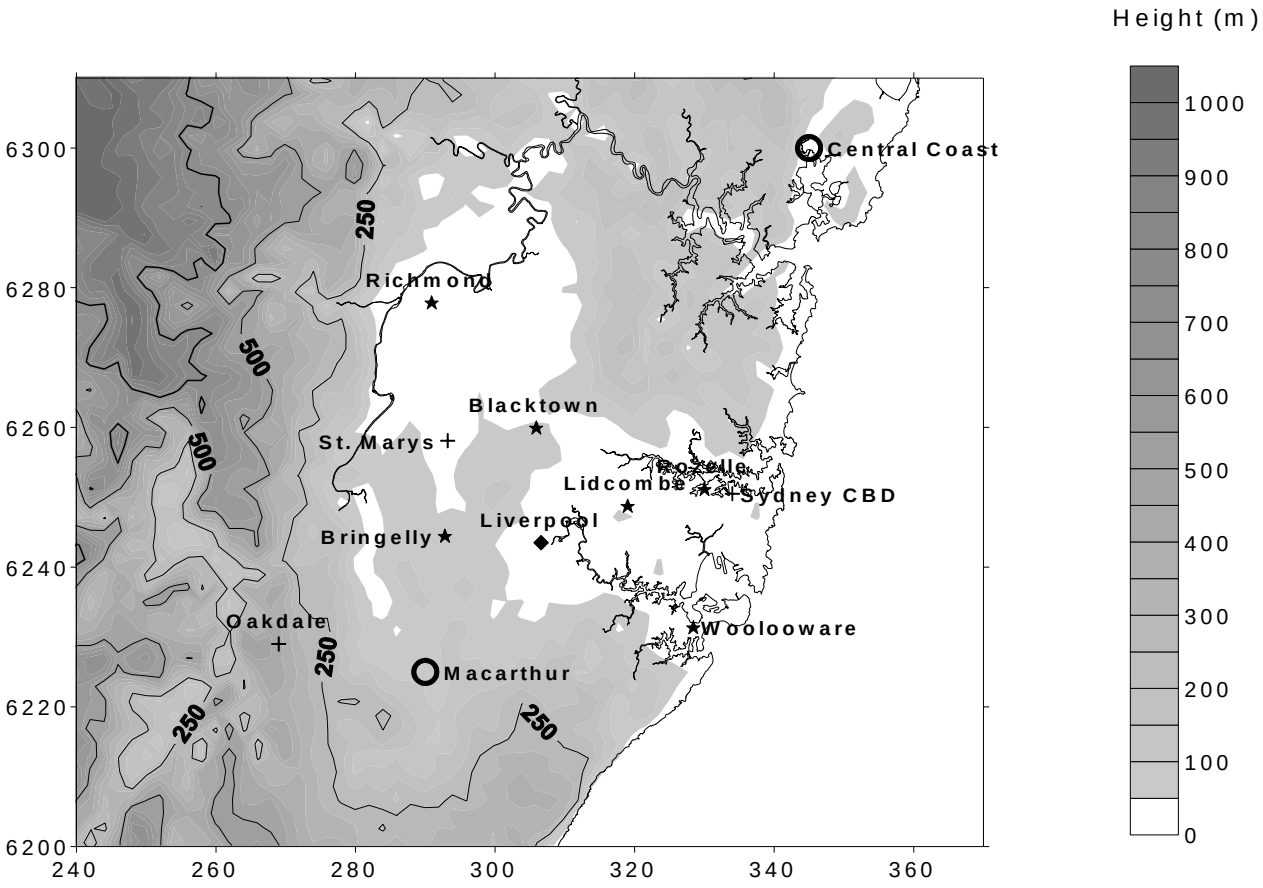


Figure 12: AAQ NEPM Monitoring network for the Sydney Region

* denotes trend stations; + denotes performance stations; ♦ denotes campaign stations
Note that the Macarthur and Central Coast sites are yet to be established. Liverpool will be reported until the Macarthur site is established.

TABLE 10 SYDNEY REGION AAQ NEPM MONITORING NETWORK

Station	Station Type[1]	Number of parameters	ozone	nitrogen dioxide	PM10	carbon monoxide	sulfur dioxide	lead
Blacktown	T	5	✓	✓	✓	✓	✓	
Bringelly	T	4	✓	✓	✓		✓	
Central Coast[2]	C	4	✓	✓	✓		✓	
Lidcombe	T	5	✓	✓	✓	✓	✓	
Liverpool[3]	C	5	✓	✓	✓	✓	✓	
Macarthur[4]	P	5	✓	✓	✓	✓	✓	
Oakdale	P	2	✓		✓			
Richmond	T	4	✓	✓	✓		✓	
Rozelle	T	5	✓	✓	✓	✓		✓
St Marys	P	1	✓					
Woolooware	T	4	✓	✓	✓		✓	
CBD†	P	2				✓		✓

[1] P denotes performance; T denotes trend, C denotes campaign.
[2] The Central Coast campaign site is scheduled to begin operation in January 2004.
[3] Data from the Liverpool station will be reported at least until the Macarthur site is established.
[4] The Macarthur site is scheduled to begin operation in January 2003.
† the CBD station is a peak site as defined in AS 2922-1987 rather than a neighbourhood site.

3.2 The Lower Hunter Region

3.2.1 Description of the Region

The natural Lower Hunter Region is defined to be that part of the Hunter River valley where it opens out to a coastal plain. It is bounded by the coast to the east, and otherwise by the higher terrain enclosing this end of the valley. It is separated from the remainder of the Hunter River valley by the rise in the valley floor northwest of Maitland. The coastal strip extends to the south to include the northern part of the Central Coast urban centre.

Within the natural Lower Hunter Region are the cities of Maitland, Kurri Kurri, and Newcastle. It also includes Port Stephens and the settlements around it. Note that with this separation in the Hunter Valley, the town of Cessnock is excluded from the region. As noted in section 2.3.4, for the purposes of this plan the Lower Hunter region includes the northern part of the Central Coast being the settlements around Lake Macquarie and Tuggerah Lake. The topography of the region is shown in figure 13.

As defined above, the Lower Hunter region is the location of a substantial industrial base including primary metallurgical works, fertiliser manufacturing, and coal-fired power generators. Emissions from a substantial motor vehicle fleet also contribute to pollution concentrations in the region.

The natural Lower Hunter region is the second most heavily populated region in NSW with a regional population estimated at over 350 000. As used here, including the northern part of the Central Coast, the population of the region is estimated to be a little more than 450 000. Thus the population criterion in Clause 14 of the NEPM requires at least two monitoring stations in the region.

Intensive EPA monitoring in the region commenced only in the early 1990s with the establishment of 3 monitoring stations, as shown in figure 13. Instruments currently located at each monitoring station are shown in table 11. Focussing on Newcastle and its immediate surrounds, the monitoring locations were selected to capture the higher concentrations of regionally significant pollutants and to be in receptor regions for major emission sources under generally prevailing wind conditions.

TABLE 11: MONITORING IN THE LOWER HUNTER (2000)

Station	Year Est.	ozone	nitrogen oxides	Particles as PM_{10}		Carbon monoxide	sulfur dioxide	lead	met.
				HiVol	TEOM				
Beresfield	1993	✓	✓	✓	✓	✓	✓		✓
Newcastle	1992	✓	✓	✓					✓
Wallsend	1992	✓	✓		✓		✓		✓

Synoptic conditions leading to elevated concentrations of air pollutants are similar to those of Sydney (which is only a hundred kilometres to the south). With a high pressure system in the Tasman, light synoptic winds prevail, allowing the generation of local flows such as katabatic drainage flows and sea breezes. Down-valley drainage flows are generated overnight, with up-valley flow established in the afternoon with the onset of the sea breeze (Hyde et al 1981, Hyde et al 1997). It is these local flows that have the greatest influence on the distribution of pollutants emitted by sources in the region. Relatively small variations in the direction of flows can see alterations to this basic pattern. For example, a more north-easterly component in the sea breeze or gradient wind can see emissions from the Newcastle area advected down to the Central Coast area towards the Sydney airshed. The role of these flows in pollution episodes in the region is also demonstrated by airshed modelling of the Lower Hunter region undertaken as part of the Metropolitan Air Quality Study (Hyde et al 1997).

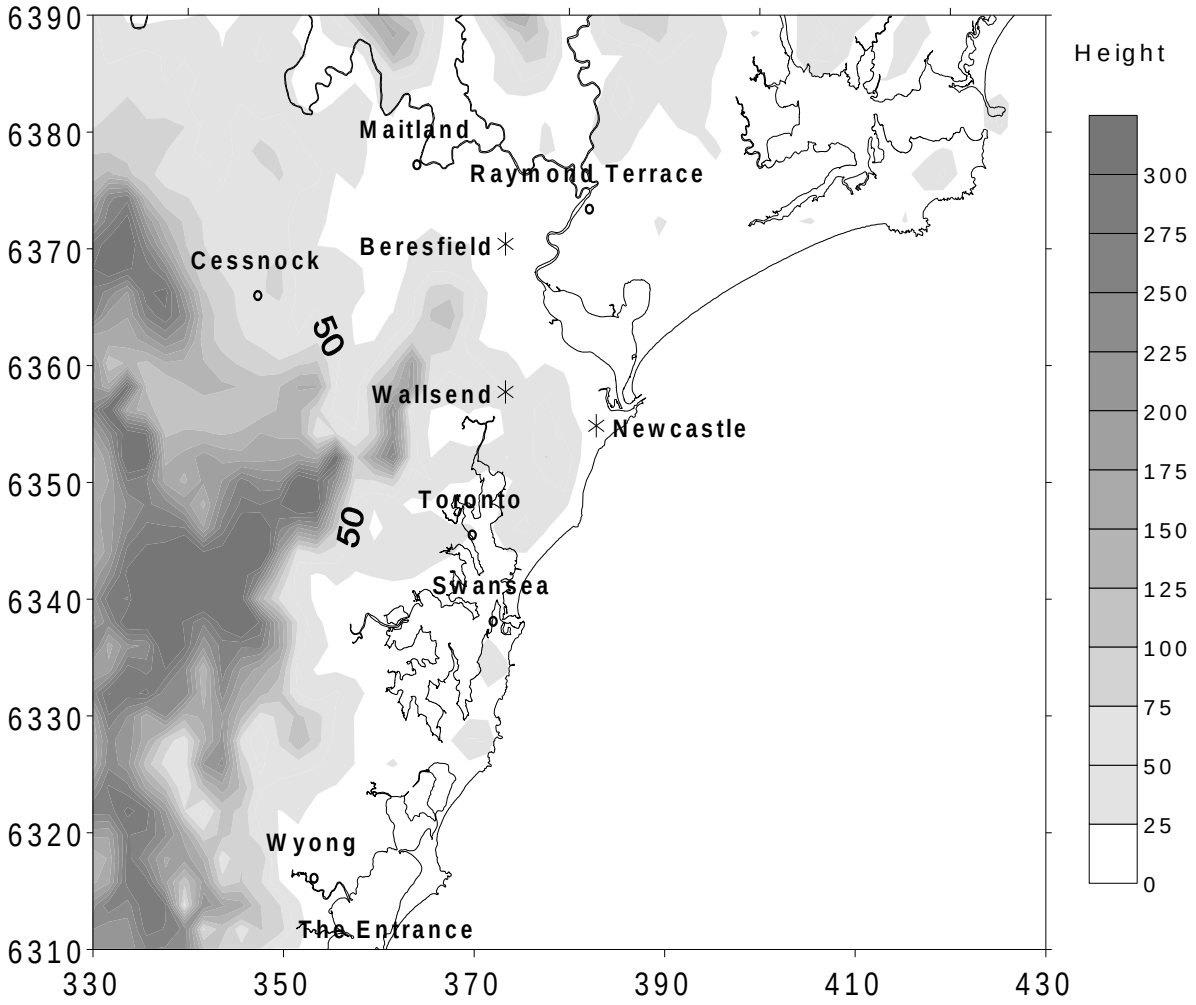


Figure 13: The Lower Hunter Region
Current monitoring stations are indicated by "*".
Shading shows height above sea level (metres).

3.2.2 Overall Air Quality

Carbon Monoxide

Monitoring of carbon monoxide in the Lower Hunter region has been undertaken at Newcastle. The Newcastle station is a regional monitoring station, located in the vicinity of the Newcastle CBD (about 1.5 to 2 kilometres to the west). It is influenced by some of the higher traffic densities in the region, and is thus an upper bound station. Table 12 shows that concentrations at the Newcastle station are substantially below the NEPM standard and never exceed 60% of the standard.

As expected given the monitoring results in the Sydney region (section 3.1), the data satisfy the criteria of PRC Screening Procedure B, table 1 of PRC (2000d). Thus the data would justify reduction of the network from the population-based minimum of two. This also provides a screening argument for other regions with smaller emissions.

TABLE 12: CARBON MONOXIDE CONCENTRATIONS IN THE LOWER HUNTER, 1993-1998

Station	8-hour concentration (ppm)		Number of days exceeding Standard
	maximum	90th percentile	
Newcastle	5.3	1.0	0

Ozone

In the Lower Hunter, there have been exceedences of the ozone standard at both the Newcastle and Wallsend monitoring stations as shown in table 13. These exceedences occur under light northerly sector synoptic winds where precursors are recirculated by a pattern of nocturnal drainage flow followed by an afternoon sea breeze. The Newcastle station captures all the one-hour events occurring in the region.

TABLE 13: LOWER HUNTER OZONE DATA FOR PERIOD 1993-1998

Station	1-hour concentrations (ppm)			Number of days exceeding Standard	
	Maximum	99th percentile	90th percentile	1 hour	4 hour
Newcastle	0.14	0.04	0.03	2	2
Beresfield	0.09	0.04	0.03	0	0
Wallsend	0.13	0.04	0.03	1	3

Nitrogen Dioxide

Concentrations of nitrogen dioxide are consistently below the standard in the Hunter as shown in table 14. Indeed the maximum one-hour concentration in the three years 1996-1998 is 0.06 ppm, less than 65% of the AAQ NEPM standard (0.12). This satisfies the criteria of Screening Procedure B, table 1 of PRC (2000d). Thus other regional centres with lower emissions may be screened using these data.

TABLE 14: NITROGEN DIOXIDE CONCENTRATIONS IN THE LOWER HUNTER, 1996-1998

Station	1 hour concentrations (ppm)			Season of maximum
	maximum	99th percentile	90th percentile	
Newcastle	0.05	0.03	0.02	Spring
Beresfield	0.06	0.03	0.02	Spring
Wallsend	0.06	0.03	0.02	Summer

Particles as PM_{10}

PM_{10} is currently monitored in the region both by TEOM and by high volume sampler (1-day-in-6-cycle). The highest concentrations of PM_{10} (as measured by TEOM) recorded at Beresfield and Wallsend in the Lower Hunter are shown in table 15. Data from high volume samplers in the region are summarised in table 16.

Particle concentrations observed at Beresfield by TEOM are significantly higher than those at Wallsend. No detailed investigation has been undertaken to determine why this station has such a

greater frequency of elevated concentrations. Local primary industry is thought to be an influence. As in the Sydney region, wildfires and hazard reduction burning are a major influence on particulate pollution in the region.

TABLE 15: PM_{10} CONCENTRATIONS IN THE LOWER HUNTER (TEOM), 1996-1998

Station	24 hour concentrations ($\mu g/m^3$)	
	maximum	maximum 6th highest in calender year
Beresfield	101	52
Wallsend	75	38

TABLE 16: PM_{10} CONCENTRATIONS IN THE LOWER HUNTER (hi-vol), 1994-1998

	24 hour concentrations ($\mu g/m^3$)		
	maximum	Number of days greater than standard	Number of unique exceedences
Beresfield	73	1	0
Newcastle	98	8	4
Wallsend	82	11	7

These data show that events at Beresfield are captured by the other two stations.

Sulfur Dioxide

Monitoring for sulfur dioxide is undertaken at Beresfield and Wallsend in the Lower Hunter. As shown in table 17, Wallsend concentrations are generally higher than those at Beresfield, but neither records an exceedence of the one-hour standard. Indeed the maximum hourly concentrations are lower than the daily standard. These data satisfy the criteria of Screening Procedure B, table 1 of PRC (2000d). This would justify reducing the monitoring in this region, and in other regions with lesser emissions.

TABLE 17: SULFUR DIOXIDE DATA IN THE LOWER HUNTER, 1996-1998

Station	Average of monthly maximums	1 hour concentrations (ppm)		Months of valid data over 3-year period[1]
		maximum	2nd highest	
Wallsend	0.05	0.10	0.08	31
Beresfield	0.03	0.04	0.04	25

1 Some stations were not operational until some number of months into 1996

Note that specific industries are required, as condition of licence, to measure sulfur dioxide at twelve locations in the Lower Hunter. These sites are recognised as peak stations under the Standards Australia classification and are generally located in the vicinity of major industrial emission sources. The impact of major sulfur dioxide emitters in these regions can therefore be effectively gauged, yielding data relating to the frequency of elevated ambient sulfur dioxide concentrations. This is outside the AAQ NEPM protocol, but provides important additional air quality information.

Lead

As there is an industrial source of lead in the region[1], screening procedures should not be applied. No monitoring complying with NEPM standard conditions is undertaken in the Lower Hunter at present. Nevertheless, campaign monitoring is scheduled to commence at Wallsend by February 2002. The need for permanent monitoring will be reviewed in light of the results from this campaign monitoring.

3.2.3 Proposed AAQ NEPM Assessment Scheme

The population criterion of section 14(2) of the AAQ NEPM requires at least two monitoring sites in the Lower Hunter region. The region contains two major population centres, Newcastle and Maitland. Current monitoring has focussed on Newcastle and its environs. NSW EPA plans to establish a trend site in the Maitland area by January 2003. Until this site is established, data from the existing stations at Wallsend and Beresfield will be reported, thus these are campaign monitoring stations. Beresfield will report PM_{10}, while Wallsend will report ozone, nitrogen dioxide, sulfur dioxide, and lead. Together, the trend stations at Newcastle and Maitland will characterise the general air quality to which the urban population of the Lower Hunter is exposed and will capture any pollution events that may occur. The monitoring network for the Lower Hunter Region is shown in figure 14 and summarised in table 18 which notes the parameters to be reported from each station.

TABLE 18 LOWER HUNTER REGION AAQ NEPM MONITORING NETWORK

Station	Station Type[1]	Number of parameters	ozone	nitrogen dioxide	PM10	carbon monoxide	sulfur dioxide	lead
Newcastle	T	5	🗐	🗐	🗐	🗐	🗐	
Maitland[2]	T	5	🗐	🗐	🗐		🗐	🗐
Beresfield[3]	C	1			🗐			
Wallsend[3]	C	4	🗐	🗐			🗐	🗐

[1] P denotes performance; T denotes trend, C denotes campaign.
[2] The Maitland station is scheduled to begin operation in January 2003.
[3] Data from Beresfield and Wallsend will be reported at least until the Maitland station is established.

[1] The source is located to the north-west of Lake Macquarie and is thus within the region as defined in this plan.

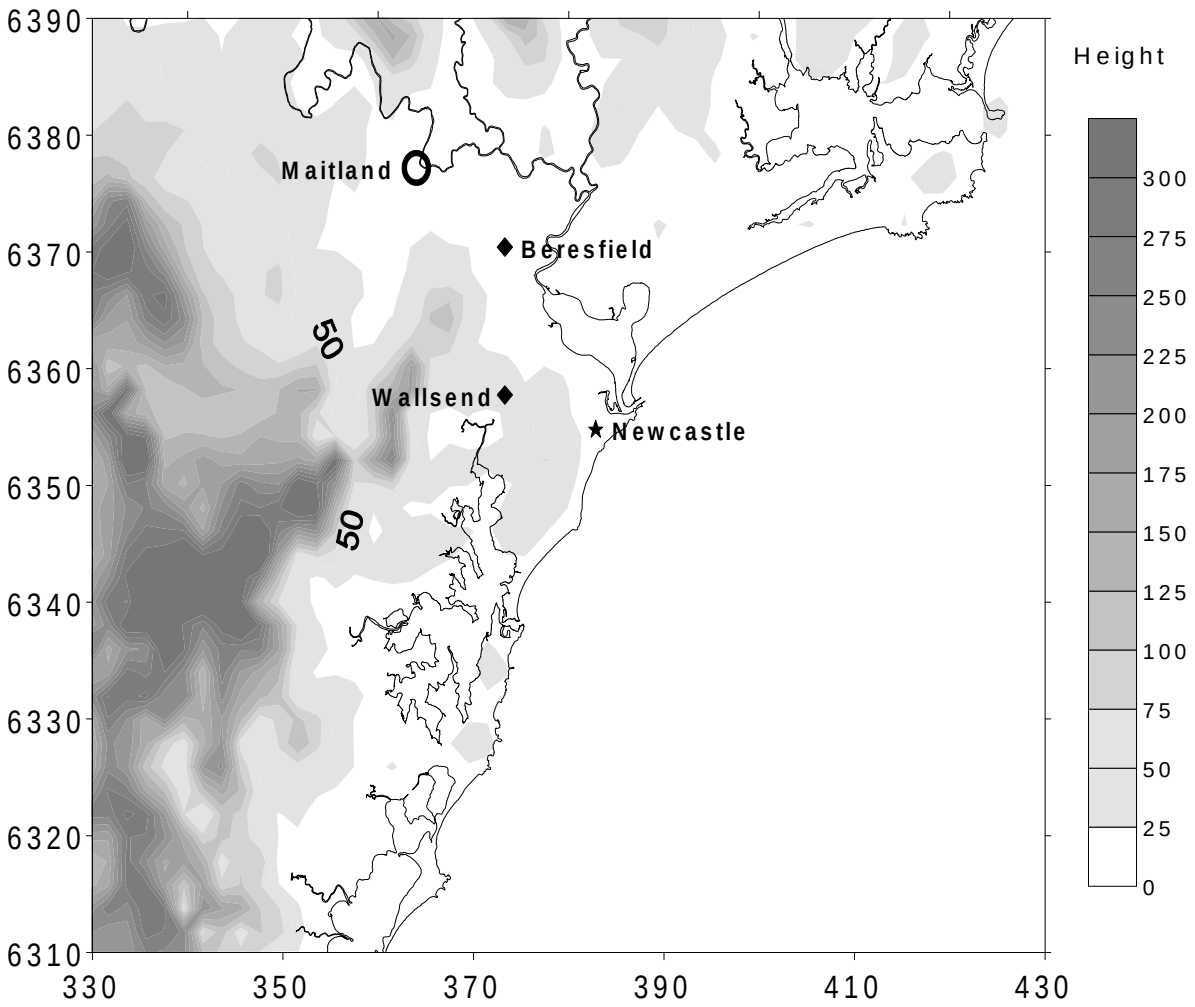


Figure 14: AAQ NEPM Monitoring in the Lower Hunter Region

* denotes trend stations; ♦ denotes performance stations

Note that the Maitland site is yet to be established.

Wallsend and Beresfield will be reported in the interim.

3.3 The Illawarra Region

3.3.1 Description of the Region

The Illawarra is the fourth major population centre of NSW. It is located on a thin coastal strip with a steep escarpment to the west. The width of the coastal strip increases from north to south until it terminates in a ridge of hills running from the escarpment to the sea, figure 15. As the significant topographic feature, the escarpment is a major influence on meteorology and hence on air quality in the region. It can steer or deflect winds, changing the apparent direction at the surface. It can also lead to the decoupling of winds above and below the escarpment. As a result an inversion can form at the top of the escarpment, limiting the dispersion of pollutants in the Illawarra region (Hyde et al, 1997).

The region is also strongly influenced by sea breezes. In the north of the region these tend to be steered by the topography to become north-north-easterly to north-easterly in direction. In the south of the region sea breezes tend to be more north-easterly to easterly. Return-flow has been observed above the sea breeze in the Illawarra region (Hyde and Prescott, 1984). Westerly drainage flows have been observed to develop on the region overnight (Hyde and Prescott, 1984), and will also have some influence on air quality.

The Illawarra region is only 80 km to the south of the Sydney region. On occasion pollutants will be transported between the two, particularly from Sydney to the Illawarra. It could be argued that the two form one single airshed. However, each has been dealt with separately here since doing so has no impact on the analysis presented or the number of monitoring stations that would result.

The Illawarra region has a population of 220 000. The population criterion in Clause 14 of the NEPM suggests at least one monitoring station in the region. Major sources in the Illawarra, apart from motor vehicle traffic, are iron and steel production and associated coke making, and primary metallurgical works.

The EPA has maintained a monitoring station at Albion Park since the early 1980s and now operates a network of four comprehensive stations and an additional three locations where total suspended particulates and lead are determined. The distribution of instruments is shown in table 19, locations being shown in figure 15.

TABLE 19: MONITORING IN THE ILLAWARRA AIRSHED (2000)

Station	Year Est.	ozone	Nitrogen oxides	Particles as PM_{10}		carbon monoxide	sulfur dioxide	lead	met.
				HiVol	TEOM				
Albion Park	1980	✓	✓	✓	✓		✓		✓
Kembla Grange	1994	✓	✓	✓					✓
Port Kembla (1)	1970							✓	
Port Kembla (2)	1970							✓	
Port Kembla (3)	1980							✓	
Warrawong	1993	✓	✓	✓	✓		✓		✓
Wollongong (north)	1992	✓	✓	✓	✓	✓	✓		✓

1. Port Kembla Fire Station (old site)
2. Electricity Substation
3. St Patrick's Convent

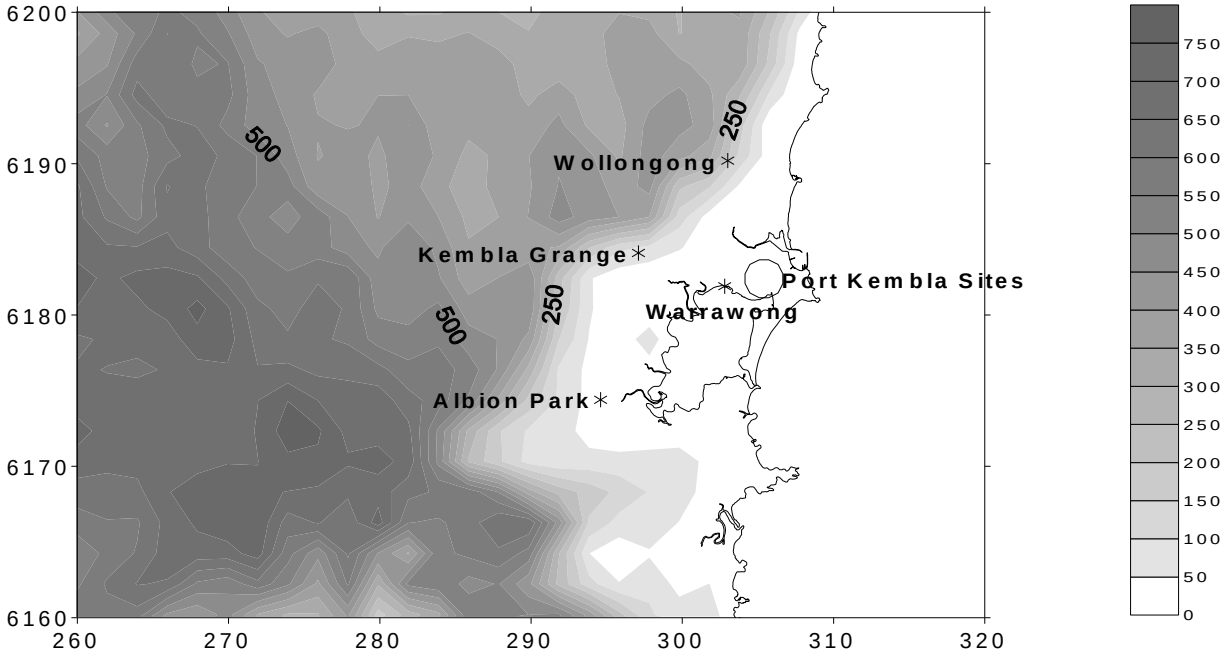


Figure 15: The Illawarra Region.
Current monitoring stations are indicated by "∗".
The circle encloses the area of the three Port Kembla stations.
Shading shows height above sea level (metres).

3.3.2 Overall Air Quality

Carbon Monoxide
Carbon monoxide is currently measured at one station in the Illawarra, Wollongong. Concentrations in the region are expected to follow the pattern established in Sydney and reflect local vehicle usage densities. Table 20 summarises the data collected from the Wollongong station in the period 1993-1998.

TABLE 20: CARBON MONOXIDE IN THE ILLAWARRA, 1993-1998

Station	8-hour concentration (ppm)		Number of days exceeding Standard
	maximum	90th percentile	
Wollongong	4.93	1.20	0

As expected based on data from the Sydney and Lower Hunter regions, concentrations of carbon monoxide in the region are low. The maximum concentration in the six years 1993-1998 is 55% of the goal, less than the criterion (60%) of Screening Procedure B, table 1 of PRC (2000d). However, to provide ongoing information on concentrations of this pollutant, monitoring at the Wollongong station will continue. These data may be used to provide screening arguments in other regions with lesser emissions.

Ozone
Ozone in the Illawarra region can occur as a result of photochemical smog produced from local emissions or from smog or precursors transported down the coast from the Sydney region. It appears that most ozone events in the Illawarra occur as a result of the combined effect of these two factors. The sea breeze, generally north-easterly in direction, is the dominant meteorological influence on elevated concentrations of ozone in the region.

Emissions of NO_x may reduce ozone concentrations on a local scale close to the source by titration. However, at some distance downwind this NO_x can produce more ozone. On many event days this potential is realised by the time the plume arrives at the Albion Park station.

Based on data from 1993 to 1998, table 21, Albion Park records the greatest number of exceedences of the NEPM standard for both four-hour and one-hour ozone concentration. Kembla Grange is the next most significant for number of events. Both of these stations record unique events, and between them they record nearly all events in the region. Albion Park is the station furthest downwind of sources and thus provides additional information about the development of photochemical pollution from emissions in the region. It also has a valuable long-term record of ozone levels in the Illawarra.

TABLE 21: OZONE CONCENTRATIONS IN THE ILLAWARRA, 1993 - 1998

Station	1-hour concentrations (ppm)		Daily maximum		No. days exceeding Standard	
	Maximum	second maximum	99th percentile	90th percentile	1 hour	4 hour
Wollongong	0.12	0.12	0.08	0.05	9	9
Albion Park	0.14	0.14	0.11	0.05	10	13
Kembla Grange	0.14	0.13	0.09	0.04	8	12
Warrawong	0.13	0.12	0.08	0.04	4	5

To capture the range of ozone events in the Illawarra, at least Albion Park and Kembla Grange are required. Monitoring will also occur at Wollongong as a trend station.

Nitrogen dioxide

Nitrogen dioxide is currently monitored at Wollongong, Warrawong, Albion Park and Kembla Grange. Summary data are presented in table 22.

Concentrations of nitrogen dioxide in the Illawarra can reach 50 to 60% of the NEPM standard. These concentrations have been recorded at all four stations, but are associated with different conditions. As in Sydney, a detailed understanding of the mechanisms leading to the occurrence of nitrogen dioxide in the Illawarra has not yet been developed. Episodes can occur throughout the year, with those in the warmer months generally associated with photochemical smog production and those in the cooler months related to more localised poor dispersion conditions. Both local NO_x sources and transport down the coast from Sydney can contribute to nitrogen dioxide in the Illawarra.

Note that the observations presented in table 22 satisfy the criteria of Screening Procedure B, table 1 of PRC (2000d). Thus these data would justify reducing monitoring of nitrogen dioxide in the region below the population-based minimum of one site and also in other regions with lesser emissions.

TABLE 22: NITROGEN DIOXIDE CONCENTRATIONS IN THE ILLAWARRA, 1996-1998

Station	1 hour concentrations (ppm)			Season of Maximum
	Maximum	99th percentile	90th percentile	
Wollongong	0.08	0.03	0.03	Summer
Warrawong	0.06	0.03	0.02	Spring
Albion Park	0.08	0.03	0.02	Spring
Kembla Grange*	0.07	0.02	0.02	Autumn

*installed 1994

While there is little difference in the maximum concentrations of nitrogen dioxide observed, the Albion Park station would appear to have the potential for the highest maximum being furthest downwind on episode days. Monitoring will also occur at Wollongong as a trend station.

Particles as PM_{10}

As in the Sydney region, the highest observed concentrations of PM_{10} have been associated with wildfires, hazard reduction burning and dust events. Similarly there is considerable variation in the spatial distribution of PM_{10} from event to event. This is due to the variation in the location of the sources (fires) and in the meteorological factors affecting the dispersion and transport of the particles.

TEOM data show that for the period 1996 to 1998, the highest concentrations of PM_{10} were observed at the Wollongong station, table 23.

TABLE 23: PM_{10} IN THE ILLAWARRA, 1996-1998

(by TEOM)

Station	24 hour concentrations ($\mu g/m^3$)	
	maximum	Maximum 6th highest in a calendar year
Wollongong	70	45
Albion Park	64	45
Warrawong	52	38

As there are no TEOM data from the Kembla Grange station, reference was also made to PM_{10} data by high-volume sampler operated on a 1-day-in-6 cycle. These data show that the highest concentrations of PM_{10} occur at Kembla Grange. No exceedences of the goal are reported from the TEOM data in the Illawarra. However, the high-volume sampler data suggest that monitoring at Kembla Grange is needed as it may experience the highest concentrations in the region. Monitoring will be undertaken at Albion Park. Kembla Grange is nominated as an upper bound station and Wollongong is nominated as the trend station.

Sulfur dioxide

There are a number of potentially large emitters of sulfur dioxide in the Illawarra, concentrated in the Port Kembla area. The EPA measures sulfur dioxide at three locations in the Illawarra: Albion Park, Wollongong, and Warrawong. Warrawong, being close to Port Kembla, measures the highest concentrations in the network, table 24.

Industry monitoring for sulfur dioxide is also undertaken at ten sites in this region.

TABLE 24: SULFUR DIOXIDE IN THE ILLAWARRA, 1996-1998

		Sulfur Dioxide Concentration (ppm)		
		Warrawong	**Albion Park**	**Wollongong**
Average of monthly maxima		0.03	0.02	0.02
1-hour concentrations	Highest	0.06	0.06	0.04
	2nd highest	0.05	0.04	0.03
Annual Average	1996	-	-	0.002
	1997	-	0.001	0.001
	1998	0.001	0.001	0.002
Months of valid data over 3 year period[1]		12[2]	34	29

1 Some stations were not operational until some number of months into 1996
2 Monitoring did not commence until January 1998

While the data for 1996-1998 shows low concentrations, an increase in emissions since that time is expected to increase ambient concentrations. Monitoring will be undertaken at Warrawong to provide information on upper bound concentrations for this pollutant.

Lead

The EPA currently operates three sites in the Illawarra where lead and total suspended particulate matter alone are measured. These have been established for many years as an independent check on emissions from the operation of a particular point source. One of these sites is located close to the premise's boundary, and the other two sites are located about 1 kilometre and 2.5 kilometres from the point source respectively.

Data from these stations from 1994 (when the point source was operational) are presented in table 25. As would be expected, the highest values observed have been at the boundary site. It is considered that all these sites are peak sites according to the Australian Standard and are hence not representative of community exposure for the purposes of the NEPM.

As none of these sites is suitable, campaign monitoring of lead will be undertaken at Warrawong. This is expected to provide an estimate of the upper bound concentration to which the population of the region is exposed.

TABLE 25: LEAD IN THE ILLAWARRA, 1994

Site	Annual average lead ($\mu g/m^3$)
Boundary site	1.11
~1km from source (St Patrick's)	0.49
~2.5km from source	0.15

3.3.3 Proposed AAQ NEPM Assessment Scheme

The presence of industrial sources in the region, the occurrence of transport from Sydney, and the complexity of the region together result in a need for a greater monitoring effort than that indicated purely on the basis of population. Accordingly, the general air quality to which the urban population is exposed will be characterised by monitoring all pollutants of interest at the trend station at Wollongong and the performance station at Albion Park. These stations will also pick up the majority of pollution events. Two additional stations are nominated to represent the local conditions at Kembla Grange and Warrawong.

The AAQ NEPM monitoring network for the Illawarra region is shown in figure 16 and summarised in table 26 which lists the parameters at each station.

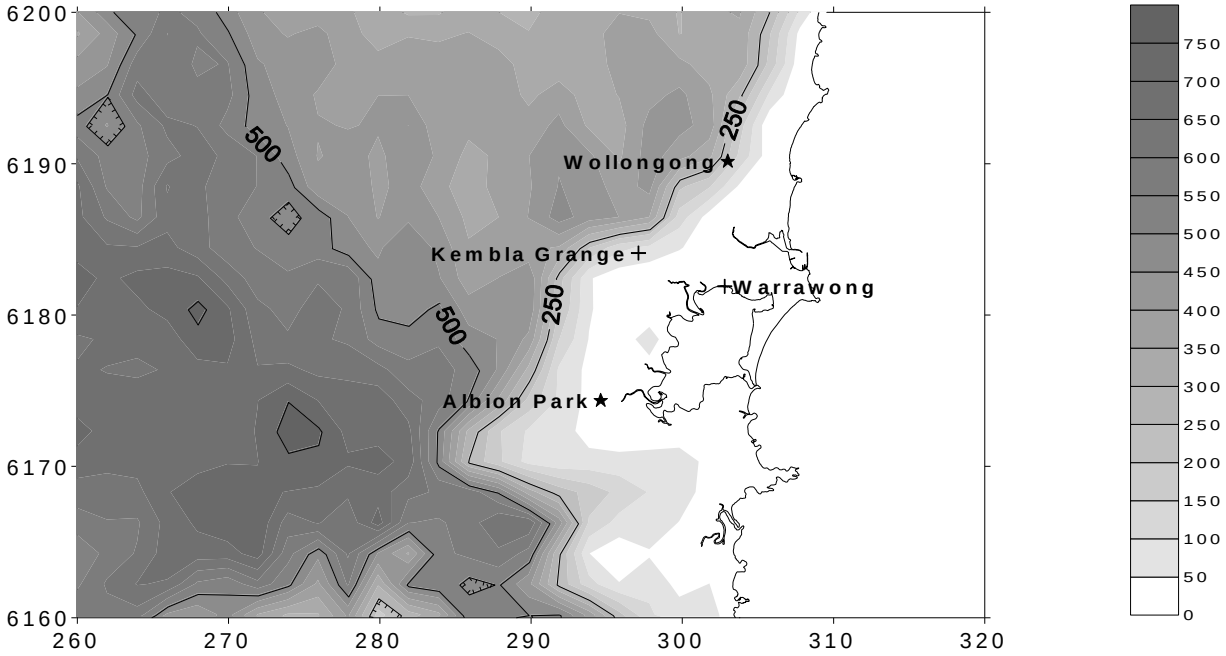


Figure 16: AAQ NEPM Monitoring in the Illawarra Region

TABLE 26: ILLAWARRA REGION AAQ NEPM MONITORING NETWORK

Station	Station Type[1]	Number of parameters	ozone	nitrogen dioxide	PM10	carbon monoxide	sulfur dioxide	lead
Albion Park	P	4	🗐	🗐	🗐		🗐	
Kembla Grange	P	2	🗐		🗐			
Warrawong	P	2					🗐	🗐 (C)
Wollongong	T	5	🗐	🗐	🗐	🗐	🗐	

[1] P denotes performance; T denotes trend, C denotes campaign.

3.4 Tamworth

3.4.1 Description of the Region

Tamworth is located some 300 km north of Sydney in a region called the north-west slopes and on the local flood plain of the Peel River. It lies within its own airshed, with no significant other urban centres nearby. The city has hills to the north and west, figure 17. There are no significant industrial sources of pollution in the region. The relatively cold winters and prevalence of wood heating leads to a potential for exceedences of the NEPM standard for PM_{10}. The population of the urban centre is 32 000, and thus at least one monitoring station is required under 14(1) of the AAQ NEPM.

There has been no monitoring of AAQ NEPM parameters in the Tamworth region.

3.4.2 Proposed AAQ NEPM Assessment Scheme

Clause 14(2) of NEPM allows fewer performance monitoring stations where it can be demonstrated that *"pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure"*. PRC (2000d) sets out criteria which when met provide a basis for determining that there is a reasonable expectation that pollutant concentrations are consistently lower than the standards. These screening procedures will be applied.

The urban centre of Tamworth is small, less than six kilometres radius. Because the production of ozone by photochemical processes takes some hours, it is unlikely that emissions from the region could be retained for a sufficient length of time to generate significantly elevated concentrations. This reasoning is offered in lieu of screening arguments as there are currently no ozone data from regional centres in New South Wales from which to apply the criteria in PRC (2000d). The need for monitoring will be reviewed in light of the results of campaign monitoring at Bathurst, and the results of the CSIRO TAPM modelling consultancy.

Monitoring data from the Sydney CBD site demonstrates that CO arising from motor vehicles in Tamworth will be low and the screening criteria are satisfied, section 3.1.2. There may be potential for elevated concentrations of CO arising from the use of solid fuels. No monitoring of CO is proposed in Tamworth at this stage. NSW will await the outcome of monitoring of CO in other regional centres such as Kalgoorlie (2001) and Toowoomba (2002) before making a final decision.

Data from the Sydney region allows screening of sulfur dioxide and lead, section 3.1.2. In addition, monitoring data from Newcastle, section 3.2.2, allow screening of nitrogen dioxide. Thus monitoring of these three parameters is not required in this region. There is currently insufficient data within New South Wales to allow screening for ozone.

Tamworth is one of several regional centres located on the tablelands where smoke from wood fires may be of concern during winter. As there is the potential for exceedences of the NEPM goal, NSW EPA has begun campaign monitoring in Tamworth.

The monitoring station is centrally located approximately two kilometres to the south of the city centre and within the urban area. The site location is relatively low lying and will receive emissions of wood smoke in overnight cold-air drainage flows towards the Peel River.

3.5 Bathurst

3.5.1 Description of the Region

Bathurst is located some 150 km west of Sydney in the Central Tablelands and on the banks of the Macquarie River, with higher ground rising to the south-west of the city centre, figure 18. There are no significant industrial sources of air pollution in the region. The relatively cold winters and prevalence of wood heating leads to a potential for exceedences of the NEPM standard for PM_{10}. The urban centre has a population of 26 000 and thus requires at least one station according to clause 14(1) of the AAQ NEPM.

There has been no monitoring of AAQ NEPM parameters in Bathurst.

3.5.2 Proposed AAQ NEPM Assessment Scheme

Clause 14(2) of NEPM allows fewer performance monitoring stations where it can be demonstrated that *"pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure"*. PRC (2000d) sets out criteria which when met provide a basis for determining that there is a reasonable expectation that pollutant concentrations are consistently lower than the standards. These screening procedures will be applied.

Monitoring data from the Sydney CBD site demonstrates that CO arising from motor vehicles in Bathurst will be low and the screening criteria are satisfied, section 3.1.2. There may be potential for elevated concentrations of CO arising from the use of solid fuels. No monitoring of CO is proposed in Bathurst at this stage. NSW will await the outcome of monitoring of CO in other regional centres such as Kalgoorlie (2001) and Toowoomba (2002) before making a final decision.

Data from the Sydney region allows screening of sulfur dioxide and lead, section 3.1.2. In addition, monitoring data from Newcastle, section 3.2.2, allow screening of nitrogen dioxide. Thus monitoring of these three parameters is not required in this region.

To further develop screening arguments for ozone in regional centres, NSW has commenced monitoring of ozone in Bathurst on a campaign basis. The need for on-going monitoring will be assessed in light of the results of this monitoring and the outcomes of the consultancy to develop additional modelling tools (TAPM).

Bathurst is one of several regional centres located on the tablelands where smoke from wood fires may be of concern during winter. As there is the potential for exceedences of the NEPM goal, NSW EPA has begun campaign monitoring in Bathurst.

The monitoring station is located to the north west of the city centre. It is in a relatively low-lying area where emissions from a substantial part of the City would be transported by katabatic air flows and by cold air drainage along the Macquarie River. It is in a position where it is also likely to receive emissions transported across the City by prevailing southerly and westerly winds.

3.6 Wagga Wagga

3.6.1 Description of the Region

Wagga Wagga is located some 400 km to the south-west of Sydney in the region called the south-west slopes and the Murrumbidgee River. There are no other significant urban centres in the region, figure 19. There are no significant industrial sources of air pollution in the region. The relatively cold winters and prevalence of wood heating leads to a potential for exceedences of the NEPM standard for PM_{10}. The urban centre has a population of 43 000 and thus requires at least one monitoring station under 14(1) of the AAQ NEPM.

No monitoring of AAQ NEPM parameters has been undertaken in Wagga Wagga.

3.6.2 Proposed AAQ NEPM Assessment Scheme

Clause 14(2) of NEPM allows fewer performance monitoring stations where it can be demonstrated that *"pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure"*. PRC (2000d) sets out criteria which when met provide a basis for determining that there is a reasonable expectation that pollutant concentrations are consistently lower than the standards. These screening procedures will be applied.

The urban centre of Wagga Wagga is small, less than six kilometres radius. Because the production of ozone by photochemical processes takes some hours, it is unlikely that emissions from the region could be retained for a sufficient length of time to generate significantly elevated concentrations. This reasoning is offered in lieu of screening arguments as there are currently no ozone data from regional centres in New South Wales from which to apply the criteria in PRC (2000d). The need for monitoring will be reviewed in light of the results of campaign monitoring at Bathurst, and the results of the CSIRO TAPM modelling consultancy.

Monitoring data from the Sydney CBD site demonstrates that CO arising from motor vehicles in Wagga Wagga will be low and the screening criteria are satisfied, section 3.1.2. There may be potential for elevated concentrations of CO arising from the use of solid fuels. No monitoring of CO is proposed in Wagga Wagga at this stage. NSW will await the outcome of monitoring of CO in other regional centres such as Kalgoorlie (2001) and Toowoomba (2002) before making a final decision.

Data from the Sydney region allows screening of sulfur dioxide and lead, section 3.1.2. In addition, monitoring data from Newcastle, section 3.2.2, allow screening of nitrogen dioxide. Thus monitoring of these three parameters is not required in this region. There is currently insufficient data within New South Wales to allow screening for ozone.

Wagga Wagga is one of several regional centres located on the tablelands where smoke from wood fires may be of concern during winter. As there is the potential for exceedences of the NEPM goal, NSW EPA has begun campaign monitoring in Wagga Wagga.

The monitoring station is located close to the centre of the city, on the northern boundary of the central business district. Emissions of wood smoke are likely to be transported to this station from a broad arc of the city, ranging from east, through south, to the west. The station is sufficiently close to the Murrumbidgee River to experience cold air drainage associated with it as it flows across the northern boundary of Wagga Wagga

3.7 Albury

3.7.1 Description of the Region

Albury (and its Victorian counterpart Wodonga) are located some 450 km to the south-south-west of Sydney straddling the Murray River. Albury itself is bounded by elevated ground to the north, east and south with the Murray River on the southern boundary between the city and the higher ground. The populated area extends into the higher ground rather than to the west where there is less elevation, figure 20. There are few significant industrial sources of air pollution in the region. The relatively cold winters and prevalence of wood heating leads to a potential for exceedences of the NEPM standard for PM_{10}. The population of Albury is 41 000 and thus at least one monitoring station is required under clause 14(1) of the AAQ NEPM.

No monitoring of AAQ NEPM parameters has been undertaken in Albury.

3.7.2 Proposed AAQ NEPM Assessment Scheme

Clause 14(2) of NEPM allows fewer performance monitoring stations where it can be demonstrated that *"pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure"*. PRC (2000d) sets out criteria which when met provide a basis for determining that there is a reasonable expectation that pollutant concentrations are consistently lower than the standards. These screening procedures will be applied.

The urban centre of Albury is small, less than six kilometres radius. Because the production of ozone by photochemical processes takes some hours, it is unlikely that emissions from the region could be retained for a sufficient length of time to generate significantly elevated concentrations. This reasoning is offered in lieu of screening arguments as there are currently no ozone data from regional centres in New South Wales from which to apply the criteria in PRC (2000d). The need for monitoring will be reviewed in light of the results of campaign monitoring at Bathurst, and the results of the CSIRO TAPM modelling consultancy.

Monitoring data from the Sydney CBD site demonstrates that CO arising from motor vehicles in Albury will be low and the screening criteria are satisfied, section 3.1.2. There may be potential for elevated concentrations of CO arising from the use of solid fuels. No monitoring of CO is proposed in Albury at this stage. NSW will await the outcome of monitoring of CO in other regional centres such as Kalgoorlie (2001) and Toowoomba (2002) before making a final decision.

Data from the Sydney region allows screening of sulfur dioxide and lead, section 3.1.2. In addition, monitoring data from Newcastle, section 3.2.2, allow screening of nitrogen dioxide. Thus monitoring of these three parameters is not required in this region. There is currently insufficient data within New South Wales to allow screening for ozone.

Albury is one of several regional centres located on the tablelands where smoke from wood fires may be of concern during winter. As there is the potential for exceedences of the NEPM goal, NSW EPA has begun campaign monitoring in Albury as one of four such regional centres.

The monitoring station is approximately 3 km to the north-east of the city centre and in a relatively low-lying area where cold air drainage flows will transport emissions from a large portion of the residential area of the city. The station is also well placed to receive wood smoke emissions under prevailing westerly winds.

3.8 Lismore

3.8.1 Description of the Region

Lismore is on the far north coast of New South Wales, at the foot of the range and some 33 kilometres from the coast, figure 21. For the purpose of this plan it has been designated a Type 1 airshed. While the mild winters make less likely significant pollution from wood heating, agricultural burning is a potential source. The population of the urban centre is 28 000 and thus at least one monitoring station is required under clause 14(1) of the AAQ NEPM.

No monitoring has been undertaken in Lismore.

3.8.2 Proposed AAQ NEPM Assessment Scheme

Clause 14(2) of NEPM allows fewer performance monitoring stations where it can be demonstrated that *"pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure"*. PRC (2000d) sets out criteria which when met provide a basis for determining that there is a reasonable expectation that pollutant concentrations are consistently lower than the standards. These screening procedures will be applied.

The urban centre of Lismore is small, less than six kilometres radius. Because the production of ozone by photochemical processes takes some hours, it is unlikely that emissions from the region could be retained for a sufficient length of time to generate significantly elevated concentrations. This reasoning is offered in lieu of screening arguments as there are currently no ozone data from regional centres in New South Wales from which to apply the criteria in PRC (2000d). The need for monitoring will be reviewed in light of the results of campaign monitoring at Bathurst, and the results of the CSIRO TAPM modelling consultancy.

Monitoring data from the Sydney CBD site demonstrates that CO arising from motor vehicles in Lismore will be low and the screening criteria are satisfied, section 3.1.2. There may be potential for elevated concentrations of CO arising from the use of solid fuels. No monitoring of CO is proposed in Lismore at this stage. NSW will await the outcome of monitoring of CO in other regional centres such as Kalgoorlie (2001) and Toowoomba (2002) before making a final decision.

Data from the Sydney region allows screening of sulfur dioxide and lead, section 3.1.2. In addition, monitoring data from Newcastle, section 3.2.2, allow screening of nitrogen dioxide. Thus monitoring of these three parameters is not required in this region. There is currently insufficient data within New South Wales to allow screening for ozone.

Lismore is located on the north coast of New South Wales and experiences mild winters. Agricultural burning may generate elevated concentrations of PM_{10}.

Lismore is provisionally classified as Type 1. Campaign monitoring of PM_{10} is scheduled to commence in January 2004.

3.9 Orange

3.9.1 Description of the Region

Orange is a regional centre in the Central Tablelands at the foot of Mt Canobolas, figure 22. It experiences cold winters and wood burning is prevalent. The population of the city is 31 000, thus at least one monitoring station is required.

3.9.2 Overall Air Quality

Limited campaign monitoring of particles has been undertaken in Orange using a nephelometer. This technique reported elevated concentrations in the cooler months. However, it is not straightforward to equate these measurements to concentrations of PM_{10}. These data will be interpreted using the results from regional monitoring of co-located nephelometer and TEOM instruments.

3.9.3 Proposed AAQ NEPM Assessment Scheme

Clause 14(2) of NEPM allows fewer performance monitoring stations where it can be demonstrated that *"pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure"*. PRC (2000d) sets out criteria which when met provide a basis for determining that there is a reasonable expectation that pollutant concentrations are consistently lower than the standards. These screening procedures will be applied.

The urban centre of Orange is small, less than six kilometres radius. Because the production of ozone by photochemical processes takes some hours, it is unlikely that emissions from the region could be retained for a sufficient length of time to generate significantly elevated concentrations. This reasoning is offered in lieu of screening arguments as there are currently no ozone data from regional centres in New South Wales from which to apply the criteria in PRC (2000d). The need for monitoring will be reviewed in light of the results of campaign monitoring at Bathurst, and the results of the CSIRO TAPM modelling consultancy.

Monitoring data from the Sydney CBD site demonstrates that CO arising from motor vehicles in Orange will be low and the screening criteria are satisfied, section 3.1.2. There may be potential for elevated concentrations of CO arising from the use of solid fuels. No monitoring of CO is proposed in Orange at this stage. NSW will await the outcome of monitoring of CO in other regional centres such as Kalgoorlie (2001) and Toowoomba (2002) before making a final decision.

Data from the Sydney region allows screening of sulfur dioxide and lead, section 3.1.2. In addition, monitoring data from Newcastle, section 3.2.2, allow screening of nitrogen dioxide. Thus monitoring of these three parameters is not required in this region. There is currently insufficient data within New South Wales to allow screening for ozone.

Campaign monitoring of PM_{10} is scheduled to commence in January 2004.

3.10 Dubbo

3.10.1 Description of the Region

Dubbo is a large regional centre in the Central Tablelands, sited near the Macquarie River, figure 22. The prevalence of wood heating during the relatively cold winter makes possible elevated concentrations of PM_{10}. The population of the centre is 30 000 and thus at least one monitoring station is required under 14(1) of the AAQ NEPM.

There has been no monitoring of AAQ NEPM parameters in Dubbo.

3.10.2 Proposed AAQ NEPM Assessment Scheme

Clause 14(2) of NEPM allows fewer performance monitoring stations where it can be demonstrated that *"pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure"*. PRC (2000d) sets out criteria which when met provide a basis for determining that there is a reasonable expectation that pollutant concentrations are consistently lower than the standards. These screening procedures will be applied.

The urban centre of Dubbo is small, less than six kilometres radius. Because the production of ozone by photochemical processes takes some hours, it is unlikely that emissions from the region could be retained for a sufficient length of time to generate significantly elevated concentrations. This reasoning is offered in lieu of screening arguments as there are currently no ozone data from regional centres in New South Wales from which to apply the criteria in PRC (2000d). The need for monitoring will be reviewed in light of the results of campaign monitoring at Bathurst, and the results of the CSIRO TAPM modelling consultancy.

Monitoring data from the Sydney CBD site demonstrates that CO arising from motor vehicles in Dubbo will be low and the screening criteria are satisfied, section 3.1.2. There may be potential for elevated concentrations of CO arising from the use of solid fuels. No monitoring of CO is proposed in Dubbo at this stage. NSW will await the outcome of monitoring of CO in other regional centres such as Kalgoorlie (2001) and Toowoomba (2002) before making a final decision.

Data from the Sydney region allows screening of sulfur dioxide and lead, section 3.1.2. In addition, monitoring data from Newcastle, section 3.2.2, allow screening of nitrogen dioxide. Thus monitoring of these three parameters is not required in this region. There is currently insufficient data within New South Wales to allow screening for ozone.

Dubbo is one of a number of regional centres in the tablelands with the potential for elevated concentrations of PM_{10} in the colder months. Campaign monitoring of PM_{10} is scheduled to commence in January 2004.

3.11 Queanbeyan

3.11.1 Description of the Region

Queanbeyan is a satellite town of Canberra, and lies within the Canberra airshed. It is on the border between New South Wales and the Australian Capital Territory. The population of Queanbeyan is 26 000 and thus at least one monitoring station is required under 14(1) of the AAQ NEPM.

There has been no monitoring of AAQ NEPM parameters in Queanbeyan. Data from nearby Canberra are presented in the Australian Capital Territory monitoring plan.

3.11.2 Proposed AAQ NEPM Assessment Scheme

Clause 14(2) of NEPM allows fewer performance monitoring stations where it can be demonstrated that *"pollutant levels are reasonably expected to be consistently lower than the standards mentioned in this Measure"*. PRC (2000d) sets out criteria which when met provide a basis for determining that there is a reasonable expectation that pollutant concentrations are consistently lower than the standards. These screening procedures will be applied.

The urban centre of Queanbeyan is small, less than six kilometres radius. Because the production of ozone by photochemical processes takes some hours, it is unlikely that emissions from the region could be retained for a sufficient length of time to generate significantly elevated concentrations. However, as Queanbeyan lies within the Canberra airshed, it is possible that elevated concentrations would occur in part due to emissions in Canberra. . The Australian Capital Territory intends to undertake monitoring of ozone within the Canberra airshed. NSW EPA believes that this monitoring will provide an upper estimate of concentrations in Queanbeyan, and will use this data to report on Queanbeyan.

Monitoring data from the Sydney CBD site demonstrates that CO arising from motor vehicles in Queanbeyan will be low and the screening criteria are satisfied, section 3.1.2. There may be potential for elevated concentrations of CO arising from the use of solid fuels. No monitoring of CO is proposed in Queanbeyan at this stage. NSW will await the outcome of monitoring of CO in Canberra and other regional centres such as Kalgoorlie (2001) and Toowoomba (2002) before making a final decision.

Data from the Sydney region allows screening of sulfur dioxide and lead, section 3.1.2. In addition, monitoring data from Newcastle, section 3.2.2, allow screening of nitrogen dioxide. Thus monitoring of these three parameters is not required in this region. There is currently insufficient data within New South Wales to allow screening for ozone.

The Australian Capital Territory intends to undertake monitoring of PM_{10} within the Canberra airshed. NSW EPA believes that this monitoring will provide an upper estimate of concentrations in Queanbeyan, and will use this data to report on Queanbeyan.

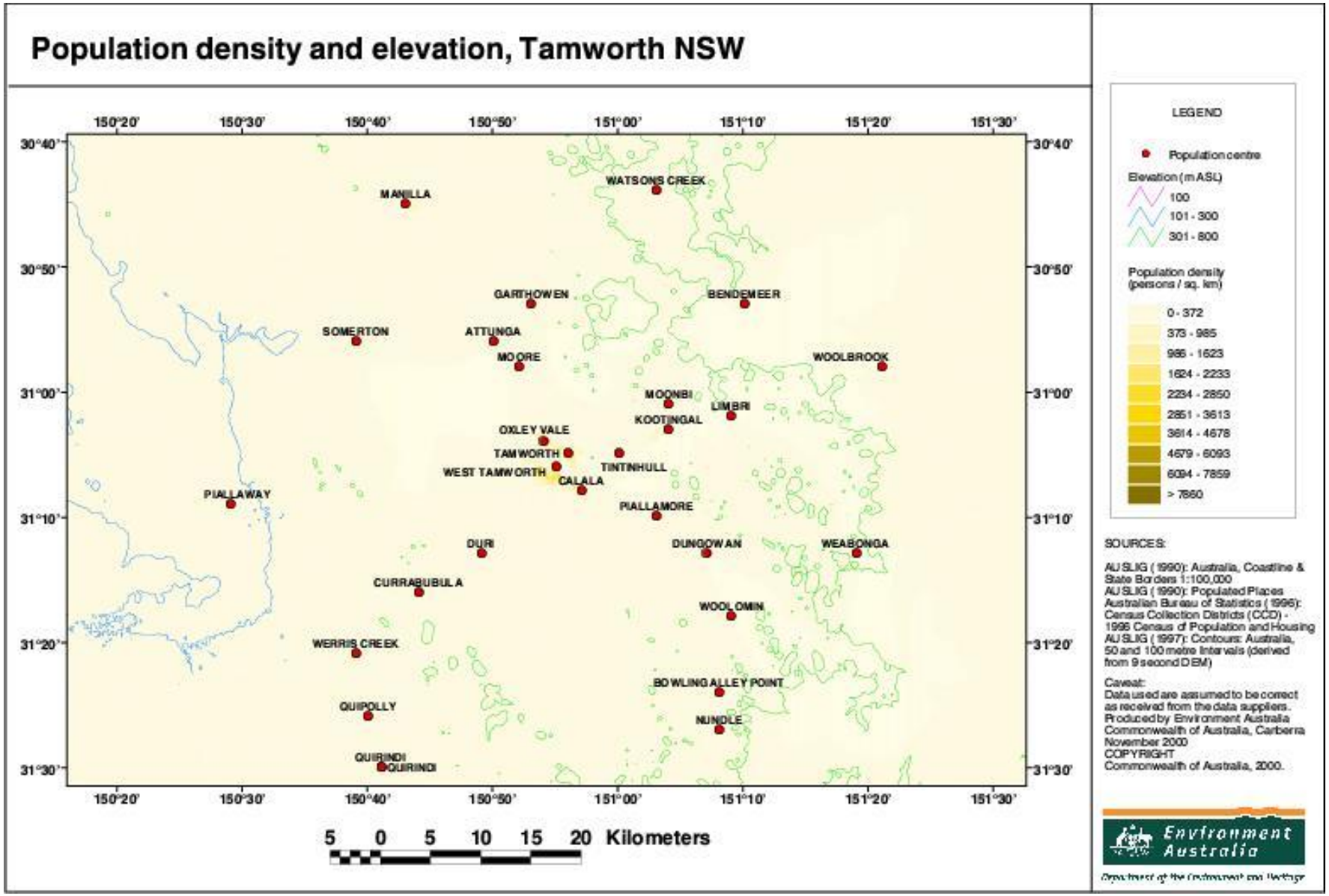


Figure 17 Population density and topography of Tamworth and environs.
Place names indicate population centres.

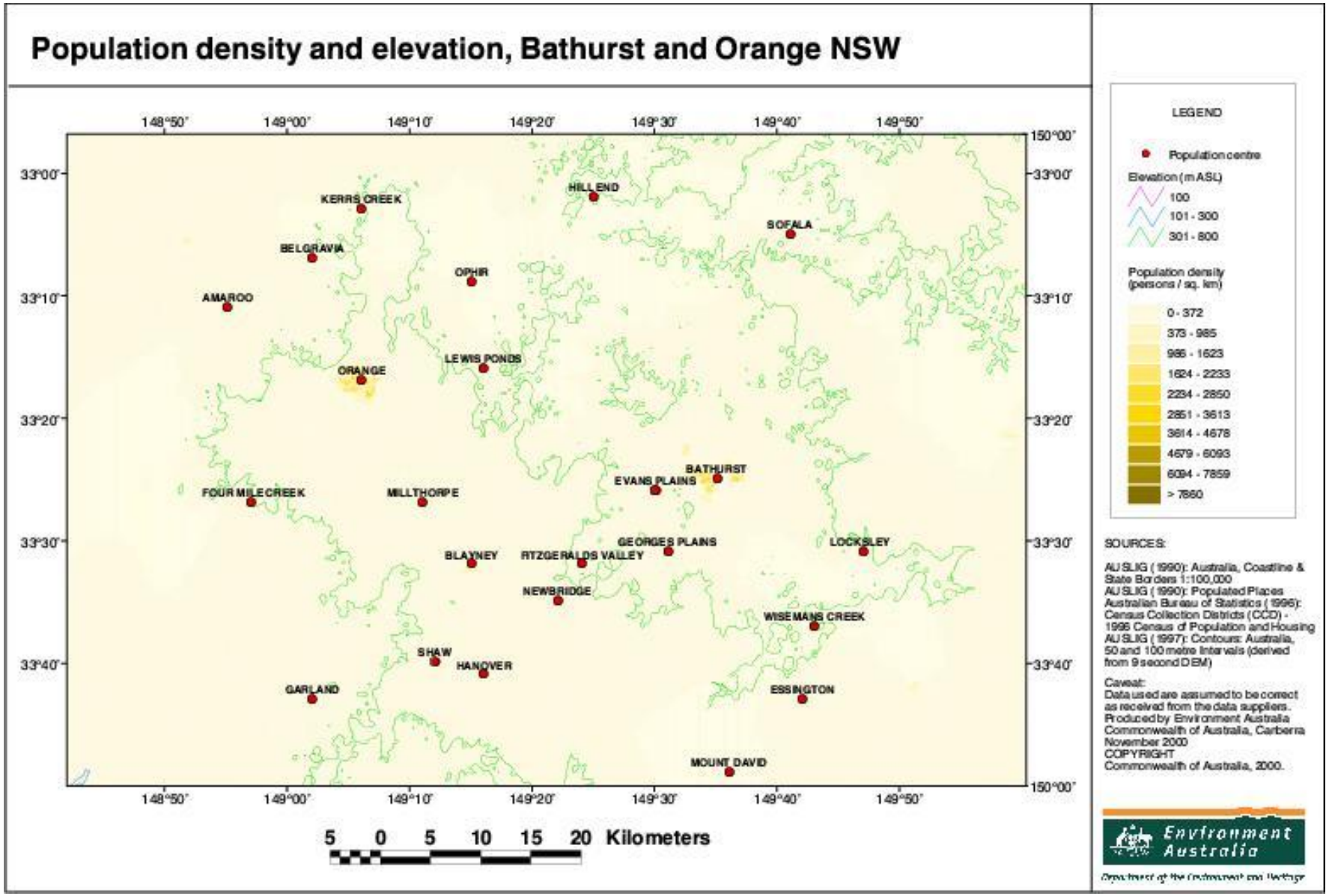


Figure 18 Population density and topography of Bathurst and environs.
Place names indicate population centres.

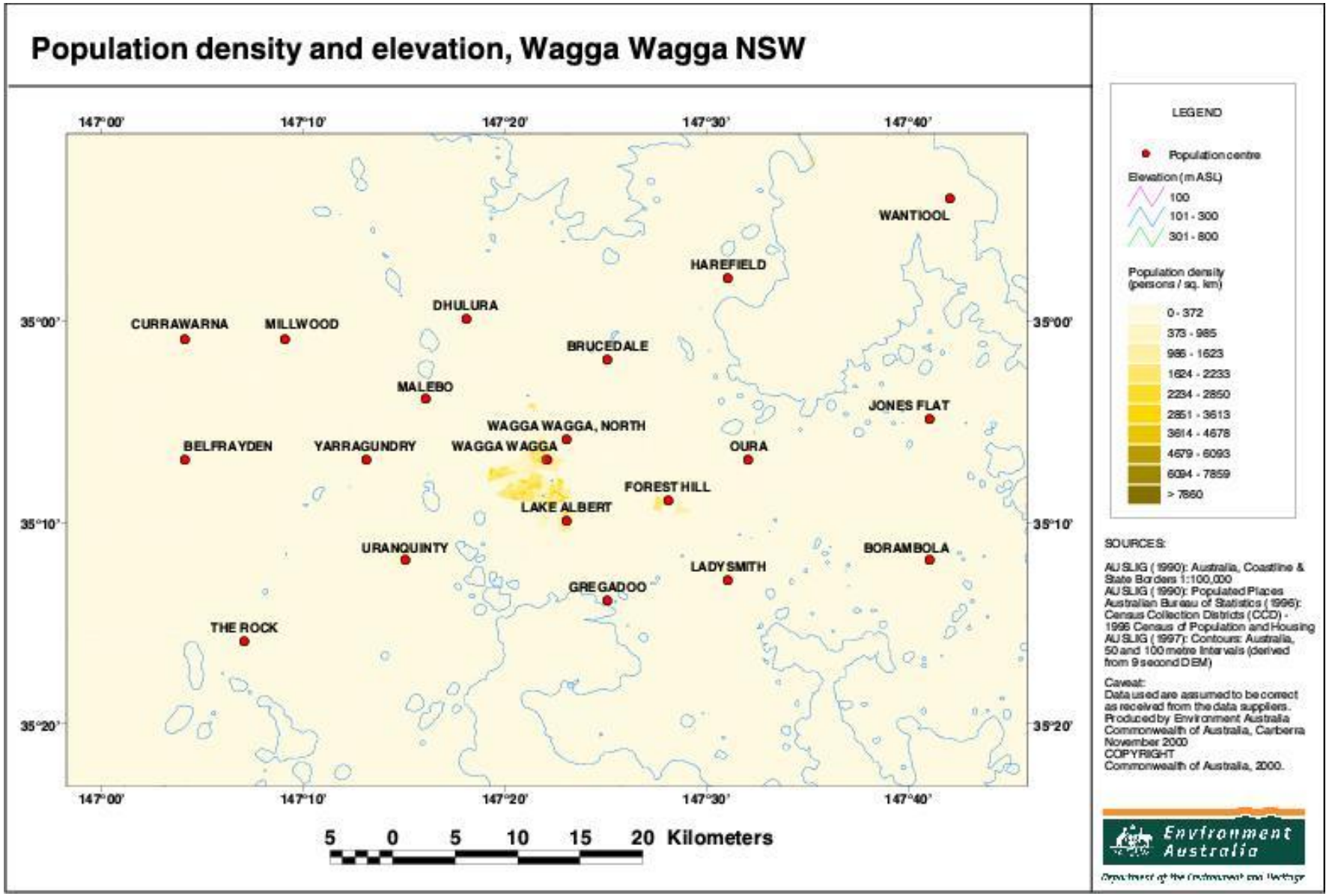


Figure 19 Population density and topography of Wagga Wagga and environs.
Place names indicate population centres.

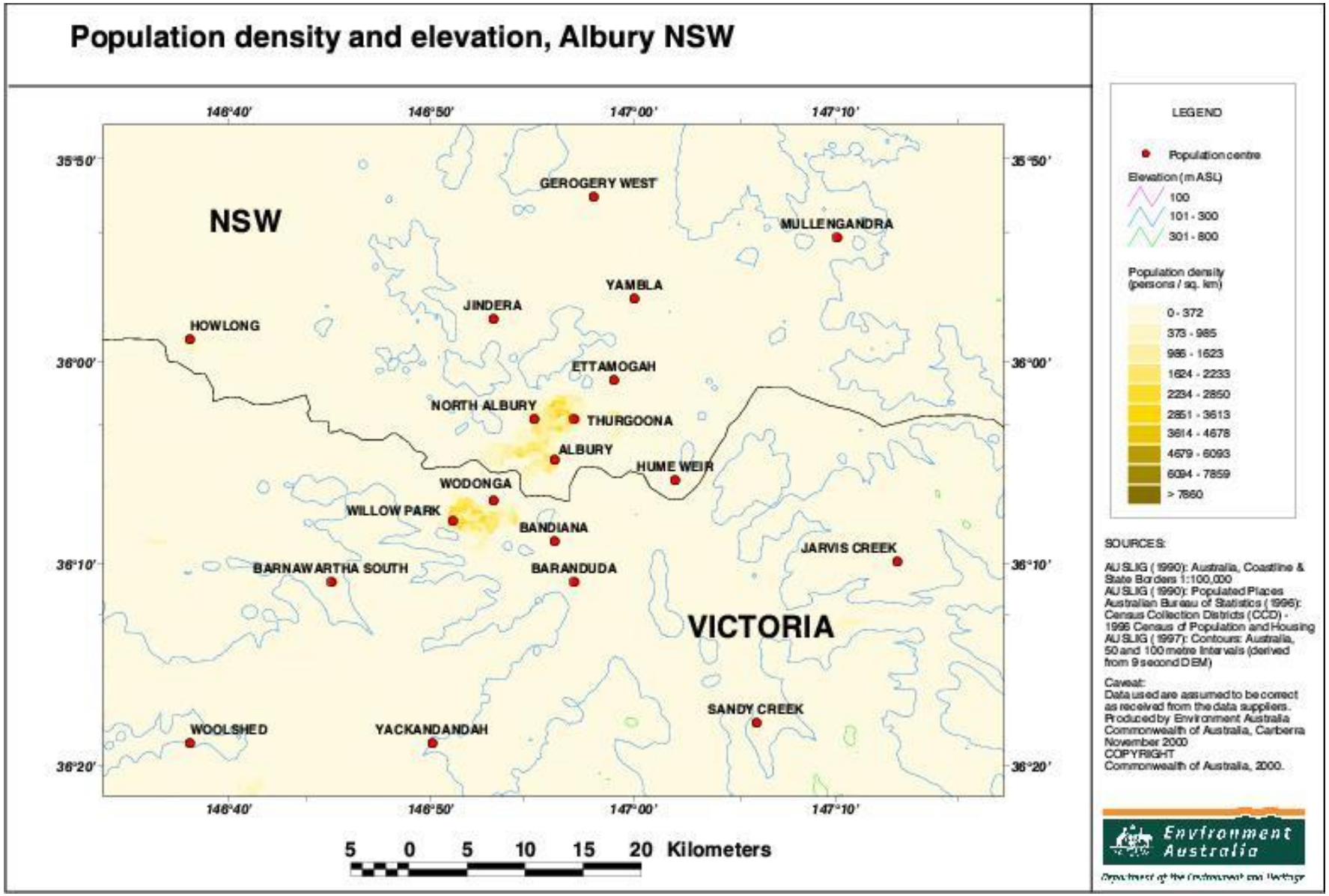


Figure 20 Population density and topography of Albury and environs.
Place names indicate population centres.

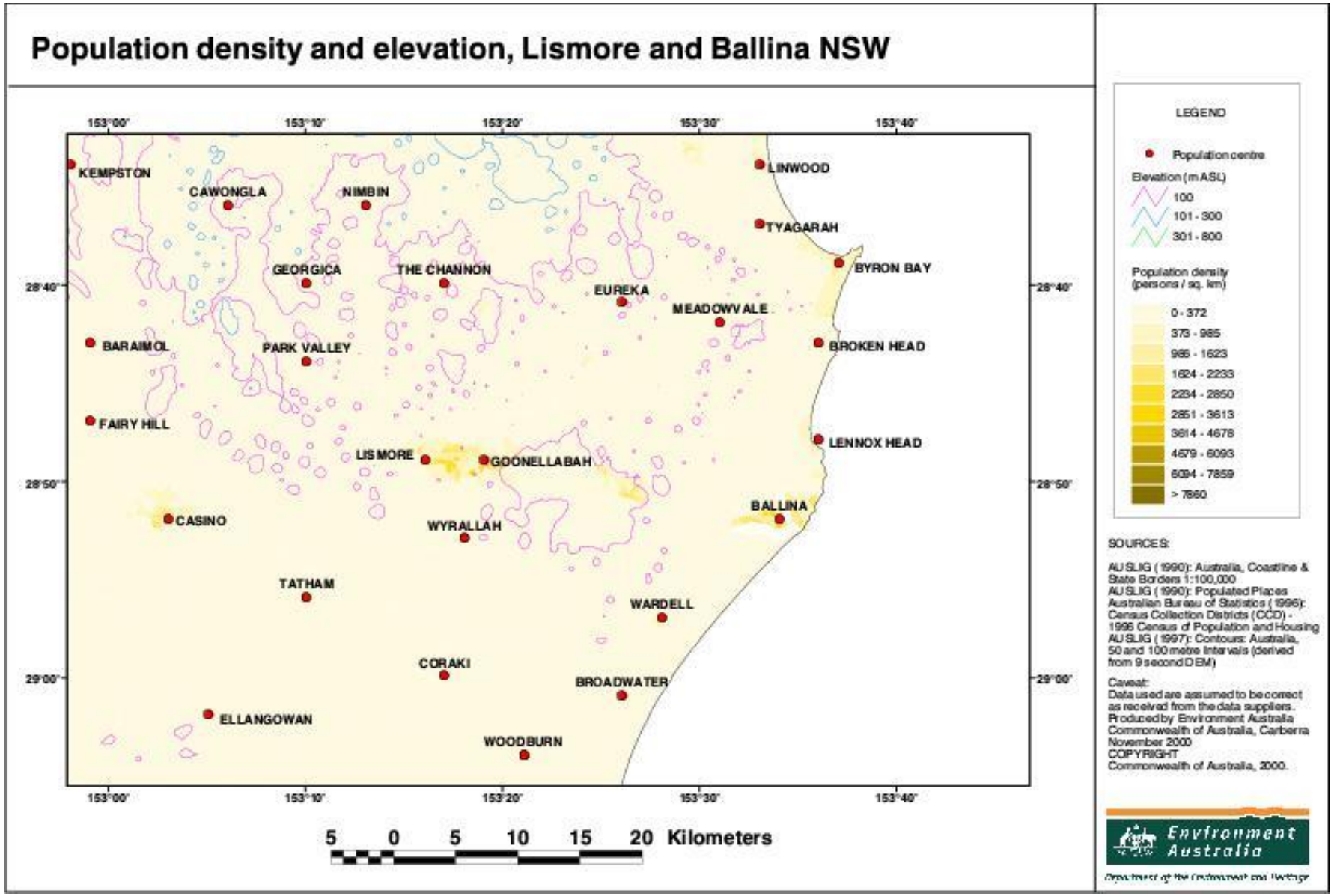


Figure 21 Population density and topography of Lismore and environs.
Place names indicate population centres.

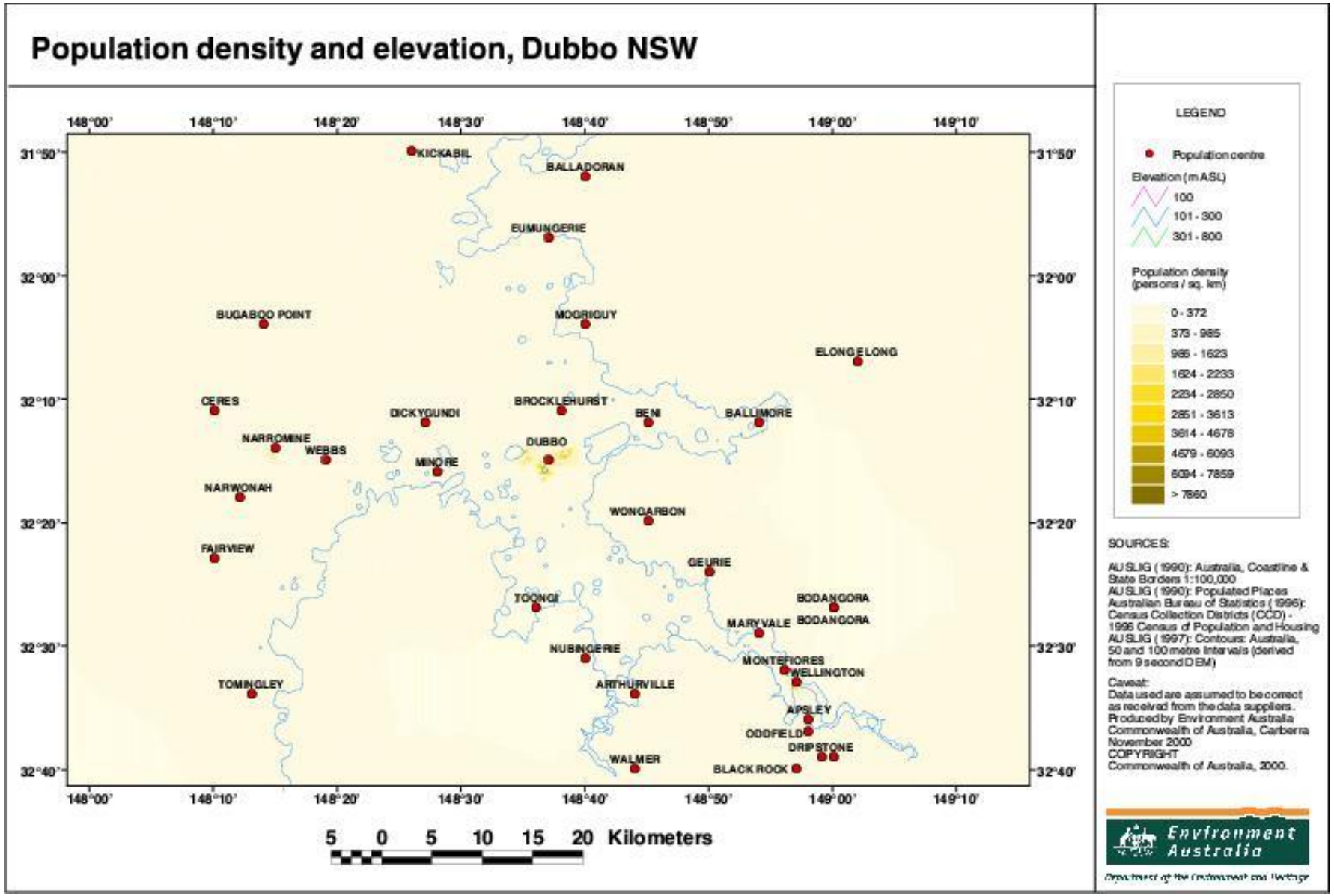


Figure 22 Population density and topography of Orange, Dubbo and environs.
Place names indicate population centres.

4 Siting and instrumentation

4.1 Instruments Standards

The NSW network is made up of instruments all of which are in accordance with the relevant Australian standard (as shown in tables 27 & 28) where standards exist. The methods shown in table 27 are those that will be used for NEPM monitoring and reporting. Table 28 shows the methods used for other measurements which are made in the network. It will be noted that, in the case of PM_{10}, the Tapered Element Oscillating Microbalance (TEOM) method will be used for NEPM monitoring and reporting although the high volume sampler method specified in the NEPM is also operated in the NSW network. The reason for this is that the high volume samplers are operated only on a one-in-six day cycle: to provide continuous data for this parameter TEOMs will be used.

TABLE 27: METHODS TO BE USED IN NEW SOUTH WALES FOR NEPM MONITORING AND REPORTING

Pollutant	Standard	Title	Method Used
Carbon Monoxide	AS3580.7.1-1992	Ambient Air - Determination of Carbon Monoxide – Direct Reading Instrument Method	Gas Filter Correlation /Infra-Red
Nitrogen Dioxide	AS3580.5.1-1993	Ambient Air - Determination of Oxides of Nitrogen – Chemiluminescence Method	Gas Phase Chemiluminescence
Photochemical Oxidant (Ozone)	AS3580.6.1-1990	Ambient Air - Determination of Ozone – Direct Reading Instrument Method	Non Dispersive Ultra-violet
Sulfur Dioxide	AS3580.4.1-1990	Ambient Air – Determination of Sulfur Dioxide – Direct Reading Instrument Method	Pulsed Fluorescence
Lead	AS2800-1985	Ambient Air – Determination of Particulate Lead-High Volume Sampler of Gravimetric Method	Atomic Absorption
PM_{10}	AS 3580.9.8-2001	Determination of Suspended particulate matter - PM10 continuous direct mass method using a tapered element oscillating microbalance analyser.	Tapered Element Oscillating Microbalance (TEOM)

TABLE 28: METHODS AND TECHNIQUES FOR OTHER POLLUTANTS

PM_{10}	AS3580.9.6-1990	Ambient Air – Determination of Suspended Particulate Matter PM_{10} – High Volume sampler with Size Selective Inlet Gravimetric Method	Size Selective Inlet (one in six day cycle)
PM2.5	No current Australian Standard	Manufacturers Method	Tapered Element Oscillating Microbalance (TEOM)
Light Scattering (visibility)	AS2724.4-1987	Ambient Air – Particulate Matter – Determination of Light Scattering Integrating Nephelometer Method	Light Scattering/ Nephelometry

4.2 Station Siting Compliance

All stations comply with the two relevant Australian standards (below) except where noted otherwise in table 29.

Air Sampling	AS 2922-1987	Ambient Air- Guide For the Siting of Sampling Units
Wind Velocity	AS 2923-1987	Guide for the Measurement of Horizontal Wind for Air Quality Applications

TABLE 29: EXCEPTIONS TO COMPLIANCE WITH STANDARDS

	Height above ground	Min distance to support structure	Clear sky angle of 120°	Unrestricted airflow of 270°/360°	20m from trees	No boilers or incinerators nearby	Min distance from road or traffic	**Comments**
Sydney Region								
Blacktown	4	4	4	4	8	4	4	Best site in very limited area on Blacktown ridge
Bringelly	4	4	4	4	4	4	4	
CBD	4	4	8	8	4	4	8	Comprises typical of peak site in CBD.
Lidcombe	4	4	4	4	8	4	4	Trees have grown since establishment of site.
Liverpool	4	4	8	4	4	4	4	Trees have grown since establishment of site.
Oakdale	4	4	4	4	4	4	4	

	Height above ground	Min distance to support structure	Clear sky angle of 120°	Unrestricted airflow of 270°/360°	20m from trees	No boilers or incinerators nearby	Min distance from road or traffic	Comments
Richmond	4	4	4	4	4	4	4	
Rozelle	4	4	8	4	8	4	4	Trees have grown since establishment of site.
St Marys	4	4	4	4	4	4	4	
Woolooware	4	4	8	4	8	4	4	Trees have grown since establishment of site.
Lower Hunter Region								
Beresfield	4	4	4	4	4	4	4	
Newcastle	4	4	4	4	4	4	4	
Wallsend	4	4	4	4	4	4	4	
Illawarra Region								
Albion Park	4	4	4	4	4	4	4	
Kembla Grange	4	4	4	4	4	4	4	
Warrawong	4	4	4	4	8	4	4	Best location in urban area specifically targeted for monitoring.
Wollongong	4	4	4	4	4	4	4	
Rural Population Centres								
Albury	4	4	4	4	4	4	4	
Bathurst	4	4	4	4	4	4	4	
Tamworth	4	4	4	4	4	4	4	
Wagga Wagga	4	4	4	4	8	4	4	Street trees within about 15 m of site

Further detailed information on the near-field environment of each monitoring station is contained in a report prepared by the Bureau of Meteorology for the NSW EPA. This report may be viewed by any interested party at the EPA offices at Lidcombe.

4.3 Instruments at each Monitoring Station

Table 30 shows the instruments at each of the monitoring stations, listed by region. The commissioning date for each parameter is given as month/year. Instruments not yet operational are indicated by a date in italics giving the scheduled date of commencement. Instruments will be deployed as soon as practicable and as they become available. Note that campaign monitoring in Dubbo, Orange, and Lismore is dependent on the outcomes of campaign monitoring in the other four regional centres.

4.4 Data Handling and Quality Assurance

Details of the NSW EPA's Quality Assurance and Quality Control procedures are specified in its NATA Laboratory Manual (and references therein). All data are stored in an electronic database. Both one hour averages and two minute data are stored for each parameter but only the one hour data are subject to routine quality assurance.

NSW is participating in the PRC's project to develop standardised data handling and reporting procedures. NSW will comply with the finalised guidelines as far as practicable. EPA retains its prerogative to store the air quality data in systems developed for internal use.

Other Relevant Parameters

Ten minute average sulfur dioxide values can be calculated for any station where the parameter is measured (see tables above) but these are not conducted on a routine basis at present.

All instruments used by the EPA for the determination of nitrogen dioxide do so by the chemiluminescent principle. Thus each instrument measures total oxides of nitrogen, nitric oxide and nitrogen dioxide.

PRC (2000f) provides guidance for collecting meteorological data. NSW EPA deploys meteorological equipment at most of its monitoring stations, as noted in tables 3, 11, and 19.

TABLE 30: AIR QUALITY MONITORING STATIONS IN NEW SOUTH WALES FOR AAQ NEPM PURPOSES

		Pollutant Monitoring Start Date (month/year)					
Station	**Station Type**	**O_3**	**NO_2 (NO_x)**	**PM_{10} (TEOM)**	**CO**	**SO_2**	**Lead (TSP)**
Sydney Region							
Blacktown	residential	**10/92**	**10/92**	**05/93**	**02/94**	**11/92**	
Bringelly	residential	**10/92**	**10/92**	**04/94**		**10/92**	
CBD	CBD				**05/75**		**05/75**
Central Coast	residential	***01/04***	***01/04***	***01/04***		***01/04***	
Lidcombe	residential	**01/72**	**08/77**	**10/94**	***01/02***	***01/05***	
Liverpool	residential	**10/91**	**11/91**	**07/93**	**03/94**	***01/05***	
Macarthur	residential	***01/03***	***01/03***	***01/03***	***01/03***	***01/03***	
Oakdale	rural	**04/96**		***07/03***			
Richmond	residential	**07/92**	**07/92**	**08/93**		**03/96**	
Rozelle	residential	**08/92**	**08/76**	***07/03***	**01/93**		**01/68**
St Marys	residential	**12/92**					
Woolooware	residential	**08/82**	**08/93**	**08/93**		**08/93**	
Lower Hunter Region							
Beresfield	semi-rural			**09/94**			
Newcastle	CBD	**11/92**	**11/92**	***07/03***	**11/92**	***01/05***	
Maitland	residential	***01/03***	***01/03***	***01/03***	***01/03***	***01/03***	
Wallsend	residential	**11/92**	**11/92**			**11/92**	***02/02***
Illawarra Region							
Albion Park	semi-rural	**11/78**	**12/92**	**03/94**		**11/86**	
Kembla Grange	residential	**01/94**		***07/03***			
Warrawong	residential / industrial					**10/93**	***09/01***
Wollongong	CBD	**02/93**	**02/93**	**02/94**	**02/93**	**02/93**	

TABLE 30: AIR QUALITY MONITORING STATIONS IN NEW SOUTH WALES FOR AAQ NEPM PURPOSES (continued)

		Pollutant Monitoring Start Date (month/year)					
Station	**Station Type**	**O_3**	**NO_2 (NO_x)**	**PM_{10} (TEOM)**	**CO**	**SO_2**	**Lead (TSP)**
Rural Population Centres							
Albury	rural			**06/00**			
Bathurst	rural	**01/01**		**07/00**			
Tamworth	rural			**10/00**			
Wagga Wagga	rural			**04/01**			
Dubbo†	rural			***01/04***			
Orange†	rural			***01/04***			
Lismore†	rural			***01/04***			

† Campaign monitoring at these stations depends on the results of initial campaign monitoring. Screening arguments may be used to reduce the extent of campaign monitoring.

5 Accreditation

NSW EPA has received NATA accreditation for its monitoring activities (as listed in Appendix A) which will include all those to be undertaken for the NEPM. This accreditation was conferred formally on 6 March, 2000. The Environmental Chemistry section of NSW EPA undertakes analysis of Pb and retains NATA accreditation for the method used.

NATA accreditation for station operation and the database reside with the Atmospheric Science section, while NATA accreditation for determination of Pb from filter papers is held by the Environmental Chemistry section.

6 Reporting

PRC (2000h) sets out a reporting strategy as required by clauses 11, 17, and 18 of the AAQ NEPM (NEPC 1988). In accordance with this, New South Wales will report to NEPC every calendar year on the performance of each station against the standards and goals. Reporting will include a summary of whether air quality meets the current goals, and analysis of the reported exceedences of the standard. Technical information will be presented in the recommended format to facilitate comparison between jurisdictions.

The report to NEPC will also be made available to the public. EPA already makes use of its website to disseminate information on air quality. EPA plan to make the report to NEPC available on the web with supporting information describing the NEPM process, and the basis for the standards and goals.

7 References

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PRC (2000c) "Monitoring strategy", National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 3, November 2000

PRC (2000d) "Screening procedures", National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 4, November 2000

PRC (2000e) "Data handling", National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 5, November 2000

PRC (2000f) "Meteorological measurements", National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 6, November 2000

PRC (2000g) "Accreditation", National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 7, November 2000

PRC (2000h) "Annual reports", National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 8, November 2000

PRC (2000i) "Lead monitoring", National Environment Protection Council (Ambient Air Quality) Measure Guideline Paper No. 9, November 2000

Appendix A: List of monitoring activities for which NSW EPA is accredited

ACCREDITATION NO: 14209

Environment Protection Authority of NSW

Ambient Air Quality Laboratories
Weerona Road
LIDCOMBE NSW 2141

CONTACT: Mr D Johnson
PHONE: (02) 9795 5062 FAX: (02) 9649 8768 MOBILE:

FACILITIES: Normally not available for public testing

7.70 Gases and aerosols
.05 Atmospheric pollution
by the methods of -
AS 2724.3, .4; AS 3580.9.6
for the following determinations -
Particulates - total suspended, PM_{10}

7.81 Constituents of the environment
.21 Air
Continuous monitoring of ambient air networks
by the methods of -
AS 3580.4.1, .6.1; AS 2447; AS 2965
for the following determinations -
Air monitoring stations: carbon monoxide; oxides of nitrogen - NO, NO_2 (by calculation), NO_x; ozone; sulphur dioxide

7.84 Residues in constituents of the environment
.71 Sampling
by the methods of -
USEPA TO_{14}
for the following determinations -
Hydrocarbons (VOCs); polyaromatic hydrocarbons

Accreditation No: 14209
(Terms Last Changed 23/02/00)

NATA Accreditation number 3040 – Environment Protection Authority of New South Wales, Chemistry Laboratories

7.70.05 Gases and Aerosols – Atmospheric Pollution
by the methods of AS 2724.3; AS 2800
in-house
for the following determinations –
Cadmium; **lead**; PAHs as listed under 7.84.22; total suspended particulates; zinc

Appendix B: Exposed Population

Station	Exposed Population
Sydney Region	
Blacktown	Trend station in a largely residential area in the north-west sub-region.
Bringelly	Trend station in a rural area in the south-west of the Sydney basin.
Lidcombe	Trend station in a mixed residential and commercial area. It has a very long record (established 1970)
Macarthur	Trend station in the south-west of the Sydney basin. Data from Liverpool will be reported until this station is established.
Oakdale	Rural area on the far SW edge of the Sydney basin - upper bound site for ozone
Richmond	Trend station representing the residential area in the north of the Hawkesbury basin
Rozelle	Trend station within the Parramatta River valley. Existing long-term station.
St Marys	Upper bound station for ozone in a residential area.
Sydney CBD	Upper bound station for CO and Pb in the central business district. This is a peak site adjacent to a heavily trafficked road in an urban canyon.
Woolooware	Trend station in a residential area on the south of Botany Bay and within 5 km of a major industrial complex. Represents coastal conditions south of the CBD, reporting peak levels when pre-cursors are trapped within coastal circulations.
Lower Hunter	
Beresfield*	Performance station in a semi-rural area used as a proxy for the yet-to-be-established Maitland site.
Newcastle	Trend station within the main population centre.
Wallsend*	Performance station in a residential area used as a proxy for the yet-to-be-established Maitland site.
Illawarra	
Albion Park	Performance station in a semi-rural area in the south of the region.
Kembla Grange	Upper bound station in a residential area to the west of Lake Illawarra.
Warrawong	Upper bound station in an industrial-residential area.
Wollongong	Trend station in the main population/commercial centre

Station	Exposed Population
Tamworth	Rural township campaign station established 2000
Bathurst	Rural township campaign station established 2000
Wagga Wagga	Rural township campaign station established 2001
Albury	Rural township campaign station established 2000
Dubbo	Rural township campaign station scheduled for January 2004
Orange	Rural township campaign station scheduled for January 2004
Lismore	Rural township campaign station scheduled for January 2004

* it is the intention to replace the Beresfield and Wallsend stations with a station in the Maitland area. In the interim data will be reported from these two stations.

Future campaign stations are scheduled on the assumption that initial campaign monitoring will not allow screening.

Appendix C: Glossary

AGL Above ground level

Agreement The agreement made on 1 May 1992 between the Commonwealth, the States, the Australian Capital Territory, the Northern Territory and the Australian Local Government Association, a copy of which is set out in the Schedule [to the Commonwealth Act]

Air NEPM National Environment Protection Measure for Ambient Air Quality (26June 1998)

airshed A volume of air confined to a geographic region, and within which pollutants are contained.

An area in which air quality is subject to common influences from emissions, meteorology and topography

ambient air The external air environment (does not include the air environment inside buildings or structures)

CBD Central Business District

CO Carbon monoxide

DOAS Differential Optical Absorption Spectrometry

EPA Environment Protection Authority of New South Wales

Fire management means all activities associated with the management of fire prone land, including the use of fire to meet land management goals and objectives

GRUB Generally representative upper bound (referring to a performance monitoring station, as described in the PRC Guideline Paper.

katabatic Refers to movements of cold air. Katabatic flows drain down a valley, analogous to stormwater flows

monitoring station a facility for measuring the concentration of one or more pollutants in the ambient air in a region or sub-region

NATA National Association of Testing Authorities

NEPC National Environment Protection Council

NEPM National Environment Protection Measure

NEPM Standards defined in Schedule 2 of the NEPM (refer also to definitions standards contained in Schedule 2).

Pollutant	Averaging period	Maximum concentration	Goal within 10 years Maximum allowable exceedences
CO	8 hours	9.0 ppm	1 day a year
NO_2	1 hour 1 year	0.12 ppm 0.03 ppm	1 day a year none
O_3	1 hour 4 hours	0.10 ppm 0.08 ppm	1 day a year 1 day a year
SO_2	1 hour 1 day 1 year	0.20 ppm 0.08 ppm 0.02 ppm	1 day a year 1 day a year none
Lead	1 year	0.50 μg/m³	none
PM_{10}	1 day	50 μg/m³	5 days a year

NO Nitric oxide

NO_2 Nitrogen dioxide

NO_X Oxides of nitrogen

NMHC Non-methane hydrocarbons

O_3 Ozone

Pb Lead

performance monitoring station a monitoring station used to measure achievement against the goal.

PM_{10} Particles which have an aerodynamic diameter less than or equal to10 μm

$PM_{2.5}$ Particles which have an aerodynamic diameter less than or equal to 2.5 μm

PMS Performance monitoring station, as defined in the Air NEPM.

ppm Parts per million

PRC Peer Review Committee

region means an area within a boundary surrounding population centres as determined by the relevant participating jurisdiction.

SO_2 Sulfur dioxide

sub-region means a populated area within a region whose air quality differs from other areas in the region due to the topography, meteorology and sources of pollutants

TEOM Tapered element oscillating microbalance

TSP Total suspended particulate matter

VOC Volatile organic compounds

$\mu g/m^3$ Microgram (1 millionth of 1 gram) per cubic metre