

People and places

1 Why is it important?

The state of the natural environment is the result of natural processes and, increasingly, the interaction of people with those processes. As population and industry increase, the natural environment comes under pressure from increased consumption of resources, increased production of pollutants (such as greenhouse gases and nutrient enrichment of stormwater and streams), and the encroachment of residential and industrial activities into natural areas. Habitat loss, fragmentation and disruption of natural systems cause a significant loss of biodiversity and can affect an area's ability to respond to other pressures such as climate change.

The aesthetic and amenity elements of the natural environment, which may be degraded by population and

economic growth, are important for human wellbeing. They are also a vital part of the economy because they attract people to move to—and remain living and working in, and enjoying—a region. The protection and enhancement of the natural environment and the careful development of industry and the built environment are essential to maintain sustainable economic growth and human welfare.

This chapter examines South Australia's population growth and the impacts of that population on urban and regional areas. It also looks at the state's heritage, which is an important part of the human environment.

In summary

Aspect and observation	Assessment grade				Confidence	
	Very poor	Poor	Good	Very good	In grade	In trend
Population						
Between 2006 and 2011 the population of South Australia increased by about 70 000—the largest increase since the early 1970s.						
Most population growth has occurred on the northern and southern fringes of the Adelaide Statistical Division, with decline in some regional areas.						
The number of residential dwellings increased more rapidly than population growth. This trend is expected to continue as the population ages and household sizes decrease.						
There has been an increase of infill residential development and this is expected to accelerate over the long term.						
Economy						
The growth in world demand for food and minerals supported an upward trend in exports.						
Nearly 40% of South Australia's exports are agricultural, and these rely on a healthy environment.						
Protection of agricultural land has increased, including legislation to better protect the McLaren Vale and Barossa regions from urban sprawl.						
An increase in mining exports led to increased greenhouse gas emissions and use of water and energy.						
Transport						
Private car use is high and growing.						
The number of cyclists travelling to and from the city increased by more than 50% between 2006 and 2011.						
Public transport use is low but increased from 43.8 million to 48.5 million passenger-kilometres, and is expected to increase more rapidly with investment in public transport and new urban design.						

Aspect and observation	Assessment grade	Confidence						
		Very poor	Poor	Good	Very good	In grade	In trend	
Pollution								
Air quality remains good in terms of national standards, with only some exceptions in specific locations.								
The quality of water in rivers and streams has generally improved as a result of increased rainfall.								
The quality of treated water released into coastal waters has improved.								
Knowledge and remediation of site contamination has increased.								
The number of licences to handle radioactive substances and operate radioactive apparatus has increased.								
Noise complaints increased by about 20% from 2006 to 2011.								
Waste								
Total waste generated has increased by 40% to 3250 kg per person. About 75% of this is recycled.								
Recent trend		Improving		Deteriorating		Stable		Unclear
Level of confidence		Evidence and consensus too low to make an assessment		Limited evidence or limited consensus		Adequate high-quality evidence and high level of consensus		
Grades		Very poor		Poor		Good		Very good

2 What do we know about it?

Most of the indicators of the relationship between South Australians and their natural environment have remained stable since the 2008 South Australian state of the environment report (EPA 2008). There was a modest increase in the rate of population growth and related urban and regional development. Trends in public and private transport behaviour were stable, as were trends in air quality and water quality. Waste generation increased markedly, but so did the rate of recycling.

2.1 Population trends

The estimated resident population (ERP) of South Australia in June 2006 was 1.57 million. Comparison with the preliminary census rebased ERP of 1.64 million in June 2011 (ABS 2012a) indicates a population increase of 70 300 over the period, equivalent to an annual rate of increase of 0.88%. This represents an average annual increase of 14 070 people—significantly above the average annual increase of 11 230 (0.73% per year) between 2001 and 2006—and is the highest since the early 1970s. Overseas immigration was the most important driver of this accelerated rate, accounting for more than 70% of the growth.

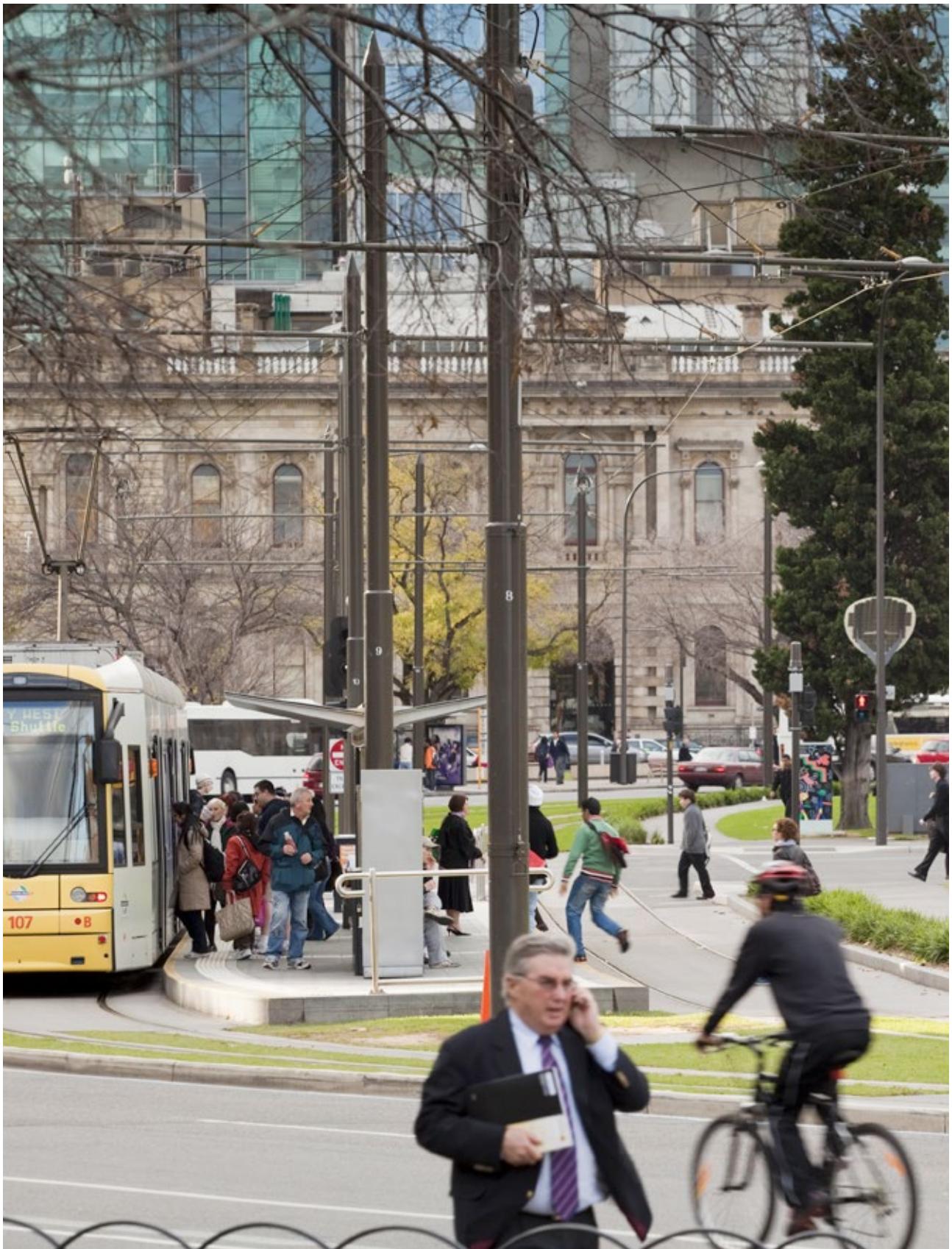
This growth estimate is significantly lower than the estimated population increase of 88 400 (an average annual growth rate of 1.1%) based on the intercensal component of growth estimates. The Australian Bureau of Statistics (ABS) recommends (ABS 2012abc) that this figure should be used to estimate intercensal growth before the final census-based ERPs for 2011 and earlier censuses are released in June 2013. Comparisons of growth rates within this report are made to the first, more conservative, figure (0.88%).

Despite the relatively rapid population growth between 2006 and 2011, South Australia's share of the Australian population has decreased consistently, from 9.4% in 1966 to 7.3% in 2011. This means that population growth has been more modest in South Australia than in most other states and territories.

Estimates of growth components (ABS 2012a) reveal that net overseas migration contributed approximately 71 200

people to the state's growth, and natural increase (births minus deaths) contributed another 35 700 people. However, between 2006 and 2011 South Australia experienced a net loss of 18 400 residents to interstate destinations. An increase in the fertility rate since 2001 boosted the number of 0–4 year olds in the population in 2011, but losses through net migration interstate reduced the number of young adults in South Australia, although there is some evidence of return migration of adults in their thirties (G Hugo, University of Adelaide, pers. comm., 1 November 2012). A major increase in net overseas migration—from an annual net intake of 4300 in 2003–04 to a peak of 17 980 in 2008–09—was the dominant factor in the state's population increase. Much of this increase was driven by an upsurge in long-term temporary migration, particularly of overseas students, but because many of these return to their home countries on completion of their studies, their long-term contribution to the migration stock is not as large as their net flow numbers suggest. It has been estimated that 15–20% of Adelaide City's population comprises overseas students (G Hugo, University of Adelaide, pers. comm., 1 November 2012).

Over the last decade, South Australia's population has continued to age (Table 1). In 2001, 19.3% of the state's population was less than 15 years old and by 2011 this proportion had decreased to 17.7%. The proportion of persons of working age (15–64 years) increased slightly from 66.1% in 2001 to 66.4% by 2011, but the proportion of people aged 65 or over increased from 14.6% in 2001 to 15.9% in 2011, equivalent to an absolute increase of 39 600 people over the decade. It is projected that the number of people in Greater Adelaide aged over 65 will increase from 194 000 in 2006 to 407 000 in 2036 (a 110% increase). The projected continued ageing of the state's population, and particularly a projected tripling of the size of the 85+ age group from 31 000 in 2006 to 98 000 in 2036 (Government of South Australia 2010), will demand specialised support services and appropriate amenities in housing, health and public transport. This increased demand on government may be partly offset by a trend for the younger elderly (aged 65–74 years) to take advantage of improvement in their general health to remain longer in the workforce.



Tram stop at Victoria Square, Adelaide
Department of Planning, Transport and Infrastructure

Table 1 South Australia's changing age structure: estimated resident population in 2001, 2006 and 2011

Age group (years)	2001		2006		2011	
	No. people	%	No. people	%	No. people	%
0–14	291 687	19.3	287 287	18.3	289 166	17.7
15–64	999 041	66.1	1 044 040	66.6	1 088 480	66.4
65+	221 000	14.6	236 561	15.1	260 586	15.9
Total	1 511 728	100.0	1 567 888	100.0	1 638 232	100.0

Source: ABS (2012d)

2.2 Urban population change and development

Adelaide and its surrounding areas continue to show a high rate of population growth, while holiday and retirement homes are an increasing feature of coastal areas.

2.2.1 Adelaide

The growth of the Greater Adelaide region and the accompanying increase in employment has been the major driver of urban development in South Australia in 2006–11. Adelaide Statistical Division (ABS 2005) has experienced the largest population growth of 59 000, which is 80% of the state's growth over 2006–11 (ABS 2012e). This growth has been accommodated by several major urban infill projects, ongoing demolition and redevelopment of the existing housing stock, plus large developments on the northern and southern fringes of the statistical division. Adelaide Statistical Division accounted for 73% of the state's population in 2011, and its average annual growth rate of 1.0% over 2006–11 is similar to the state's average annual growth rate of 0.9%.

With the release of the 2011 census, the ABS adopted a new geographical classification termed the Australian Statistical Geography Standard (ASGS). Under this classification, statistical divisions and statistical local areas have been abolished and a new greater capital city statistical area has been defined to identify the functional areas of the state capital cities. In the case of Adelaide, this is known as the Adelaide Greater Capital City Statistical Area, or Greater Adelaide. In 2011 the ERP of Greater Adelaide was 1 262 940, some 5.3% larger than Greater Adelaide's ERP in 2006 of 1 199 605 (2011 ASGS boundaries), and equivalent to an average annual growth rate of 1.03% per year between 2006 and 2011. Given current uncertainty about the census rebasing of

the ERP totals between 2006 and 2011 (ABS 2012b,c), growth estimates between the 2001 and 2011 censuses are perhaps a more reliable indication of recent growth. In the decade between the censuses of 2001 and 2011, the population of Greater Adelaide grew from 1 154 742 to 1 262 940—an increase of 108 198 people, or 10 819 people per year, and an average annual growth rate of 0.9% (Table 2).

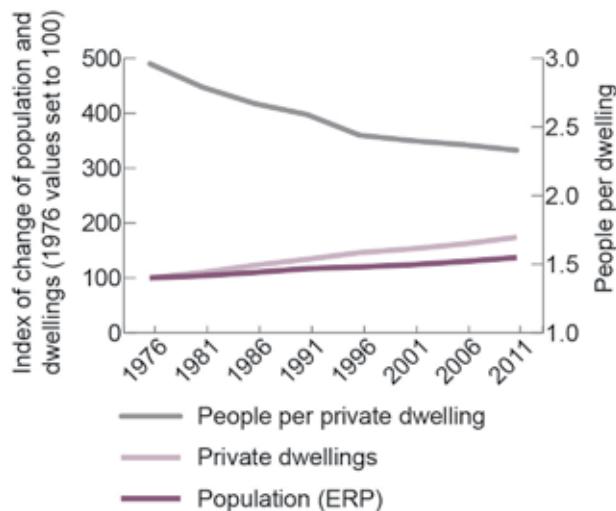
The Outer Adelaide Statistical Division has absorbed an increased population of 10 000 over 2006–11 (14% of the state's population growth). Its proximity to Adelaide and the availability of land led to an average annual rate of population growth in this division of 1.5% between 2006 and 2011—the most rapid rate of population increase of all the state statistical divisions and substantially higher than the state's annual rate of population growth of 0.9%. As this division includes a large share of the state's most productive agricultural land and critical water catchment areas, this growth has placed considerable pressure on infrastructure and services to meet the increased demands, and may have increased impact on the environment.

The 30-Year Plan for Greater Adelaide (30-Year Plan; DPLG 2010b) projected that the population of the Greater Adelaide planning region (comprising a larger area than the ABS definition of Greater Adelaide) will increase from 1.29 million in 2006 to 1.85 million people by 2036.

2.2.2 Housing

The demand for housing, as measured by the number of private dwellings, has increased more rapidly than the population since 1976 (Figure 1). This has been caused by population ageing, increased rates of family dissolution and generally good economic times that increased the demand for dwellings and reduced the size of households. Since the 1996 census, the rate of decrease in the number of people per private dwelling in the Greater Adelaide

planning region has slowed (Figure 1), with decreased affordability of housing possibly being a factor in 2001–11 (G Hugo, University of Adelaide, pers. comm., 1 November 2012). When overseas visitors are excluded from the analysis, the average household size at the national level shows a very small increase from 2.532 to 2.537 people per household (defined as people in private dwellings) between 2006 and 2011 (idblog 2013), the first halt in the decline since the baby boom of the 1950s. In South Australia as a whole, the very slow downward trend continued from 2.386 to 2.383 people per household from 2006 to 2011, due to the ageing of South Australia's population. Single-person households have been the fastest growing household type in South Australia during the last 10 years.



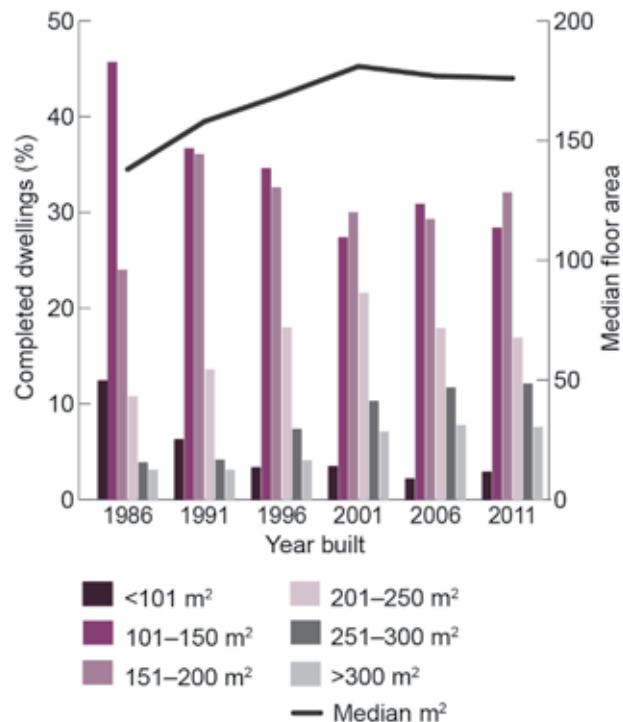
ERP = estimated resident population

Notes:

- 1 Because of the lack of comparable information on the number of people per private dwelling (occupied and unoccupied) before 1986, the population estimate used is the ERP divided by the total number of private dwellings.
- 2 The recent decrease in people per dwelling may be underestimated because of an increase in the proportion of overseas students included in the ERP since 2006, and because most overseas students do not reside in private dwellings.
- 3 The Greater Adelaide region (as defined in the 30-Year Plan) includes the Adelaide metropolitan area, the Outer Adelaide Statistical Division (except for Kangaroo Island) and the Rural City of Murray Bridge.

Sources: Australian Bureau of Statistics selected census ERP tabulations 1976 to 2011, ABS (2012e)

Analysis of the floor area of detached dwellings (Figure 2) shows that, until 2006, rising incomes and aspirations were reflected in a consistent increase in the proportion of detached dwellings with large floor areas (more than 300 square metres). Large houses use more energy to heat and cool, and more materials and energy to construct and eventually demolish, and thus have a large influence on the environmental footprint of a city. However, since 2006 this trend has reversed slightly, with the proportion of detached dwellings with floor areas greater than 300 square metres declining from 7.8% in 2006 to 7.6% in 2011. The median floor area of detached dwellings increased rapidly from 1986 to 2001, but has since declined modestly from a peak of 181 square metres in 2001 to 176 square metres in 2011. It is likely that increased energy prices, more demanding building code requirements (including a six star energy efficiency rating) and smaller lot sizes may be dampening the demand for houses with large floor areas.



Note: The data exclude Kangaroo Island.

Source: June 2012 property cadastre and valuation snapshot, Department of Planning, Transport and Infrastructure, unpublished

Figure 1 Comparison of growth in population and private dwellings, Greater Adelaide Region, 1976–2011

Figure 2 Floor area of detached dwellings by year of completion, Adelaide and Outer Adelaide Statistical Divisions, 1986–2011

2.2.3 Urban expansion

Historically, a large proportion of new housing in South Australia has occurred on cheaper land on the fringe of the established metropolitan area, encroaching onto land that may have been better suited to primary production, or into natural areas, leading to an alteration of the natural environment, including a loss of biodiversity. This type of development increases the heat island effect (where cities are hotter than the surrounding rural areas), increases demand for energy and water, and increases the cost of providing transport and other infrastructure. Most importantly, broad hectare development is usually located some distance from the workplaces of most of its residents and on sites that are (at least initially) poorly served by public transport. Therefore, it generates an increase in car use, which leads to an increase in greenhouse gas emissions.

Figure 3 shows the historical spread of urban development in Adelaide. It shows the contrast between the compact spatial extent of the city for the first century of its development and the sprawl of the city after World War 2. This spread was particularly rapid during 1960–89, as a result of increased car ownership and rapid post-war population growth. In the two decades since, residential development has been slower and more spatially constrained. It is the intention of the 30-Year Plan to constrain the next 25 years of residential development within the 2038 boundaries identified in Figure 3.

2.2.4 Other urban centres

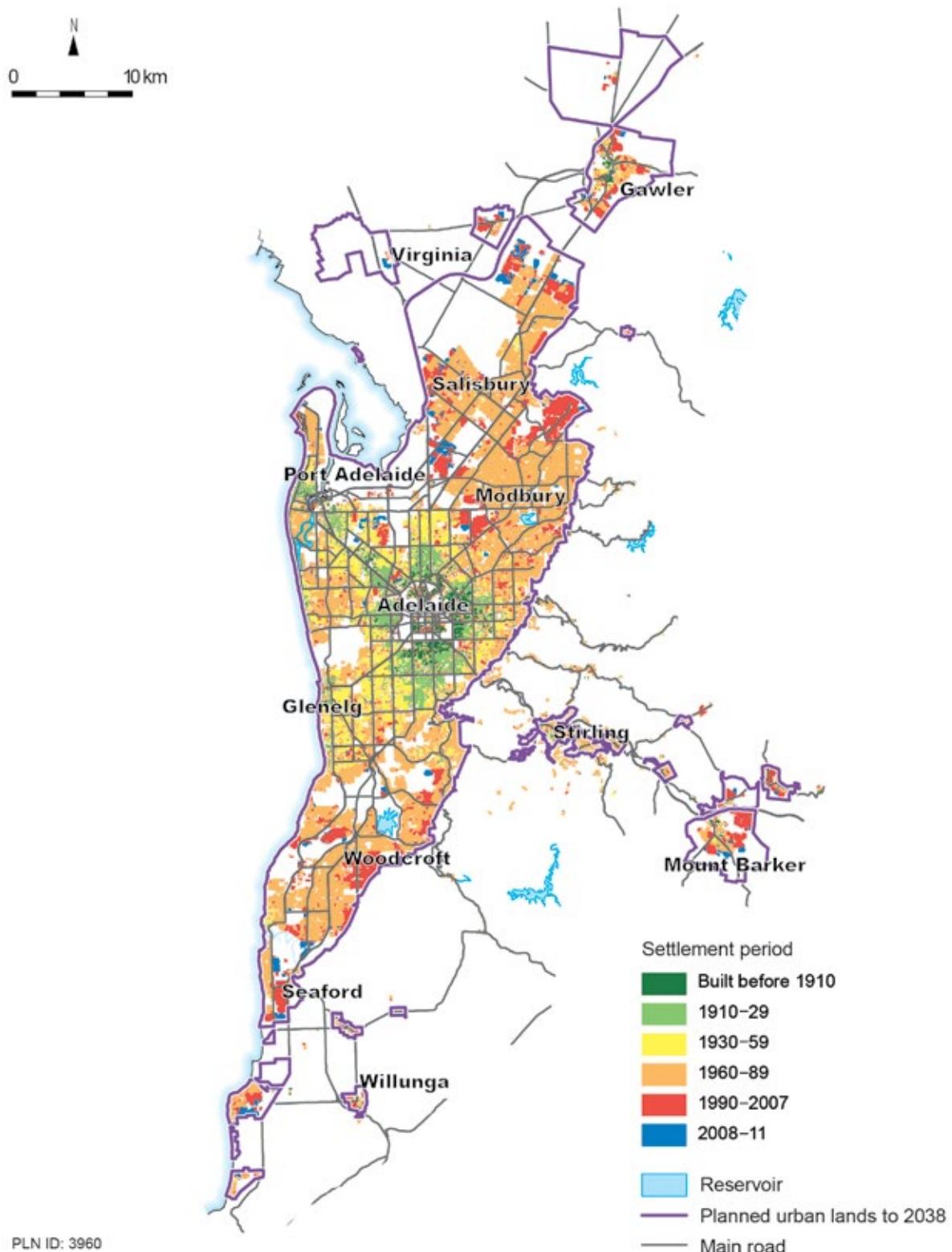
Many of the population trends for urban centres identified in the 2008 South Australian state of the environment report (EPA 2008) are still evident (Figure 4). For example, the urban centres with the highest rates of population growth between 2006 and 2011 are those either on the fringes of the Greater Adelaide Capital City Region (such as Mount Barker, Nairne, Hahndorf, Gawler and Angle Vale) or those just outside the Greater Adelaide Capital City Region but within easy commuting distance (such as Murray Bridge, Victor Harbor–Goolwa and Strathalbyn), and Nuriootpa in the Barossa Valley. There has also been significant growth of mining centres such as Roxby Downs, and a low rate of growth in major urban centres that service those developments, such as Whyalla and Port Augusta. Growth in these centres will likely slow with the delay in the Olympic Dam expansion. The major regional centre of Mount Gambier has experienced significant growth.

The populations of coastal towns such as Moonta, Victor Harbor–Goolwa and Normanville have continued to be boosted by retirement migration (mainly from Adelaide

but also from rural areas in the hinterland) and the construction of holiday homes. Many coastal settlements in the state experienced a more rapid increase in unoccupied rather than occupied private dwellings between 2006 and 2011. This is indirect evidence of an increase in holiday homes and future retirement homes.

At the 2011 census, the coastal local government areas of Robe, Yorke Peninsula, Yankalilla, Barunga West and Elliston each had more than 40% of their private dwellings categorised as unoccupied, and Mid Murray District Council, with its attractive riverside sites, had 42% of its private dwellings unoccupied (ABS 2011). All-of-state analysis of population change in coastal local government areas in 2001–06 and 2006–11 indicates that, despite the total population growth rate accelerating from 0.7% to 0.9% per year, the average annual rate of growth in ERP of coastal local government areas (defined as outside the greater capital city statistical areas that border the coastline) halved from 1.0% to 0.5% per year between 2001–06 and 2006–11 (idblog 2012). Population growth is still strong on the Fleurieu Peninsula and on the Copper Coast, but has slowed in many small centres on Eyre and Yorke peninsulas.

There has also been a noticeable decrease in the population of towns serving dryland farming areas such as Bordertown, Keith and Peterborough, and a similar decrease of population in several Riverland centres such as Berri and Loxton, related to the decreased availability of irrigation flows during the drought years from 1998 to 2010. Local reports from the Riverland region (ABC 2012) indicate that low fruit prices, high input costs (especially for electricity) and lingering debt have combined to force as many as 300 local residents to temporarily move out of the region to take part in fly-in fly-out mining industry work each year. Mining industry-related work offers steady salaries, predictable shift work and a stable income that is difficult to obtain from farm work alone. Although it is hoped that the short-term economic fix from mining will allow farmers to remain residents of the Riverland, many of the smaller blocks of land are marginally economically sustainable, suggesting that there may be long-term depopulation of the Riverland's farm and town populations.



Source: Valuation data supplied by the Department of Planning, Transport and Infrastructure

Figure 3 Residential development of Adelaide and environs, pre-1910–2011, and planned development areas to 2038

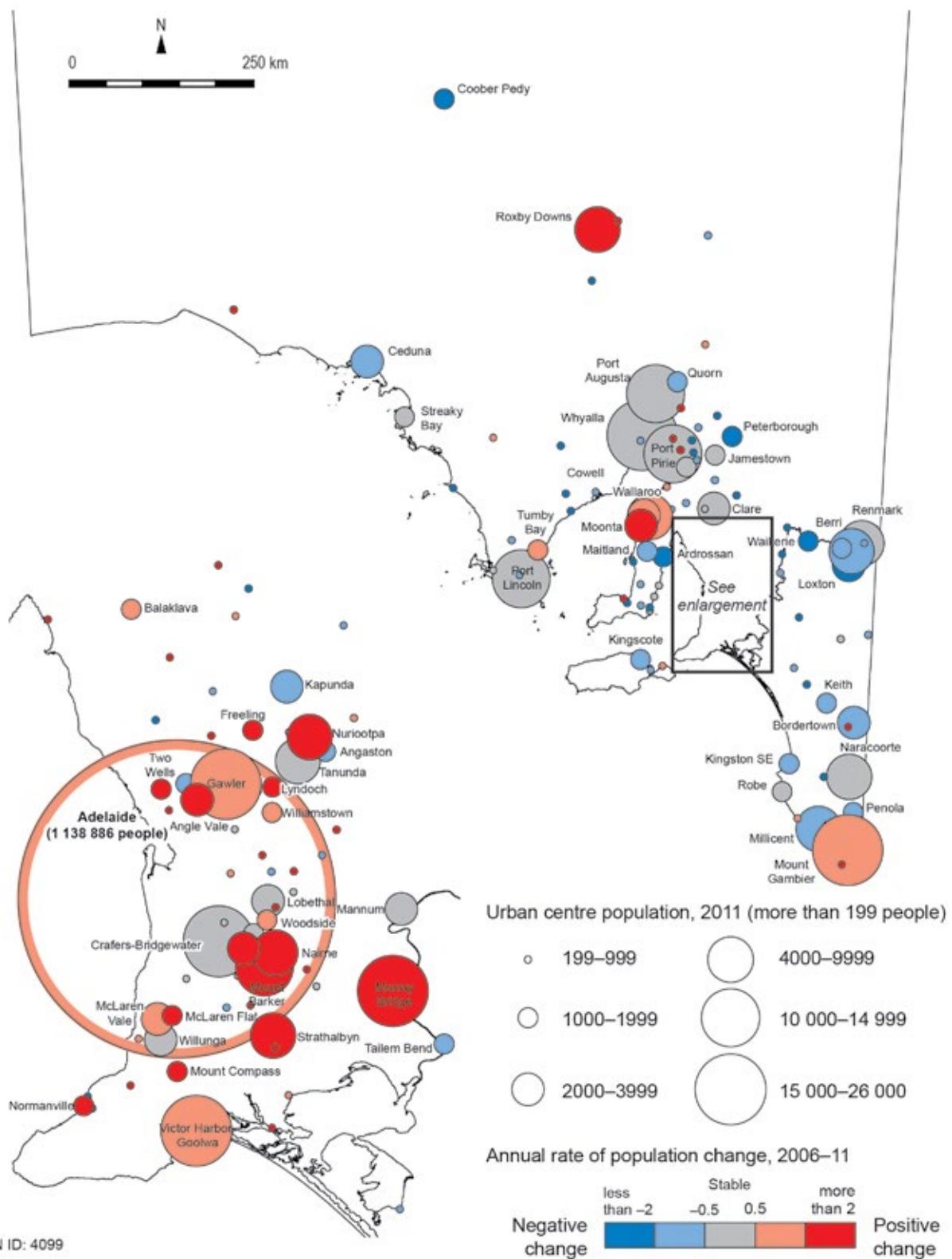


Figure 4 Estimated resident population of urban centres, 2011, and average annual change in estimated resident population, 2006–11

2.2.5 Liveability

Adelaide ranked ninth among 140 world cities on the 2012 Economist Intelligence Unit's liveability index and retained its place as the most liveable Australian city according to the Australian City Liveability Index. In 2012, Adelaide hosted 7.5 million international visitor nights, up from 5.7 million in 2008, but saw a drop in domestic visitor nights from 8.1 million in 2008 to 7.2 million in 2012 (DIT 2012a).

2.3 Regional population change and development

The regional pattern of population change over 2006–11 is summarised in Table 2 and Figure 5. Apart from the Adelaide and Outer Adelaide statistical divisions (see Section 2.2.1), population growth in the other divisions since 2006 has been relatively minor at 1000 people or less over the five years. Indeed, both South East and Murray Lands statistical divisions have experienced minor population declines, largely because of ABS adjustments.

Like Victor Harbor in the Outer Adelaide Statistical Division, the Yorke and Lower North Statistical Division (particularly the Copper Coast) has been the recipient of retirement migration from other parts of the state. This has resulted in the third highest annual growth rate between 2006 and 2011 of 0.45%, and the oldest population in the state. Eyre and Northern statistical divisions witnessed modest rates of population increase (0.2% compared with 0.9% per year for the state) as a result of the development of mineral resources and an increased demand for labour.

2.3.1 Local area population change

Spatial differences in population change are most pronounced, and environmental impacts are likely to be most evident, at the larger scale of the statistical local area (SLA) and local government area (LGA). Figures 6 and 7 show the spatial patterns of population change at the SLA level, the total absolute change over 2006–11 and the average annual percentage change.

Substantial absolute increases in population have the potential to significantly affect the natural environment. The largest absolute increases over 2006–11 occurred in the SLAs on the southern and northern edges of the Adelaide metropolitan area: increases of 7860 in Onkaparinga–South Coast, 7530 in Salisbury Balance, 3850 in Playford–West and 3250 in Playford–West Central. As these population increases were generally on new broad hectare residential sites with very little residential

population in 2006, the percentage increases were high at 4.5% to 11.1% per year—five to ten times the annual population growth rate of the state. Over 2006–11, these areas have witnessed the greatest and most intense environmental impacts from population growth—impacts that need to be addressed by environmentally sensitive urban design and biodiversity conservation principles.

Other SLAs in the Adelaide Statistical Division have experienced significant population growth over the last five years, particularly those in the councils of Port Adelaide Enfield (increase of 9960), Marion (4050) and Adelaide City (3320), where there has been substantial urban redevelopment and apartment construction in established residential areas. In these areas, the annual rate of increase was between 1.5% and 3.5%, significantly higher than the state rate. Population increases in the range of 1000–2000 over 2006–11 have been driven by residential redevelopment in the established inner city councils of Charles Sturt (increase of 4180), West Torrens (2800) and Campbelltown (1850), where increasing housing density has resulted in a more intensive use of existing urban infrastructure. However, the loss of backyards and tree cover has the potential to increase both the heat island effect and the level of stormwater run-off if care is not taken to offset these effects with more open space, tree plantings and water-sensitive urban design. The loss of backyards can also lead to a loss of suburban habitats for some species.

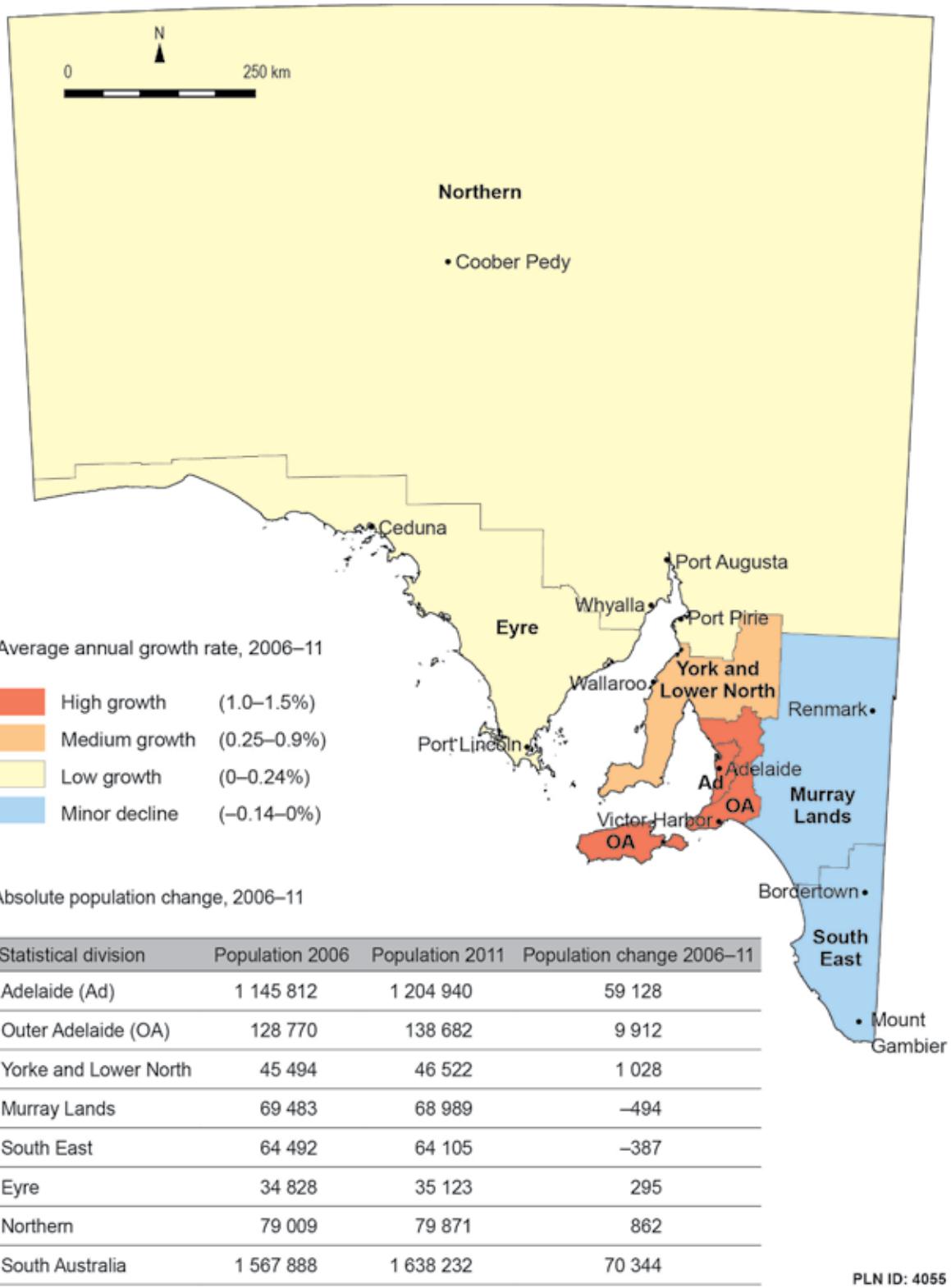
Other areas on the fringes of metropolitan Adelaide have absorbed some of the spillover growth from Adelaide—for example, Mount Barker Council and Gawler have had population gains of 2800 and 1500, respectively. Significant population gains of more than 1000 have also occurred in the regional LGAs of Alexandrina (increase of 2560), Murray Bridge (1800) Victor Harbor (1620), Copper Coast (1230) and Light (1120), with the rate of growth more than double the state's average annual growth rate. Mount Gambier and Lower Eyre Peninsula also experienced significant growth in 2006–11. These regional LGAs gained population because of their desirable coastal locations and associated retirement migration, their status as regional population centres or their proximity to Adelaide.

Table 2 Estimated resident population, population shares, population change and average annual growth rates of the seven South Australian statistical divisions, 1976–2011

Statistical division	1976	1981	1986	1991	1996	2001	2006	2011 ^a
Estimated resident population								
Adelaide	923 868	953 696	1 003 802	1 056 561	1 078 437	1 107 986	1 145 812	1 204 940
Outer Adelaide	60 648	69 839	81 894	93 231	104 331	113 992	128 770	138 682
Yorke and Lower North	40 646	41 721	43 592	43 996	44 150	44 398	45 494	46 522
Murray Lands	60 658	63 267	65 520	68 012	68 185	68 557	69 483	68 989
South East	59 525	61 628	62 893	62 855	62 707	62 588	64 492	64 105
Eyre	32 962	34 454	34 935	33 165	33 011	34 020	34 828	35 123
Northern	95 763	94 164	89 914	88 479	83 432	80 187	79 009	79 871
Total	1 274 070	1 318 769	1 382 550	1 446 299	1 474 253	1 511 728	1 567 888	1 638 232
Population distribution (%)								
Adelaide	72.5	72.3	72.6	73.1	73.2	73.3	73.1	73.2
Outer Adelaide	4.8	5.3	5.9	6.4	7.1	7.5	8.2	8.5
Yorke and Lower North	3.2	3.2	3.2	3.0	3.0	2.9	2.9	2.9
Murray Lands	4.8	4.8	4.7	4.7	4.6	4.5	4.4	4.3
South East	4.7	4.7	4.5	4.3	4.3	4.1	4.1	4.1
Eyre	2.6	2.6	2.5	2.3	2.2	2.3	2.2	2.2
Northern	7.5	7.1	6.5	6.1	5.7	5.3	5.0	4.9
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Growth	1976–81	1981–86	1986–91	1991–96	1996–01	2001–06	2006–11	
Adelaide	29 828	50 106	52 759	21 876	29 549	37 826	59 128	
Outer Adelaide	9 191	12 055	11 337	11 100	9 661	14 778	9 912	
Yorke and Lower North	1 075	1 871	404	154	248	1 096	1 028	
Murray Lands	2 609	2 253	2 492	173	372	926	-494	
South East	2 103	1 265	-38	-148	-119	1 904	-387	
Eyre	1 492	481	-1 770	-154	1 009	808	295	
Northern	-1 599	-4 250	-1 435	-5 047	-3 245	-1 178	862	
Total	44 699	63 781	63 749	27 954	37 475	56 160	70 344	
Average annual growth rate (% per year)								
Adelaide	0.64	1.03	1.03	0.40	0.54	0.67	1.01	
Outer Adelaide	2.86	3.24	2.62	2.30	1.79	2.47	1.49	
Yorke and Lower North	0.52	0.88	0.18	0.10	0.11	0.49	0.45	
Murray Lands	0.85	0.70	0.75	0.10	0.11	0.27	-0.14	
South East	0.70	0.41	-0.01	0.00	-0.04	0.60	-0.12	
Eyre	0.89	0.28	-1.03	-0.1	0.60	0.47	0.17	
Northern	-0.34	-0.92	-0.32	-1.2	-0.79	-0.30	0.22	
Total	0.69	0.95	0.91	0.40	0.50	0.73	0.88	

a Preliminary estimated residential population figures rebased to the preliminary 2011 census results.

Sources: ABS (2012e, and earlier years)



Source: ABS (2012e)

Figure 5 Population trends for the statistical divisions of South Australia, 2006–11

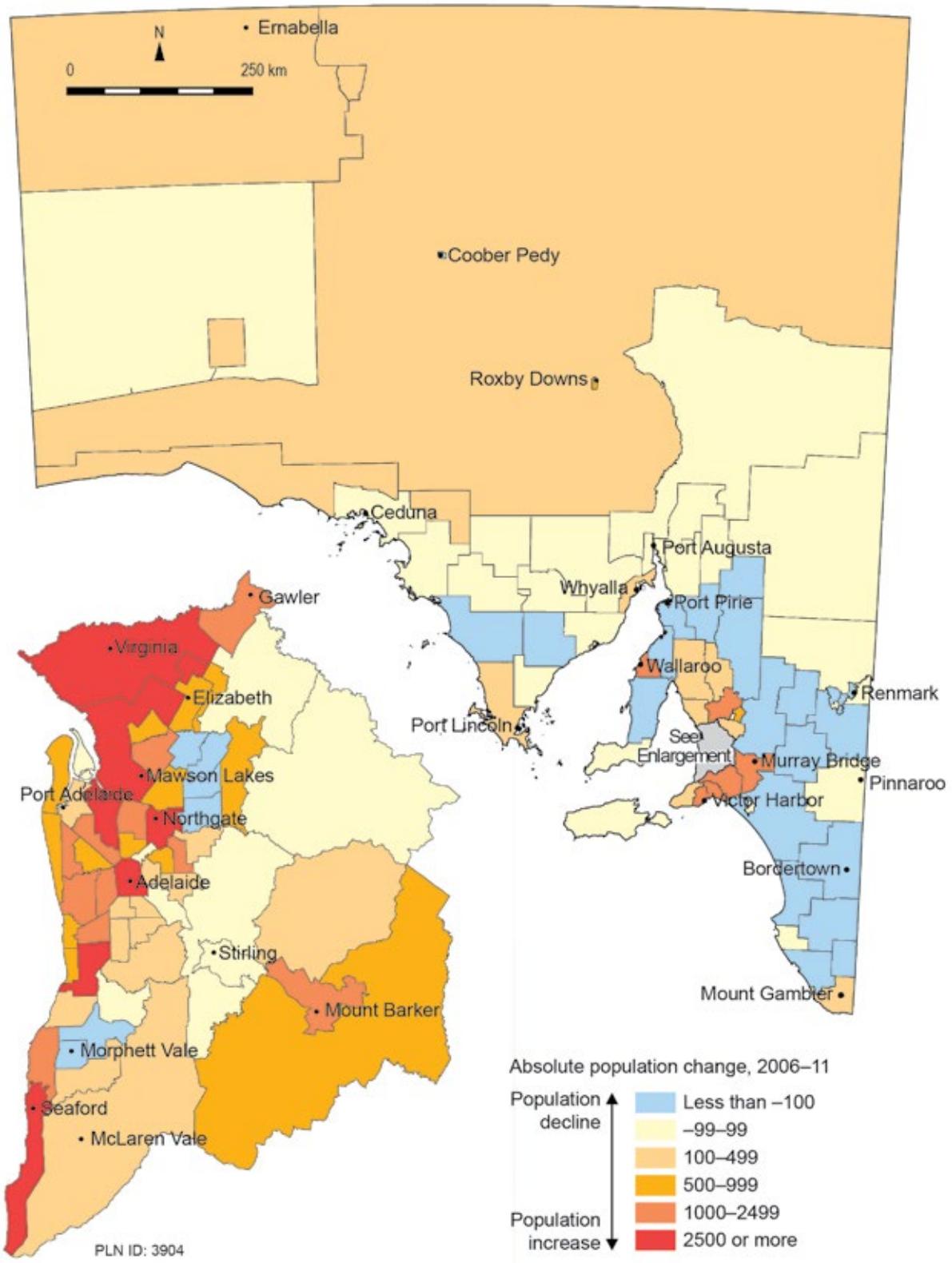
Figure 7 highlights the regional SLAs where the average annual growth rates exceed 1.0%, including Unincorporated Far North, Ananga Pitjantjatjara, Roxby Downs, Unincorporated West Coast, Unincorporated Lincoln and Unincorporated Flinders Ranges. However, all these SLAs had small populations in 2006 and the increases represent less than 500 people over 2006–11. Some of these SLAs also have large proportions of Indigenous people and some of the population change is an artefact of a more complete enumeration of these populations in 2011 than in 2006.

Adjustments made by the ABS have resulted in a major downgrading of growth rates in the regional areas of the state (ABS 2012bc). This is evident in Figure 6, which shows the absolute change in population between the 2006 and 2011 censuses. Of the 127 SLAs mapped, 28 had population decreases of at least 100 people, mostly in the dryland agricultural areas of Eyre Peninsula, Yorke and Lower North, Murray Lands and South East Statistical Divisions.

The largest absolute population decreases were in the metropolitan area. The populations of Tea Tree Gully–North, Tea Tree Gully–Central, Onkaparinga–Morphett and Onkaparinga–Woodcroft decreased by approximately 200 to 1055 people as young adults moved away from home. Examination of the proportional losses in the metropolitan area (Figure 7) indicate that, because of the large base populations, these losses comprised less than 1.0% of the population. Figure 7 also indicates that losses in the range of 200–500 in areas such as Loxton Waikerie (East and West), Northern Areas District Council (DC), Peterborough DC, Renmark Paringa DC, Tatiara DC and the Coorong DC are a more significant percentage of these populations. This may have an adverse effect on the sustainability of the agricultural workforce and ultimately on the quality of environmental management in these more marginal areas, particularly as the rural workforce continues to age and is not fully replaced by young people. A further 33 SLAs on the northern margins of these SLAs had essentially stable populations between 2006 and 2011 (i.e. population gains or losses of 99 people or less).

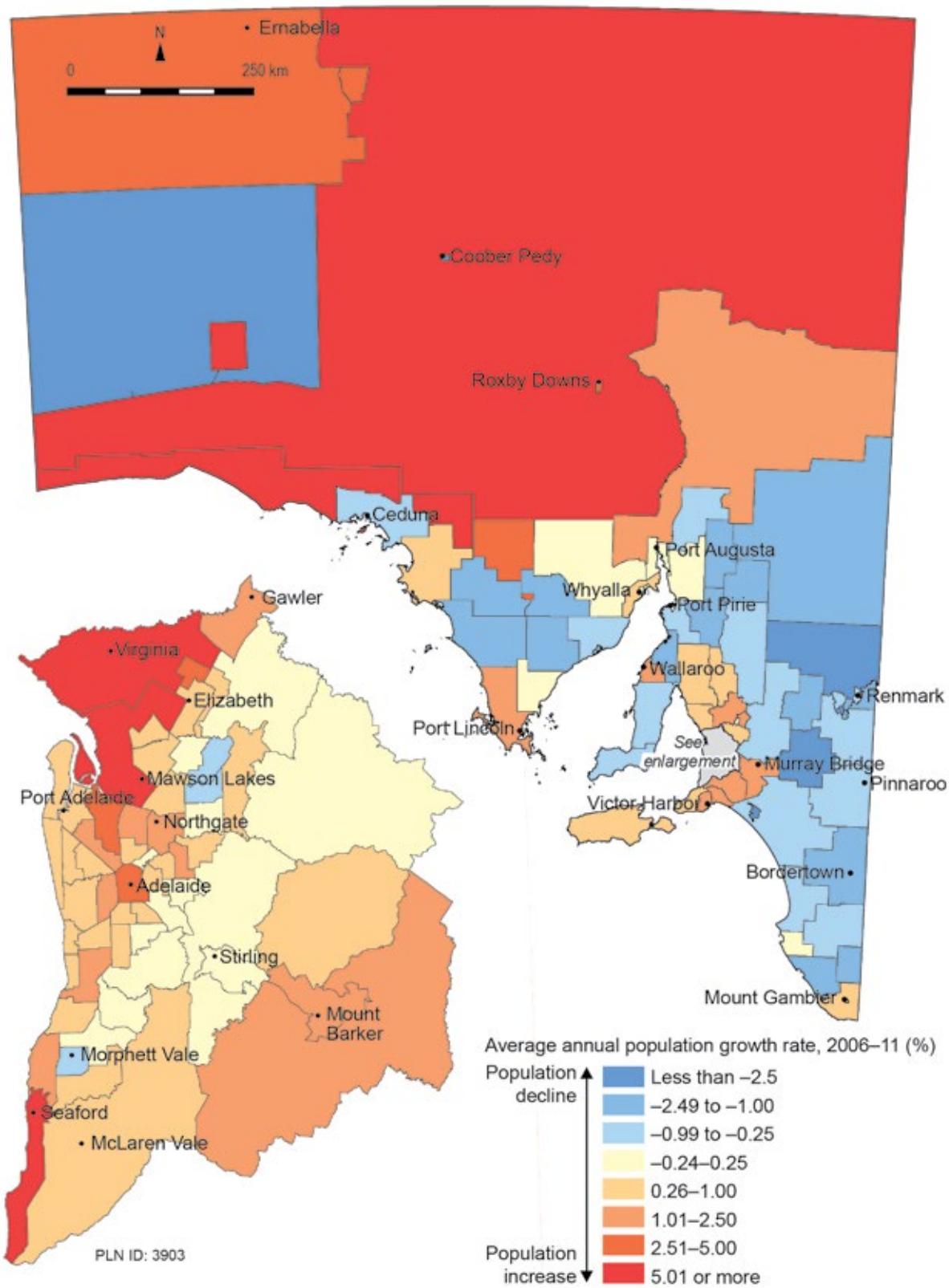


Adelaide central business district from the eastern suburbs
Department of Planning, Transport and Infrastructure



Source: ABS (2012e)

Figure 6 Absolute change in estimated resident population by statistical local area, 2006–11



Source: ABS (2012e)

Figure 7 Average annual percentage change in estimated resident population by statistical local area, 2006–11

2.3.2 Regional development

The South Australian Government has invested more than \$30 million to support minerals exploration and mining in the state, and the number of mines has more than doubled in the past five years. In 2008, the mining sector contributed \$2.8 billion to gross state product (4.3%) and employed about 7500 workers. In 2011, it contributed \$3.9 billion to gross state product (5.1%) and employed about 8800 workers.

The growth in the mining sector, and its associated high wages, has led to a shift in rural employment, with significant numbers of farm owners and employees leaving the land for employment in the mining sector. This trend is likely to continue.

In addition to this, many people who are employed in the mining sector choose to fly in and fly out to work. Although most of these employees live in Greater Adelaide, a shift may occur with some employees seeking a lifestyle change (now affordable because of higher incomes) by relocating to regional centres.

The primary production sector has continued to perform strongly over the last five years. However, there is a continuing trend towards farm amalgamation and the loss of small family farms as a result of market volatility and prolonged drought, which damaged the dairy industry in the Lower Murray.

2.4 Heritage

South Australia's heritage is made up of aspects of the past and the present that are considered worth protecting

for the benefit of future generations. This heritage can include:

- wilderness, coastlines, native vegetation and threatened species
- historic buildings and monuments
- shipwrecks, lighthouses and whaling stations
- art, artefacts, fossils, and agricultural and industrial heritage
- customs, language and beliefs.

The significance and location of the heritage help to determine the type of protection needed—for example, World Heritage listings protect and conserve heritage of global importance, and there are also national, state and local listings. Local heritage places are listed in Local Council Development Plans through the *Development Act 1993*, and state heritage places are entered into the South Australian Heritage Register by a Register Committee appointed by the independent South Australian Heritage Council. Both processes require compliance with prescribed criteria for listing.

South Australia's various heritage listings include:

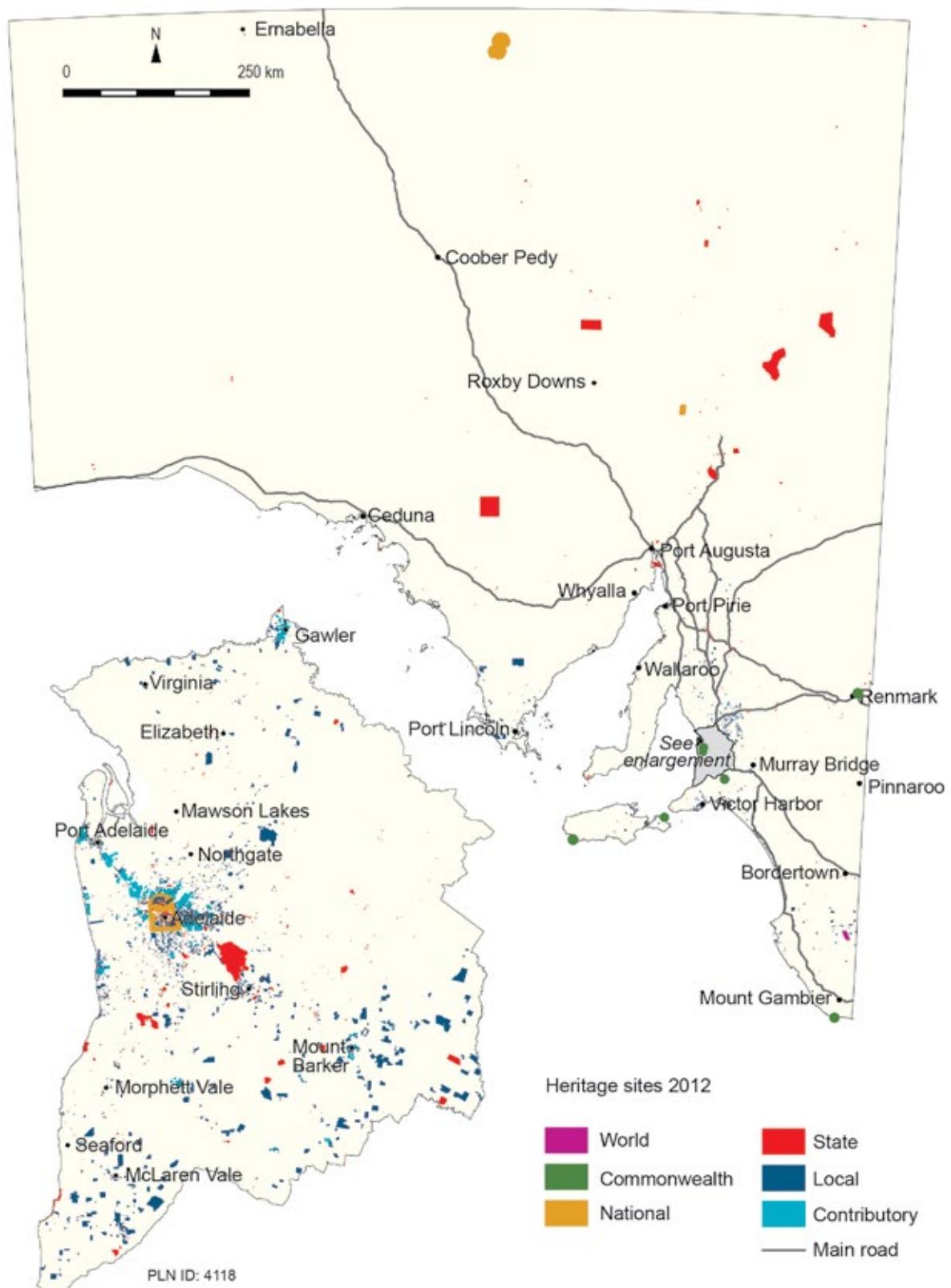
- more than 6400 local heritage places and areas
- more than 2200 state heritage places and areas
- seven heritage places and areas in the Commonwealth Heritage List
- five heritage places and areas in the National Heritage List
- one heritage place (Naracoorte Fossil Mammal Site) in the World Heritage List.

The distribution of South Australian heritage sites in 2012 is shown in Figure 8.



Houseboats at Mannum on the River Murray offer regional development through tourism

Belinda Scott



Source: Data from the Australian Heritage Database, Australian Government Department of Sustainability, Environment, Water, Population and Communities

Figure 8 Heritage sites in South Australia, 2012

3 What are the pressures?

The pressures resulting from population and economic growth include transport, pollution and waste, which impact on the environment and human wellbeing. These and other pressures also affect the heritage features of the state.

3.1 Transport

Transport is essential to the economic and social functioning of communities; however, vehicle use and transport infrastructure can have negative impacts on the environment, communities and people through pollution and energy use.

There has been a modest rise in the total traffic flow as measured by the vehicle-kilometres (the number of vehicles on a given road or traffic network multiplied by the average length of their trips measured in kilometres) travelled in the state from 2007 to 2010 (from 14 212 to 14 615 million vkm per year), but overall the estimates have changed little from earlier estimates in 2002 and 2005, suggesting only minor changes in total environmental impact.

3.1.1 Trend

Passenger vehicles (essentially private cars) dominate road use in South Australia, consistently accounting for 76% of kilometres travelled (Figure 9). Light commercial vehicles account for another 15% of the kilometres travelled. Other vehicles such as articulated trucks, rigid trucks, buses and motorcycles each account for less than 5%. The total distances travelled by these vehicles have seen little change over the years (Figure 9). In 2007–12, South Australia had the smallest growth in number of motor vehicle registrations of Australian states and territories, with a total increase of 10.2% and an average annual increase of 2%, compared with the Australian average of 13.3% and 2.6%, respectively (ABS 2012f). In Adelaide, 81.4% of people travel to work by car and 9.7% by public transport (DIT 2012a).

Cars used for private transport have increased on our roads by 3.6% in the last five years. Although

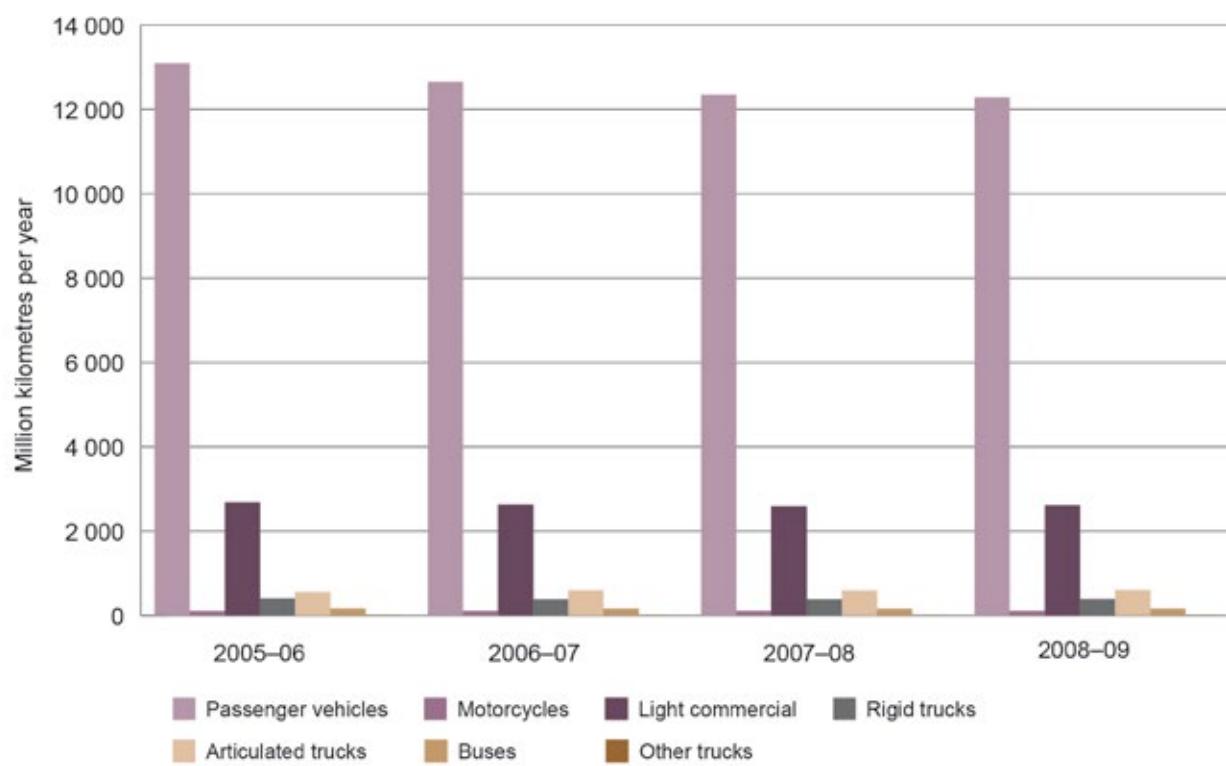
this potentially presents issues relating to increased greenhouse emissions and urban air quality impacts, new-model vehicles are becoming increasingly fuel efficient and are turning to alternative fuels and electrified drive trains. The number of motor vehicles per 1000 people increased by 8%, from 732 in 2006 to 793 in 2012. Light commercial vehicle (panel vans and utilities) registrations increased by 41% between 2007 and 2012 and now total 167 360, and light commercial tonne-kilometres (a tonne-kilometre corresponds to one tonne of freight carried over one kilometre) travelled have been steadily increasing, consistent with the increase in freight haulage noted below.

3.1.2 Freight

The state's road freight vehicles carried 184 million tonnes in 2008–09, an increase of 8.7 million tonnes or 4.9% over the previous 12 months. This suggests a significant increase in fuel usage and emissions. Despite a decline in the average laden distance of 0.6% in 2008–09, an increase in tonnes carried ensured that the annual South Australian road freight task increased by 2.7% or 0.5 billion tonne-kilometres to 18.7 billion tonne-kilometres in 2008–09 (Pekol 2011).

To date, the road transport sector has depended on petroleum-based fuels. Growth in the Australian road transport task has led to a corresponding increase in fuel consumption, which, in turn, has led to an increase in greenhouse gas emissions from the sector. The principal greenhouse gas is carbon dioxide but vehicles also produce nitrous oxide and methane, which contribute to climate change (DIT 2012).

Heavier loads from transporting goods use more fuel. As the state's freight task expands in response to growing manufacturing and mining sectors, the freight industry will need to consider further emissions abatement and offsetting, including alternative fuel use, vehicle design and modification, and maximising efficiencies through logistics planning.



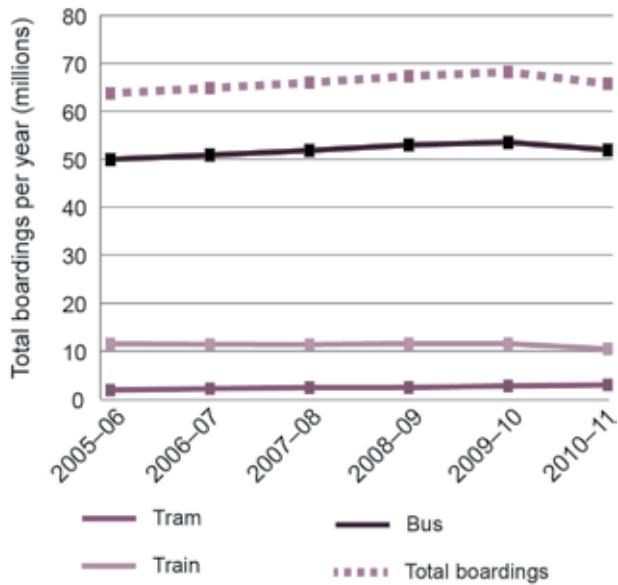
Source: CTEE (2011)

Figure 9 Annual road kilometres travelled by vehicle type in South Australia, 2005–06 to 2008–09

Growth in economic activity is projected to increase the state's road freight tonnes by 15.7 million tonnes or 18.6% by 2018–19. Given expectations for average distance travelled, average loads and road freight productivity, the annual road tonne-kilometre task is projected to increase by 19.5% to 22.8 billion tonne-kilometres in 2018–19 (Pekol 2011). Increases in volumes of freight on our roads can lead to associated increases in vehicle emissions. It is important that industry adopts measures to help mitigate or offset such increases and gradually transfer more freight to rail. The South Australian Government and the Australian Government have committed to the construction of the Goodwood and Torrens Junctions projects, which will enable longer, more reliable and more efficient trains to operate on the train network, and increase rail's competitiveness with other forms of transport. Further investment by the private sector and the Australian Rail Track Corporation in more facilities, increased capacity and increased axle loads will ensure that rail will remain competitive with road, enabling a transfer to rail where this is economically sustainable.

3.1.3 Public transport

Total patronage of public transport (tram, train and bus) has remained reasonably stable in the Adelaide metropolitan transport area since 2005–06 (Figure 2.10), with some evidence of increased patronage (especially of trams) as the service has been extended and improved. Train patronage remained relatively stable between 2005–06 and 2009–10 at 11.7 million boardings per year, but decreased in 2010–11 because of the temporary closure of lines for track upgrading. Bus boardings increased from 50.1 million in 2005–06 to 53.7 million in 2009–10. Boardings appear to have decreased in 2010–11, but this is due to additional through-running bus services that reduced the number of bus transfers required by passengers.



Source: DPTI (2011)

Figure 10 Boardings of public transport in Adelaide metropolitan area by mode, 2005–06 to 2010–11

Estimates of annual passenger-kilometres travelled by public transport are perhaps one of the best indicators of the use of public transport in metropolitan Adelaide. In 2006–07, the total annual passenger-kilometres travelled by public transport was estimated at 43.8 million, with usage increasing by between 0.9 and 1.5 million passenger-kilometres a year to reach 48.5 million passenger-kilometres in 2010–11, equating to increases of 0.9% to 3.4% per year (DPTI 2012, unpublished data). The biggest increase of 1.5 million passenger-kilometres occurred between 2006–07 and 2007–08 when the new inner city tramline from Victoria Square to City West was opened. Extension of this system to the Adelaide Entertainment Centre in March 2010 also boosted passenger usage.

3.1.4 Private vehicles

Although there has been an encouraging increase in the patronage of public transport in the Adelaide metropolitan area since 2005–06, car travel still accounts for more than 70% of the passenger-kilometres travelled on metropolitan roads, and for most of the greenhouse gas emissions. Adelaide residents still prefer the flexibility and comfort of private vehicle transport, except where there may be obvious time or financial gain from using public transport. This appears to be the case with suburban residents employed in the central business district (CBD), where carpark fees and delays

from congestion appear to discourage private vehicle use, provided there is a readily available and timely public transport alternative. Recent planning decisions to discourage additional car park construction, and the proposed levy on certain car park spaces in the CBD, are aimed at fostering this trend. Motorcycle (including scooters) registrations continued to grow at a faster rate than any other vehicle type, with an annual increase of 7.7%.

3.1.5 Bicycles

The number of cyclists travelling to and from the city increased from 6153 in 2006 to 9443 in 2011. Cordon counts of cyclists (12-hour counts of cyclists entering or leaving Adelaide CBD on an average weekday between 7am and 7pm collected in October, an ‘average’ month for cycling) have grown by 51% over the past five years—an average annual increase of 9.5%. As measured by the 2011 cordon counts, cycling accounted for 9500 trips to and from the city, or about 4.3% of all vehicle trips in and out of the city. Although counts are collected at 33 locations, they do not account for all cyclists since there are possible routes that are not covered.

3.2 Pollution

To sustainably maintain our population and economic activity, it is essential to effectively manage the impacts of pollution and waste created by human activities. This includes protection of air and water quality, protection from harmful noise and radiation, and improved management of waste. (Trends in air quality, noise, radiation and waste are covered in this chapter; water quality is discussed in the *Water* chapter).

A key approach to the monitoring and control of pollution in South Australia is the licensing of activities of environmental significance by the Environment Protection Authority (EPA). Over 2006–11, the EPA licensed 2100 such activities that included petroleum and chemical facilities, manufacturing and mineral processing, waste treatment and disposal, animal husbandry, food processing, and materials handling and transportation. In addition to controlling these significant point sources of potential pollution, the EPA also monitors the pollution from diffuse sources and evaluates the cumulative impacts from all sources on the community and environment.

The South Australian *Environment Protection Act 1993* creates a general environmental duty for everyone to take reasonable and practicable measures to avoid harm to the environment. The EPA maintains a pollution reporting

and enquiries line to receive calls about environmental concerns. In terms of the number of reports, noise stands out as an issue of concern to most people (Figure 11). If complaints about noise to local councils and the police are added, the figure becomes even more substantial. The main sources of complaints and measures to deal with noise are discussed in Section 3.2.2.

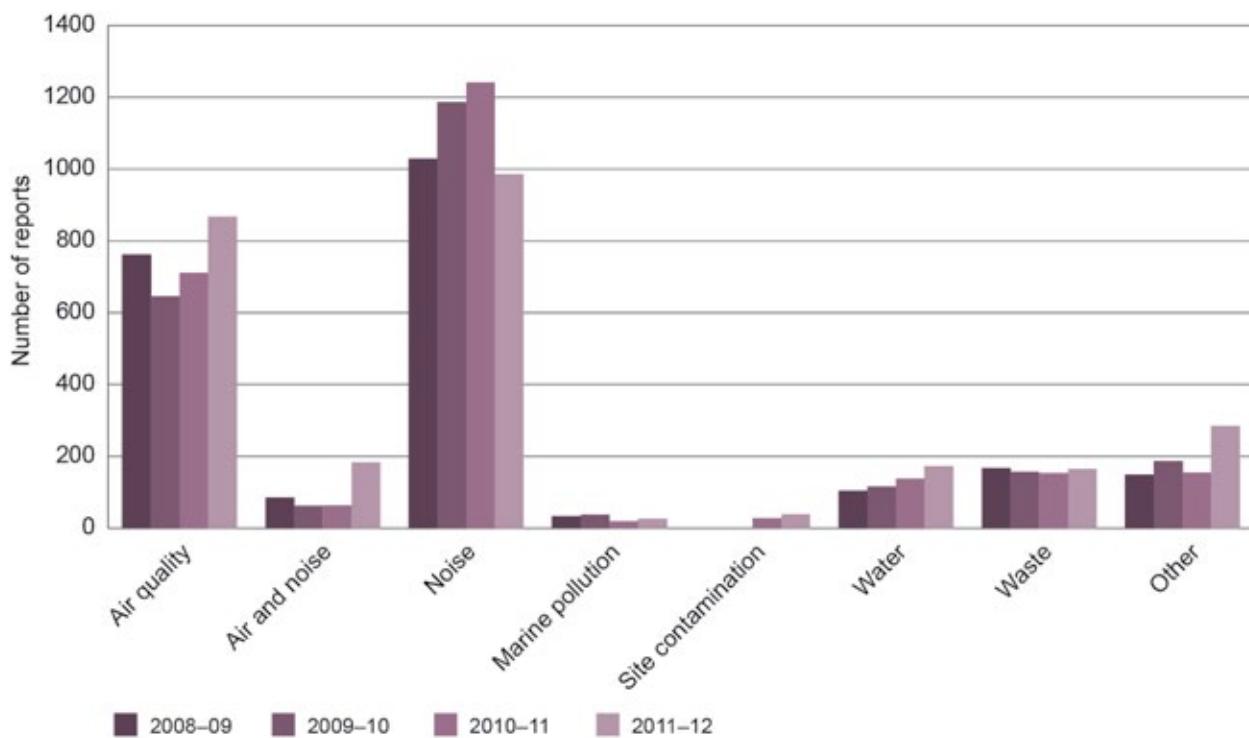
3.2.1 Air pollution

The human health effects of air pollution include aggravation of asthma, cancer, fibrosis, bacterial and fungal infection, allergic reactions and absorption of toxic materials into the blood. The risks are highest for sensitive groups such as children and the elderly.

The impacts of air pollution on ecosystems are also significant and can include loss of soil function (e.g. from acid deposition), reduction of yield of food crops and changes in the structure of plant communities. High concentrations of particulate matter can clog stomatal openings of plants and interfere with photosynthesis, leading to growth stunting or death in some plant species.

Elements of air pollution and their impact include:

- fine particles from motor vehicles, industry, agriculture, bushfires and solid fuel fires; these impact on public health, climate change, rainfall and amenity
- gaseous pollutants such as sulfur dioxide, fluoride, carbon monoxide and nitrogen oxides from industry, solid fuel fires and coal combustion; these impact on public health, flora and fauna (agriculture), corrosion of the built environment, rainfall and climate change
- air toxics and volatile organic compounds from automobiles, industry, solid fuel fires and coal combustion; these impact on public health and are contributing to an enhanced greenhouse effect
- photochemical smog; this affects the respiratory system and contributes to an enhanced greenhouse effect
- lead (heavy metals) and sulfur dioxide; these affect the central nervous and respiratory systems, particularly of children.



Note: Reports associated with site contamination were not recorded separately before 2010–11.

Source: EPA (2008–12)

Figure 11 Number of reports received by the South Australian Environment Protection Authority, 2008–09 to 2011–12

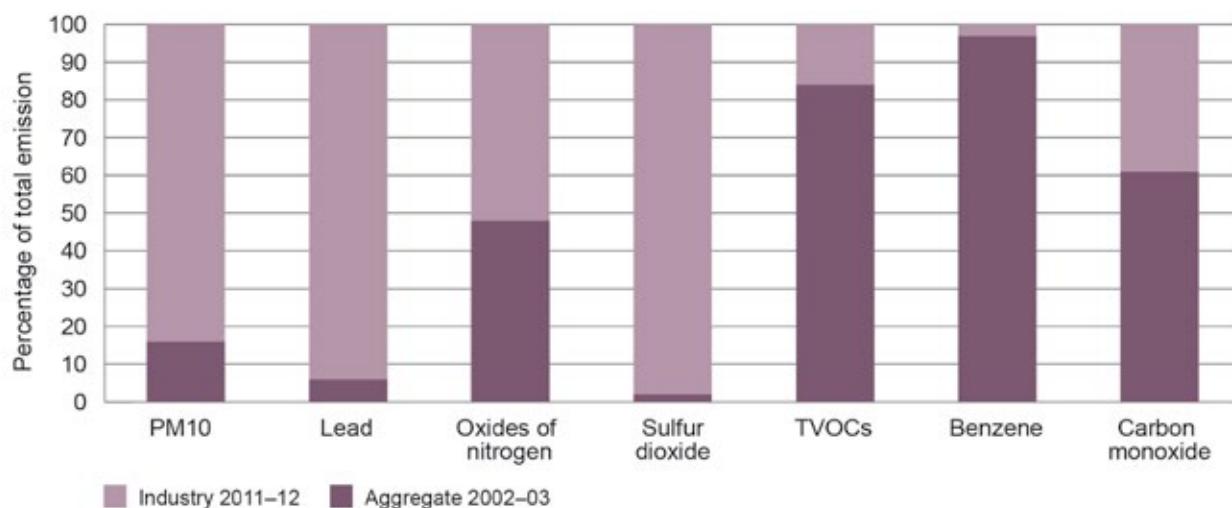
In South Australia there is particular concern about:

- particulate matter in Adelaide, Port Pirie and Whyalla
- wood smoke in Mount Gambier and Mount Barker
- sulfur dioxide at Oliver Street in Port Pirie
- lead in Port Pirie
- ozone levels in Elizabeth.

In metropolitan Adelaide, the amount of fine particulate matter (particulate matter smaller than 10 micrometres [PM_{10}] and smaller than 2.5 micrometres [$PM_{2.5}$]) in the atmosphere has decreased slightly since 2008. However, the trend remained stable over the years leading up to 2010, which was a period of serious drought in South Australia. During the drought, major dust storms and bushfires occurred on several occasions; in addition, particles normally generated in urban areas were likely to remain in suspension as they were not washed away by rain. As a result, the PM_{10} daily standard was exceeded regularly within the Adelaide metropolitan area and in the regional centres of Whyalla and Port Pirie. Trends for nitrogen dioxide, carbon monoxide, sulfur dioxide and ozone remained relatively stable from 2008–11 across metropolitan Adelaide, but sulfur dioxide levels increased at Port Pirie. There has been an overall decrease in lead particles measured at all monitoring sites.

In addition to the network of monitoring stations, an important source of information about air pollution emissions is the web-based database for the National Pollutant Inventory (www.npi.gov.au). A wide range of industries, if they exceed reporting thresholds, are required to provide estimates of their emissions each year. In addition to industry-reported data, aggregate emissions data are calculated, which include emissions from a broader range of sources including vehicles, lawn mowers, small engines, wood heaters and petrol stations. The last time aggregate data were updated was in 2002–03, partly because it is a resource-intensive process that requires inputs from many sources including modelling, surveys, socio-economic statistics, emission factors, fuel usage and traffic data.

Figure 12 compares the most recent industry data from 2011–12 with aggregate data from 2002–03, indicating the relative significance of industry and aggregate air emissions for key air pollutants. In South Australia, total volatile organic compounds, benzene and carbon monoxide emissions are dominated by aggregate sources while PM_{10} , lead and sulfur dioxide are dominated by industrial sources. Approximately equal shares can be attributed to industry and aggregate sources for nitrogen oxides.



PM_{10} = particulate matter less than 10 micrometres in diameter; TVOCs = total volatile organic compounds
Source: National Pollutant Inventory

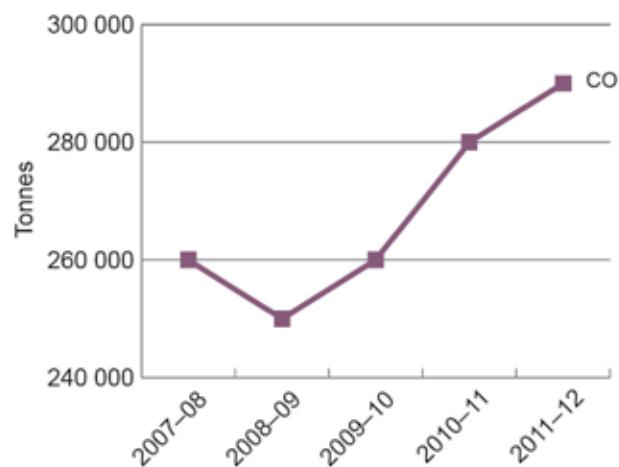
Figure 12 Comparison of aggregate and industrial sources of air emissions in South Australia 2002–03 and 2011–12

Trends in key substances from industrial sources were stable over 2007–12 for most emissions except PM₁₀, carbon monoxide, and lead (Figure 13a–d). The increase in PM₁₀ reported under the National Pollutant Inventory is not mirrored in the data from monitoring stations discussed below, presumably because the increase was caused by an increase in regional mining activities not captured by the network of monitoring stations.

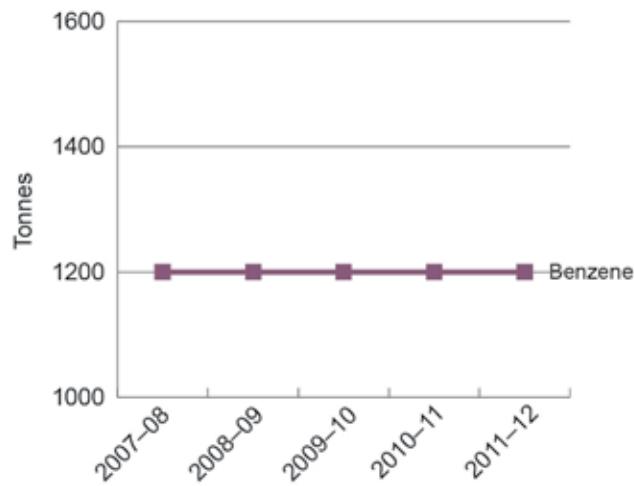
Generally, during dry conditions and when winds are high, dust blown from regional areas may combine with

other forms of particle pollution, such as those from industry, motor vehicles, bushfires and sources in the metropolitan area, to cause dust levels above National Environment Protection (Ambient Air Quality) Measure 1998 (Air NEPM) standards. However, increased rainfall and humidity have been major factors in reducing these levels in 2011 (Figure 14). The metropolitan monitoring network provides a comprehensive picture of particle concentrations across Adelaide.

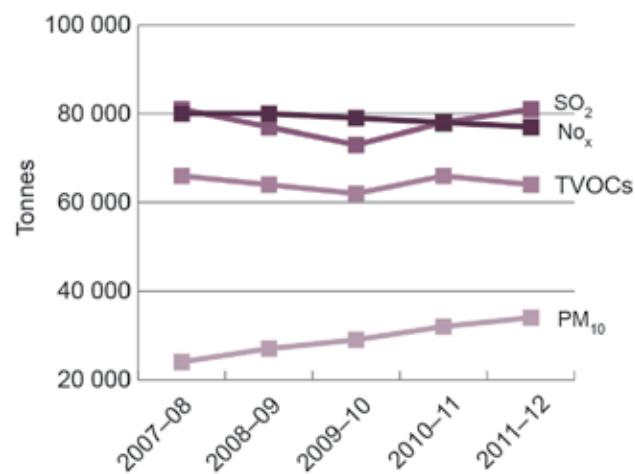
a Trends in emissions of carbon monoxide (CO)



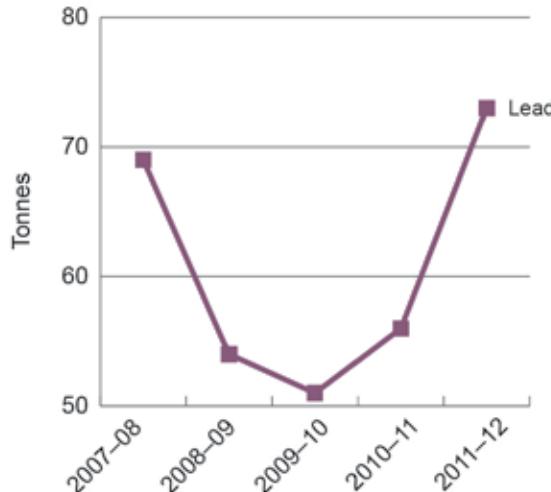
c Trends in emissions of benzene



b Trends in emissions of sulfur dioxide (SO₂), oxides of nitrogen (NO_x), total volatile organic compounds (TVOCs) and particulate matter (PM₁₀)

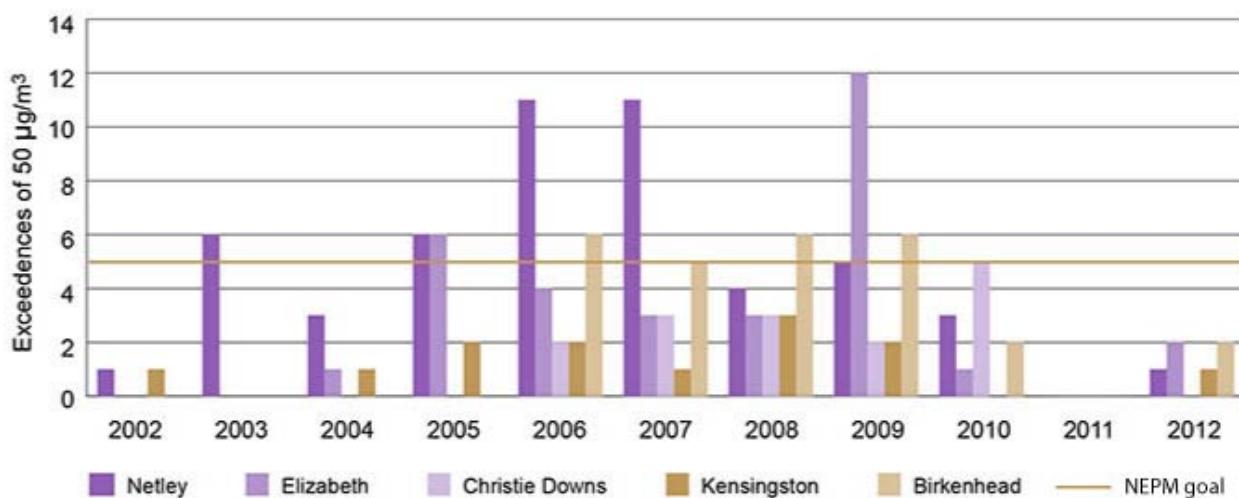


d Trends in emissions of lead and compounds



Source: National Pollutant Inventory

Figure 13 Trends in emissions in South Australia reported under the National Pollutant Inventory, 2007–08 to 2011–12



NEPM = National Environment Protection (Ambient Air Quality) Measure; PM₁₀ = particulate matter smaller than 10 micrometres
Note: No exceedences of the Air NEPM standard or goal occurred in 2011.

Source: Environment Protection Authority data

Figure 14 Annual exceedences of the Air NEPM PM₁₀ standard at Adelaide monitoring sites, 2002–12

Air monitoring in Whyalla

The Whyalla monitoring network measures particle concentrations at residential and near-industry sites across Whyalla. Exceedences of the Air NEPM standard have reduced in recent years as a result of improved industry emission controls and wetter weather (Figure 15).

Air monitoring in Mount Gambier

Air quality monitoring of particle concentrations in Mount Gambier showed numerous exceedences of the Air NEPM standards during winter, resulting in poor winter air quality. The data also showed a decrease in PM₁₀ particles between 2010 and 2011 winter monitoring. Overall, winter patterns of fine particle pollution continued to be consistent with the dominance of wood smoke on cold winter nights. Episodes of pollution comprising coarser particles from sources on the fringes of Mount Gambier were recorded and were possibly contributed by industries in the region.

Spring monitoring in 2011 showed a decrease in fine particles from residential areas and improved air quality, with no exceedences of Air NEPM standards during this period. There was, however, an increase in both PM_{2.5} and PM₁₀ particles from the industrial sector.

3.2.2 Noise pollution

Noise above safe levels leads to a number of known health impacts such as stress, high blood pressure, loss of sleep, inability to concentrate and loss of productivity. It has similar effects on the wellbeing of animals, and noise

has been shown to affect the reproductive capacity of some animals.

Main sources of noise are:

- industrial noise (including mining, freight terminal operations, etc.)
- transport noise (from roads, vehicles, trains and airports)
- construction and garbage collection noise
- domestic tool and machine noise
- dogs barking.

At present, the most significant noise issues arise from transport (particularly rail). With the proposed increase of residential dwellings adjacent to transport corridors by the 30-Year Plan, there will be an increase in the number of people potentially exposed to noise. However, as detailed in Section 4.3.5, new building code specifications have been put in place to mitigate the noise exposure of residents. Some local councils also provide assistance to reduce noise exposure in existing dwellings, such as the acoustic advisory service and noise management incentive scheme offered by the Adelaide City Council (Adelaide City Council 2013).

The number of noise complaints recorded by the EPA during 2007–12 were:

- 2007–08: 939
- 2008–09: 1029
- 2009–10: 1186

- 2010–11: 1241 (and 329 enquiries; the EPA started recording noise-related enquiries [as distinct from complaints] from 2010–11)
- 2011–12: 1170 (and 354 enquiries).

Although the numbers show a general increase, the following qualifications apply:

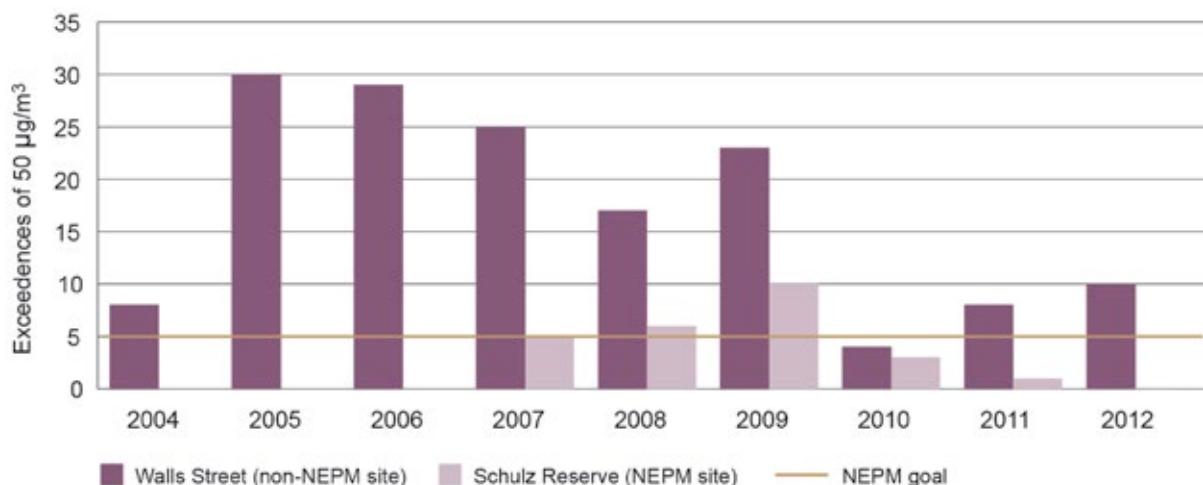
- The same person may complain about the same noise source more than once and, as each complaint is recorded separately, this could lead to double counting.
- Noise complaints may be included as a secondary complaint in other complaints and thus not be captured separately.
- The data above is only for complaints made to the EPA and exclude complaints to councils and the police.

The number of complaints to local councils in relation to barking dogs exceeds the total number of complaints about noise from all sources made to the EPA (Table 3). The trend remains stable, indicating that current measures (a fine for the dog's owner) are ineffective.

Table 3 Complaints to South Australian councils about barking dogs, 2008–12

Year	Metropolitan area	Rural and regional areas	Total
2008–09	2767	1479	4246
2009–10	2638	1838	4476
2010–11	2262	1974	4236
2011–12	2979	1006	3985

South Australia has a significant wind resource, which has been the focus of development in the renewable energy sector over the past 10 years. The result has been significant development of wind farms across the state, the majority of which have concentrated in the Mid North and South-East regions. In recent years, wind farm installations have been associated with an increase in noise complaints. The focus of these complaints centres on 'low frequency' sound output of the wind farm, which is currently the topic of further research by the National Health and Medical Research Council (NHMRC 2010) and targeted monitoring by the EPA.



NEPM = National Environment Protection (Ambient Air Quality) Measure; PM₁₀ = particulate matter smaller than 10 micrometres

Note: Compliance with the Air NEPM is assessed at Schultz Reserve only. Monitoring at Walls Street commenced on 2 July 2004; monitoring at Schultz Reserve commenced on 27 April 2007.

Source: Environment Protection Authority data

Figure 15 Annual exceedances of the Air NEPM PM₁₀ standard at Whyalla monitoring sites, 2004–12

3.2.3 Site contamination

Site contamination in South Australia is regulated through specific provisions in the *Environment Protection Act 1993* and the Environment Protection Regulations 2009. These provisions define site contamination, assign responsibility and give the EPA authority to retrospectively deal with site contamination.

The EPA has developed a set of guidance material and other publications to communicate site contamination issues and requirements to affected parties. Property owners, occupiers and others have a legal obligation pursuant to section 83A of the Environment Protection Act to advise the EPA of any site contamination that affects or threatens underground water. When the EPA becomes aware of off-site contamination via groundwater, they or an appropriate person advise the people who are potentially directly affected of the level of, and evidence for, any risk. In addition to advising potentially affected residents, the EPA maintains a searchable web-based index of notifications of impacts to groundwater. To further ensure the protection of human health, the South Australian Government discourages the use of groundwater from a well or bore unless it has recently been tested and shown to be safe for that purpose.

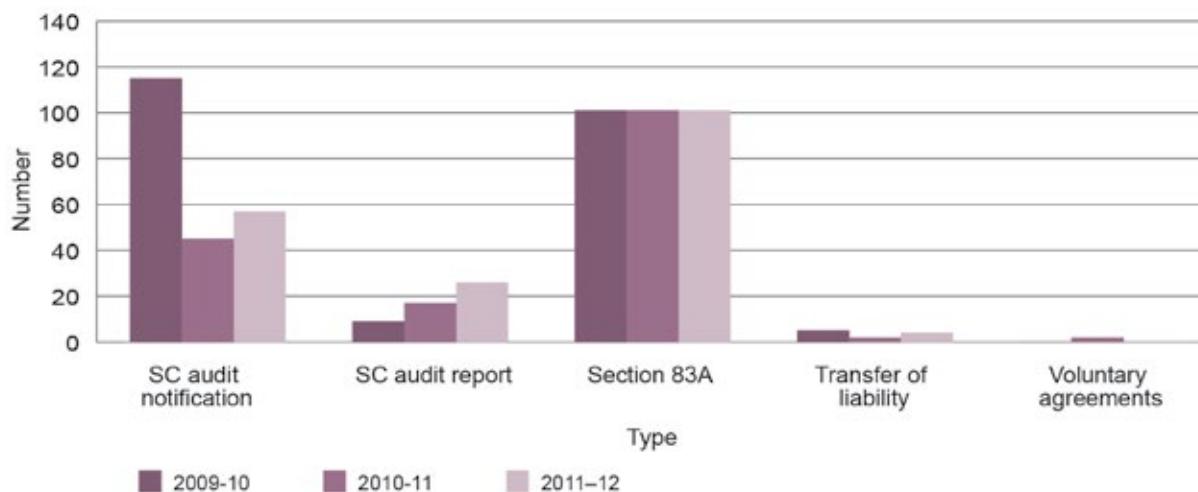
On 1 July 2009, amendments to the Environment Protection Act were introduced to specifically deal with site contamination. The EPA has recorded the following information specific to site contamination on the public

register under section 109 of the Environment Protection Act up to 15 June 2012 (Figure 16):

- 217 notifications of the commencement of a site contamination audit under section 103Z(1)
- 52 site contamination reports received and accepted under section 103Z(3)
- 303 notifications of site contamination of underground water under section 83A
- 11 exclusions or limitation of liability for site contamination under section 103E
- 2 approved voluntary site contamination assessment proposals under section 103I.

Increases in population and population density are likely to lead to redevelopment of previous industrial sites for more sensitive purposes (e.g. residential), and development closer to landfills and contaminated sites. This will necessitate careful investigation and spatial monitoring of contaminated sites, including those abandoned after industrial uses decades ago. Information about current and recent site contamination investigations can be viewed on the EPA's website (www.epa.sa.gov.au/environmental_info/site_contamination).

One of the complexities of site contamination is that chemical substances can migrate to surrounding properties through the soil or groundwater, causing offsite contamination. This poses obvious risks where, for example, the site contamination affects groundwater that is used by surrounding residents through a bore or other means. (See the *Water* chapter for further information about groundwater.)



SC = site contamination

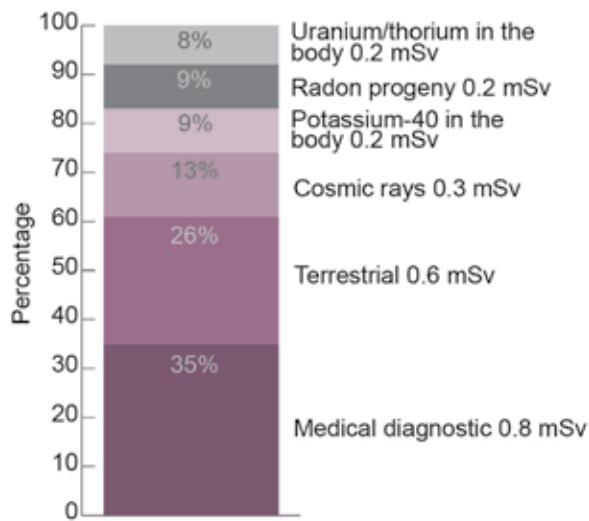
Source: Environment Protection Authority data

Figure 16 Site contamination information recorded on the South Australian public register, 2009–10 to 2011–12

3.2.4 Radiation

Ionising radiation

Natural radiation sources contribute around 65% of the annual per person radiation dose to the Australian population, with around 35% of the dose coming from the diagnostic use of radiation (X-rays) in health care and from radiation treatment for cancer (Figure 17).



mSv = millisievert

Source: Hardege (2005)

Figure 17 Australian annual per person radiation dose from natural and medical sources

Non-ionising radiation

Sources of non-ionising radiation include mobile telephones and base stations, power lines, lasers and cosmetic tanning units. The harmful effects of exposure to high levels of non-ionising radiation are well known (such as high exposure to ultraviolet [UV] radiation, which increases the risk of skin cancer), but there is little scientific evidence of harmful effects from chronic low levels of exposure. The greatest source of exposure of South Australians to UV radiation is the sun, although exposure can also be associated with the use of a range of industrial, medical, domestic and cosmetic devices. The public perception of UV radiation risk associated with the use of cosmetic tanning units has changed and the number of businesses operating cosmetic tanning units has decreased, falling from 35 in 2010–11 to 27 in 2011–12.

Radiation from uranium and mineral sands

Uranium mining and mineral sands industries play a significant role in South Australia's economic development, and are expected to continue to do so

into the foreseeable future. Although the main radiation exposure from uranium mining is to workers at sites, all doses received by workers who are exposed to radiation are well below the occupational limits prescribed in state, national and international legislation. Radiation monitoring continues to indicate that doses to workers who are not exposed to radiation, and other workers offsite, are not above normal background levels.

Figure 18 shows the locations of uranium deposits in South Australia (DMITRE 2012).

3.3 Waste

With an increasing and more affluent population and a growing diversity of consumer goods, waste is a significant environmental, social and economic issue. In addition to the waste generated by the disposal of products, urban renewal generates demolition and building wastes, and agricultural and industrial processes generate chemical and other hazardous wastes.

3.3.1 Waste trends

Table 4 and Figure 19 provide a summary of total waste generated in South Australia since 2003–04 and the changes over time in the proportion of recycled waste and waste going to landfill.



Source: DMITRE (2012)

Figure 18 Location of uranium deposits in South Australia

Table 4 Annual South Australian resource recovery, landfill quantities and waste per person, 2003–11

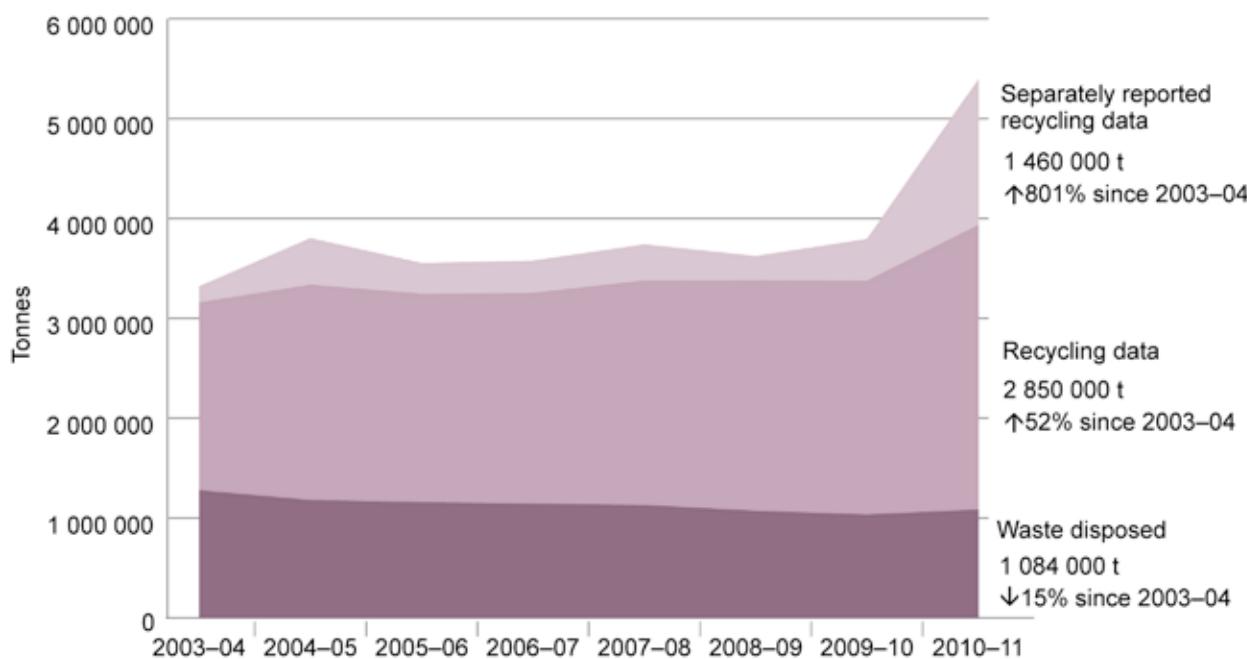
	2003–04	2005–06	2006–07	2007–08	2008–09	2009–10	2010–11	Change (%)	
								2009–10 to 2010–11	2003–04 to 2010–11
Total recycling reported	2 042 000	2 396 000	2 434 000	2 611 000	2 552 000	2 760 000	4 310 000	56	111
<i>Recycling data (tonnes)^a</i>	1 880 000	2 088 000	2 110 000	2 248 000	2 309 000	2 340 000	2 850 000	22	52
<i>Separately reported recycling data (tonnes)^b</i>	162 000	308 000	324 000	363 000	243 000	420 000	1 460 000	248	801
Waste to landfill (tonnes)	1 278 000	1 158 000	1 144 000	1 130 000	1 072 000	1 035 000	1 084 000	4.7	-15
Total waste generation (tonnes)	3 320 000	3 554 000	3 578 000	3 741 000	3 624 000	3 795 000	5 394 000	42	62
Recovery rate (%)	61.5	67.4	68.0	69.8	70.4	72.7	79.9	10	30
<i>Excluding extra soil from major infrastructure projects^c</i>							74.8	2.9	22
South Australian population	1 534 000	1 550 042	1 584 500	1 601 800	1 622 700	1 644 600	1 657 000	0.8	8
Per person diversion to recycling (kg)	1 330	1 550	1 540	1 630	1 570	1 680	2 600	55	95
Per person landfill (kg)	830	750	720	710	660	630	650	3.2	-22
Per person total waste (kg)	2 160	2 300	2 260	2 340	2 230	2 310	3 250	41	50

a Includes most of the traditionally reported material categories

b Data for recycled soil, sand, rock and fly ash materials

c Includes waste fill generated from projects such as the Adelaide Desalination Plant and the Royal Adelaide Hospital

Source: Rawtec (2012)



Source: Rawtec (2012)

Figure 19 Annual South Australian recovery and landfill disposal, 2003–04 to 2010–11

In 2010–11, 5.4 million tonnes of waste was generated in South Australia, an increase of 42% since 2009–10 and of 62% since 2003–04 (Figure 19; Rawtec 2012).

In 2010–11, South Australians diverted 79.9% (4.3 million tonnes) of materials from landfill to recycling—a 56% increase from the 2.76 million tonnes recycled in 2009–10 and a 111% increase from the 2.04 million tonnes recycled in 2003–04 (Rawtec 2012).

The large increase in 2010–11 was attributed to approximately 1.26 million tonnes of waste fill diverted to recycling from major infrastructure projects including the Adelaide Desalination Plant and the Royal Adelaide Hospital. After subtracting the effects of these infrastructure projects from South Australia's 2010–11 resource recovery data, South Australia still achieved a recovery rate of approximately 74.8%, an increase of 2.9% from 2009–10.

The total waste generated per person has risen by 50% since 2003–04. The per person recycling rate has increased to the second highest level of the last seven years at 2600 kilograms.

Along with conventional types of household waste such as paper and plastics, the amount of waste generated from electrical and electronic products has increased substantially. In 2007–08, 31.7 million new televisions, computers and computer products were sold in Australia. In the same year, 16.8 million televisions, computers

and computer products were disposed of in Australia, with 84% going to landfill. The phase-out of analogue televisions is contributing to this figure. Waste volumes are expected to increase dramatically: the number of these items reaching their end of life is anticipated to increase to 44 million by 2027–28 (Hyder Consulting and PricewaterhouseCoopers 2009).

In South Australia, it is estimated that the total waste for televisions and computers in 2011–12 was 427 700 units. By 2015–16, this is expected to grow to 668 200 units, an increase of 56% (Equilibrium 2012).

3.3.2 Waste management

Mounting pressure on global energy and mineral resources (as reflected in rising prices and resource scarcity) is a key driver for the reuse, recycling and recovery of resources as measures to use materials and energy more efficiently. This is consistent with the waste hierarchy, an internationally accepted guide for prioritising waste management (Figure 20).

Costs associated with recycling and disposal of waste influence behaviour. Costs include transport, government levies and charges, and infrastructure operating costs. In particular, regional and outback areas of South Australia find it difficult to support recycling programs because of transport costs, limited access to end markets for recyclable materials, and lack of sufficient volumes

to make resource recovery and waste management financially viable. The level and volatility of international commodity prices place pressure on recycling and recovery of materials, and make it difficult for recyclers to respond to market conditions.



Source: Zero Waste SA (2011)

Figure 20 Waste hierarchy

As detailed above, electrical and electronic products are an increasing component of waste. Televisions, computers and other electronic items contain valuable resources such as tin, nickel, zinc, aluminium and copper, and hazardous materials such as lead, mercury, cadmium, and brominated and antimony compounds. Close to 100% of the materials in televisions and computers can be recovered (Hyder Consulting and PricewaterhouseCoopers 2009); however, it is labour intensive to separate these components.

Materials recovery infrastructure in the Adelaide metropolitan area is ageing and in need of modernisation and refurbishment. New technologies make it more efficient to sort materials and reduce contamination of recycled materials. Changes in the materials of commonly used products (such as from wood to plastics), or the introduction of completely new materials (such as rare tantalum and neodymium) and the use of

composite materials (metallised plastics or copolymers) means that waste from these products becomes more complex, and often more difficult to separate into their component elements.

Although there is no current scientific evidence regarding the health and environmental risks from televisions, computers and other electrical products in Australian landfills, it is recognised that there are potential risks associated with leaching and evaporation of hazardous substances from landfill into soil and groundwater (Hyder Consulting and PricewaterhouseCoopers 2009).

The trend of increasing use of toxic substances (e.g. in pharmaceuticals, paint, herbicides, insecticides) and the unrecorded stockpile of banned substances in sheds and on farms also places pressure on the proper collection, treatment and disposal of these substances.

Food waste is often overlooked as an important waste type because it is biodegradable and is typically thrown away with other household waste. A large part of wasted food is made up of scarce soil-derived water, minerals and energy; after this enters landfill it produces methane, a powerful greenhouse gas. In the context of South Australia's generally poor soils, food waste is a potentially important source of organic fertiliser. Following a successful trial in 2010, a number of local councils are now providing a food waste recycling service.

3.4 Heritage

Development pressure, insufficient resources, a shortage of conservation skills and divergent views about the importance of some places all contribute to the risk of inadequate protection for South Australia's heritage places. There are also pressures on remote natural heritage places from development such as mining, which may require special responses to manage. One example is the South Australian Government's ban on mining in Arkaroola through special-purpose legislation.

Heritage expertise is held by a small group of highly skilled craftspeople and professionals, and there is a risk of future gaps in skills. Many heritage places are also at risk of deterioration as a result of declining resources for maintenance and renewal.

4 What are we doing about it?

The South Australian Government has established overarching policies and programs, as well as controls and activities to address specific pressures.

4.1 Policies and programs

South Australia has a number of policies and programs in place to address the pressures of population and economic growth in urban and regional areas.

4.1.1 Adelaide

Adelaide is characterised by low population densities, with mostly detached dwellings on medium-sized blocks of land (although the median lot size in South Australia is now one of the smallest in Australia), and residential areas sited some distance from places of employment. This dispersed, low-density type of urban design is very energy intensive and wasteful of land and other resources (Newman and Kenworthy 1989, Newman 1999, Trubka et al. 2007). The 30-Year Plan promotes a more sustainable, compact urban design while still enabling growth. This is to be achieved through a variety of means, including:

- increasing density
- co-locating services with transport and mixed-use development
- promoting walkable environments
- reducing overall reliance on car travel
- promoting short-distance travel and public transport
- increasing energy efficiency of buildings
- promoting alternative energy use
- promoting green technologies
- establishing networks of greenways and open space
- incorporating water-sensitive urban design techniques into new developments
- requiring new developments to be connected to alternative water sources.

The 30-Year Plan, as a whole-of-government policy, offers an opportunity to reduce the use of resources and

create less waste and pollutants by decreasing car travel, promoting public transport and shortening the journey to work (Gray et al. 2010). It also offers improved access to services and employment.

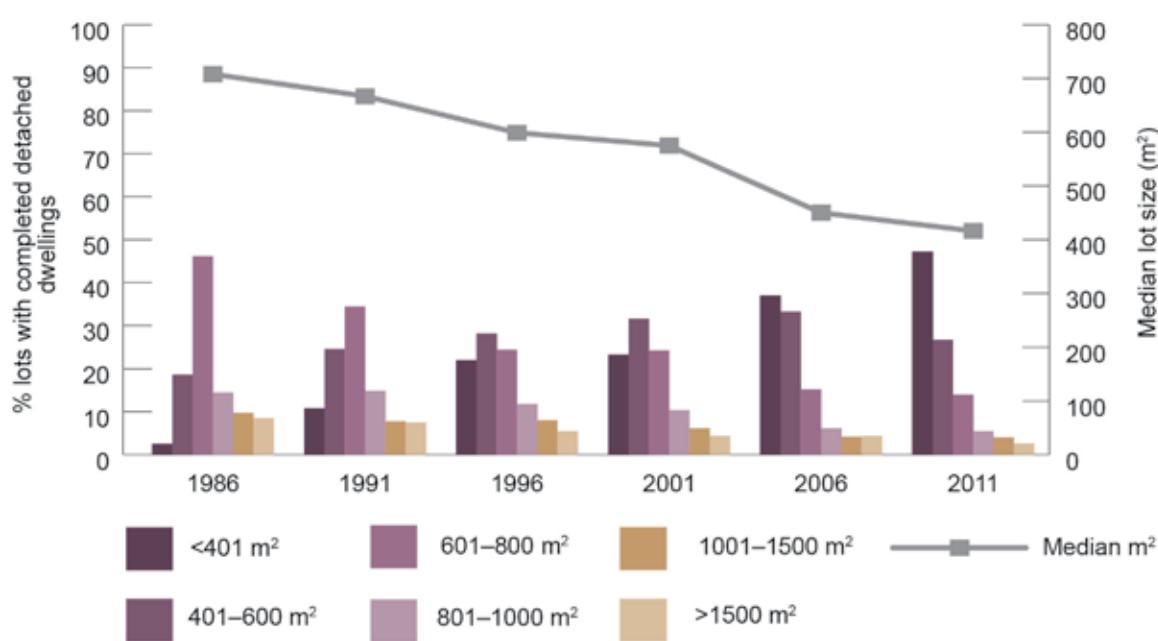
The 30-Year Plan has set a target ratio of infill-to-fringe residential development of 70:30 by 2036. This will be achieved by locating the majority of new housing in existing zoned urban areas, particularly around transport corridors. With new building codes and planning policy, this should not increase exposure to noise and air pollution. In addition, to further protect rural lands from residential development, the government has introduced measures to protect the McLaren Vale and Barossa regions from residential subdivision.

In the first stage of the process, the government has developed a range of new land-use planning zones. These zones:

- allow a combination of major land-use types (such as residential, retail, office, commercial and civic) in compact and higher density growth and regeneration areas
- support an innovative mix of higher density urban development on land that abuts key transit corridors.

Higher density living within the Adelaide metropolitan area presents opportunities for more effective waste management and promotion of reuse, and redevelopment of existing infrastructure.

Initiatives to reduce the lot size of recently completed detached dwellings within Greater Adelaide and planning policy that promotes redevelopment in established urban areas have had a significant impact in slowing Adelaide's urban sprawl. Since 2001, the number of small lot sizes (less than 600 square metres) had increased to such an extent that by 2006 they accounted for the majority of the detached dwelling completions in the Adelaide and Outer Adelaide Statistical Divisions (Figure 21). This trend has continued since 2006 and, by 2011, the median lot size in these two statistical divisions was just 416 square metres, significantly smaller than comparable estimates from other metropolitan areas interstate (HIA Economics Group 2011).



Note: The data are for calendar years and exclude Kangaroo Island.

Source: June 2012 property cadastre and valuation snapshot, Department of Planning, Transport and Infrastructure

Figure 21 Lot size of detached dwellings by year of completion, Adelaide and Outer Adelaide statistical divisions, 1986–2011

In addition to, and complementing, the change to a compact urban design, the government is developing a range of water-sensitive urban design policies and initiatives, including a blueprint for urban water for Greater Adelaide that integrates use of all water sources, including stormwater and recycled wastewater. The blueprint will provide overall strategic direction for water planning in South Australia; refer to the *Water* chapter for more details.

4.1.2 South Australia's Strategic Plan

Progress against South Australia's Strategic Plan (SASP) (SASP Audit Committee 2012) includes:

- SASP Target 45: Increase South Australia's population to 2 million by 2027.

This target is unlikely to be achieved because it requires an average annual growth rate of 1.26%, which is higher than the average annual growth rate recorded between 2003 and 2011 (0.9%). The target is also above the 1.1% 'high growth' scenario projection issued by the ABS (ABS 2008). Achievement of the target will be influenced by net overseas migration.

- SASP Target 46: Increase regional populations outside Greater Adelaide by 20 000 to a total of 320 000 or more by 2020.

Progress on this target is rated as 'steady or no movement' but 'within reach'. A decrease in population between the 2010 baseline and 2011 and a change in boundaries mean that an increase of 25 400 people is required by 2020 to reach the target population of 320 000. At the current rate of net regional population growth, this target is likely to be met after 2020.

- SASP Target 56: Ensure the provision of key economic and social infrastructure accommodates population growth.

The target does not lend itself to ready assessment and the SASP Audit Committee recommended that the wording be reviewed. The formation of a new Department of Planning, Transport and Infrastructure in 2011 will help ensure that transport and infrastructure needs are considered in the early planning stages for areas of identified population growth.

- SASP Target 63: Increase the use of public transport to 10% of metropolitan weekday passenger vehicle-kilometres travelled by 2018.

Progress towards the target has been assessed as positive and its achievement as within reach, although public transport use is required to increase at an

accelerated rate to achieve the target by 2017–18.

Significant activity is focused on improving public transport, supported by implementation of the 30-Year Plan.

- SASP Target 67: Reduce waste to landfill by 35% by 2020.

This is an ambitious goal, but achievement of the target is within reach. The government released an updated waste strategy (Zero Waste SA 2011) in December 2011 with two key objectives: maximising the useful life of materials through reuse and recycling, and avoiding and reducing waste.

- SASP Target 68: By 2036, 70% of all new housing in metropolitan Adelaide will be built in established areas.

This is a new target in the 2011 SASP and was tracking at 57% in 2010. This reflects current levels of land supply in the various locations at the beginning of the intended life of the 30-Year Plan. In addition, in 2010, 43.5% of the newly built houses in metropolitan Adelaide were built within 800 metres of the current or extended transit corridors indicated in the 30-Year Plan. Opportunities for more infill around transit corridors will increase as local development plans are amended to introduce new zoning policies.

In SASP 2012, the South Australian Government announced seven strategic priorities that identified the areas of the SASP that the government has chosen to focus on (DPC 2012). The work, budgets, policymaking and legislative agenda of the government will reflect these priorities. The seven priorities are:

- creating a vibrant city
- safe communities, healthy neighbourhoods
- an affordable place to live
- every chance for every child
- growing advanced manufacturing
- realising the benefits of the mining boom for all
- premium food and wine from our clean environment.

4.1.3 Planning Strategy for South Australia

Progress against the Planning Strategy for South Australia (PSSA; Government of South Australia 2011a) (to December 2011) includes:

- The share of overall new housing in the established areas of metropolitan Adelaide as a proportion of the total housing built across the remainder of Greater Adelaide, including fringe areas and towns and rural locations, has tracked between 56% and 58% in 2008–10.

- Ecosystem restoration initiatives, including tree planting and revegetation, are being undertaken by the natural resource management (NRM) boards (see the *Introduction* for more information on NRM regions) and local councils. Work undertaken by the Adelaide and Mount Lofty Ranges NRM boards during 2009–10 to increase the extent of functional ecosystems included reconstruction of 243 hectares of land, and management of native vegetation on 7339 hectares of land.
- Climate change modelling indicates that new urban design will contribute to an overall decline in the state's greenhouse gas emissions.
- Air quality is being addressed as part of the government's planning policy reforms, the first stage of which was completed in 2011.
- The government has committed \$12 million over four years towards the development of greenways (including cycling and walking corridors) along major transit corridors. Work commenced in 2010–11 on developing a greenway from Adelaide to Marino Rocks along the Noarlunga rail line.
- Water-sensitive urban design and natural resource management will be addressed as part of PSSA reforms, likely to be undertaken from 2013–15.
- In 2010–11, renewable energy comprised 22% of South Australia's electricity production. This is considerably higher than the 4.1% recorded in 2004–05 and the 9.7% in 2007–08, and is already above the Strategic Plan target of 20% renewable energy production by 2014 (DPC 2012).
- New dwellings, or additions of more than 50 square metres that include a wet area, are required to be connected to rainwater tanks and have hot water systems that are either solar heated, gas heater compliant or wood combustion heated.

4.2 Transport

Complementing the new urban design, which supports compact development and less reliance on individual car travel, the South Australian Government is attempting to decrease the impact of transport on the environment by promoting active travel (e.g. cycling and walking) and expanding and modernising the state's public transport.

The government has developed a 'Streets for People' (South Australian Active Living Coalition 2012ab) compendium to provide guidance for a rethink of conventional street design to support increased physical activity. The compendium presents key principles to shape pedestrian and cycling-friendly streets, introduces the

Link and Place street design approach, and clarifies the approval process and addresses risk and liability issues. The Streets for People principles have already influenced emerging designs in the Bowden Development and the Leigh and Bank streets revitalisations.

Significant public transport works are currently under way to improve the public transport network. A reliable and effective public transport system is a key tool to successfully implementing new urban design. In 2008 the South Australian Government began a decade-long investment (\$2.6 billion including Australian Government funding) to provide faster, more frequent, less energy intensive, less polluting and more efficient services for train, tram and bus customers, and a safer public transport system. Changes include the following:

- An extra 100 buses are now on the network, providing more than 750 additional services focusing on high-demand areas and incorporating an extension of Adelaide Metro bus services to Gawler. Adelaide's most used public transport corridor, the O-Bahn bus way, is now serviced by more buses.
- An extended tram line to the Adelaide Entertainment Centre provides a free public transport option to customers, along with a park-and-ride facility.
- The tram line has been extended, providing a service from Glenelg to the city and Hindmarsh. An additional four trams were introduced in 2011–12, bringing the total fleet number to 21.
- The South Australian Government has committed to a long-term investment in public transport, including a 5.5-kilometre extension of the Noarlunga rail line

to Seaford. Future plans include completing the electrification of the Seaford line and adding up to 66 new electric railcars. Complete electrification of the Gawler and Outer Harbour lines remains a target.

- The train line upgrades are the first steps towards electrification of the metropolitan network, which will result in significant reductions of carbon dioxide emissions for the state.
- Almost 300 extra buses over the next decade will deliver bus feeder services, linking local areas to dedicated rail corridors and high-frequency bus corridors.

The average age of South Australia's vehicle fleet decreased from 11.1 years to 10.1 years between 2006 and 2012. Vehicles manufactured in 2010 are the most prevalent in the state's fleet, with 70 895 of these vehicles registered on our roads. Newer, more fuel-efficient vehicles will increase the fuel efficiency of the vehicle fleet and result in reduced emissions.

Of the 730 885 cars registered in South Australia in May 2012, 1858 (0.25%) were hybrid electric vehicles (ABS 2012f). Although this represents a small fraction of the total, hybrid technology vehicles have been available in fewer models and with relatively higher prices compared with traditional internal combustion engine vehicles. Uptake has been at the slower rates normally experienced by new technologies, with early adopters and government fleets assisting uptake in South Australia. Given the average age of the state's vehicle fleet, it will take several more years for this category of more fuel-efficient vehicles to substantially affect the private



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vehicle emissions of our communities. To this end, the government has committed to developing a low-emission vehicle strategy for South Australia, which will aim to reduce greenhouse gas and toxic air emissions from road-based freight and passenger vehicles by increasing the proportion of low-emission vehicles on our roads.

As of 2011, more than 22% of Adelaide's metropolitan bus fleet runs on compressed natural gas, which produces lower carbon dioxide emissions compared with traditional diesel. Research has also shown that heavy vehicles using compressed natural gas generally produce significantly less particulate matter (PM_{10}), sulfur and nonmethane volatile hydrocarbons (air toxics) (Beer et al. 2001). Compared with their diesel counterparts, the Adelaide Metro's gas buses produce up to 50% less carbon dioxide, up to 80% less carbon monoxide and up to 90% less nitrogen oxide emissions, as well as reducing traffic noise.

The metropolitan bicycle network (Bikedirect) has expanded rapidly over the past five years. The total length of shared-use paths and roadways with bike lanes or sealed shoulders increased by 76% between 2006 and 2011.

4.3 Pollution

Pollution control and monitoring is an important role of the South Australian EPA.

4.3.1 Pollution-related enforcement and compliance

The EPA administers approximately 2100 licences for activities of environmental significance and undertakes a risk-based approach to ensuring compliance with requirements. The number of inspections of high-priority sites during 2009–12 were as follows:

- 2009–10: 961
- 2010–11: 257
- 2011–12: 283.

The inspections resulted in a range of actions, including verbal and formal written warnings and environment protection orders (EPOs). For a small number of more serious cases of noncompliance, the EPA commenced civil or criminal prosecutions.

4.3.2 Environment protection orders

EPOs can be issued for the purpose of securing compliance with:

- the general environmental duty

- a condition of an environmental authorisation
- a condition of a beverage container approval
- any other requirement imposed by or under the *Environment Protection Act 1993*
- an environment protection policy.

The number of EPOs issued by the EPA has remained steady, and the number issued by police and local councils has declined (Table 5). The reason for this significant downward trend for police and local councils is not known; it could be the result of an increase in verbal orders in place of written orders, a decrease in reporting of orders issued, a drop in contraventions, or a reduction in resources allocated to pollution matters by these authorities.

Table 5 Environment protection orders recorded, 2007–12

Organisation	2007–08	2008–09	2009–10	2010–11	2011–12
EPA	15	22	25	15	21
Police	139	144	128	53	20
Councils	53	7	23	8	0
Total	207	173	176	76	41

EPA = Environment Protection Authority

4.3.3 Investigations and prosecutions

More serious incidents of pollution may result in civil or criminal prosecutions. The EPA has a dedicated investigations branch that examines breaches of the *Environment Protection Act 1993*, and the number of investigations has remained relatively steady over the past four years (Table 6).

Table 6 Pollution investigations by the Environment Protection Authority, 2008–12

Year	Investigations undertaken	Investigations finalised
2008–09	30	14
2009–10	44	25
2010–11	36	17
2011–12	35	20

4.3.4 Air

Air quality is affected by actions controlled at all levels of government. For example, standards for emissions from vehicles and small engines are a national responsibility, control of dust from a residential development is the responsibility of local councils, emissions from large industries are regulated by the EPA, planning authorities must consider air quality in assessing new developments, and emergency services authorities are involved in protecting public health from smoke and toxic fumes.

The key measures and actions for managing air quality in South Australia are described in this section.

National standards

Australia has national standards for six pollutants contained in the Air NEPM:

- carbon monoxide
- nitrogen dioxide
- ozone
- sulfur dioxide
- lead
- particles (PM_{10} and $PM_{2.5}$).

The Air NEPM came into effect in 1998 and has recently undergone a comprehensive 10-year review. The review confirmed the higher risk of particles relative to the other pollutants and, in response, a project to develop a National Plan for Clean Air is now under way, under the auspices of the Standing Council on Environment and Water, which consists of environment ministers from the Australian Government and all state and territory governments (COAG 2012).

An important source of air pollutants is vehicle fuels, which are regulated under the *Fuel Quality Act 2001* (Cwlth). South Australia is an active participant in the development of fuel standards that include consideration of air quality, such as through limiting components and additives that contribute to toxic emissions to the atmosphere. The South Australian Government also released a low-emission vehicle strategy in 2012 that promotes the use of alternative fuels and the development of vehicle technologies that have smaller impacts on air quality, including through support of the Automotive Collaborative Research Centre.

Other areas where South Australia is actively participating in the development of national standards to improve air quality are the establishment of product standards for the import, manufacture and sale of wood heaters, small engines used in garden equipment, generators and marine engines.

National Plan for Clean Air

The National Plan for Clean Air has its main focus on reducing the exposure of the Australian population to fine particles, but it will also examine the risks of nitrogen dioxide, ozone and sulfur dioxide. The carbon monoxide standard is not being reviewed at this stage, because carbon monoxide generally occurs at very low levels in ambient air that are well below the standard and are not considered to be a significant risk to people living in Australian cities.

There are no identified threshold concentrations for particles below which there are no effects on humans. This means that, even when concentrations are below the current standards, there is still some risk to our communities. Although the effects on individuals may appear relatively small, the costs of air pollution impacts may add up to substantial amounts in a population of a million or more. That means that it is important that air quality is as good as can be achieved in balance with other lifestyle, social and economic needs of our communities. There are benefits to any improvement in air quality, even if the national standards are not always achieved.

Recognising this value of improving air quality, the National Plan for Clean Air project is considering a long-term exposure reduction goal, which will complement current standards and provide a basis for measuring the performance of each state and territory government in improving the risks to its communities from air pollution. Its final form and how it will be measured will become clearer as the plan takes shape in 2013–14.

The plan is projected for completion in late 2014 and will, for the first time, provide a national framework to help jurisdictions implement abatement programs, including performance measures towards achieving the Air NEPM particle standards over the next 10 years and beyond. The South Australian Government is actively involved in the development of the National Plan for Clean Air, through the EPA and the Department for Health and Ageing.

Environment protection

The *Environment Protection Act 1993* is the legislative foundation for regulating air quality in South Australia. The Act creates a general duty to take all reasonable and practical steps to prevent environmental harm. It enables the development of specific environment protection policies such as the Environment Protection (Air Quality) Policy; provides the basis for imposing conditions on business and industries to improve their performance in minimising risk from emissions to air through a licensing system; and allows for input to conditions on new

developments to minimise their impacts on air quality, such as through guidelines on separation distances.

Specific actions to improve air quality under the Act include:

- improving information for communities about air quality through the EPA website and targeted campaigns (e.g. more effective operation of wood heaters)
- establishing emission limits and ground-level concentrations (EPA 2006)
- establishing guidelines on methods and standards for monitoring emissions, including for stack testing, quality requirements and reporting
- developing environment improvement programs as part of licensing conditions for industries with significant emissions
- requiring the use of best available technology and practice in managing emissions
- monitoring and modelling air quality through a network of monitoring stations
- establishing licence conditions that focus on risk management
- establishing tight controls on the management of dust from transportation or materials handling activities
- developing an air quality health warning system
- developing an emergency response to emission incidents to support emergency services.

Development

The *Development Act 1993* requires the development of a planning strategy for the state, which sets planning and development policy. As part of the planning strategy, the South Australian Government published the 30-Year Plan in 2010 (DPLG 2010a), which provides the overarching strategic direction for planning Adelaide, and incorporates a range of targets and policies for improving air quality for people living or working in the city.

In support of this objective, in September 2011 the government released *Healthy connected communities: creating healthy urban villages for the future—transit-oriented developments through a health lens* (Government of South Australia 2011b) that provides guidance on incorporating healthy design into developments, including designing for good air quality.

In 2012, the government also released *Reducing noise and air impacts from road, rail and mixed land use: a guide for builders, designers and the community* (DPTI 2012), which provides guidance on the principles and possible approaches for designing residential, mixed-use or other

sensitive developments to minimise adverse impacts to communities from major transport corridors.

The South Australian planning policy promotes more consistent and better development policies across local councils, including the creation of overlays for transport corridors in development plans. The policy requires development authorities to consider air quality issues from major road and rail traffic when assessing development proposals.

The flow of traffic has a major impact on air quality (the slower the traffic, the higher the pollution) and a number of initiatives have recently been undertaken or are in progress to improve traffic flow in Greater Adelaide. This includes major road upgrades such as the North-South Corridor, improvements to roads in the eastern suburbs, introduction of bus-only lanes in Adelaide City, rail extension projects (Gawler and Seaford), overpasses (Keswick and Oaklands) and promotion of alternative transport (bicycle lanes, Greenways project, cycling information program).

Public health

The *South Australian Public Health Act 2011* provides for the protection of South Australians' health and the reduction of the incidence of preventable illnesses such as those caused by air pollution. The Act requires that a state public health plan is developed that assesses the state of public health in South Australia, identifies existing and potential public health risks, and develops strategies for addressing (eliminating or reducing) those risks. It also needs to identify opportunities and outline strategies for promoting public health in the state.

A draft of the first state public health plan was released for public consultation at the time of writing and clearly includes clean air as a requirement for and determinant of good health, noting that exposure to urban air pollution accounts for 2.3% of all deaths. The plan anticipates an increase in respiratory diseases and allergies from the likely increase in air pollution (from dust and bushfires) under a changing climate. It identifies the health benefits of a focus on green infrastructure—an interconnected network of physical assets that deliver landscape and environmental values or functions—for improving air quality.

Local government

One of the functions of South Australian local councils is to manage, develop, protect, restore, enhance and conserve the local environment, and improve amenity. Councils are therefore often at the forefront of air quality issues.

Greater Adelaide is a large and diverse city, comprising older, established areas and young suburbs that are actively growing around new commercial hubs; more industrialised areas with particular problems at interfaces between competing land uses; and areas in the Adelaide Hills with a unique mix of activities. While some air quality issues are common to all urban areas, many councils may face individual issues. Many councils have been highly active in developing their own environmental strategies, addressing issues ranging from adaptation to climate change to improving lifestyle choices for residents regarding local transport, many of which have the potential for direct benefits for air quality.

Reflecting this multipronged approach to managing air quality, the EPA has developed an Air Quality Framework for prioritising and coordinating actions in response to pressures on air quality. The framework aims to:

- promote increased engagement with communities with readily accessible and good-quality information on air quality
- improve mechanisms for coordinating air quality management actions
- integrate air quality considerations early in planning and design (including through guidelines, standards and model policies)
- review the Environment Protection (Air Quality) Policy
- provide better guidance for industry on monitoring, modelling and reporting
- improve knowledge through targeted research and investigations.

In accordance with the new population exposure approach, the EPA is building two new monitoring stations in support of the 30-Year Plan. One will be in the Adelaide CBD and another on the Le Fevre Peninsula. The locations of existing monitoring stations are shown in Figure 22.

Air pollution from transport

The EPA is working on a number of research projects to better understand air pollution from transport and its impact on the Adelaide airshed, including the development of a model for reducing the population's exposure to emissions. The EPA is also involved in quantifying the impact on air quality of the government's future programs and targets, such as the railway electrification and the reduction in vehicle-kilometres travelled by motorists under the 30-Year Plan.

During 2012, the EPA extended its collaboration with the University of South Australia to support a PhD project aimed at improving calculations of motor vehicle emissions in the inventory database and producing

the framework for reducing the population's exposure to traffic emissions. The EPA also partnered with the University of Adelaide and the Department for Health and Ageing in a project investigating the benefits of alternative transport on air quality and public health.

Air pollution from significant industries

Nyrstar operates one of the world's largest lead-smelting facilities in Port Pirie. Historically, the smelter has been the source of the well-documented lead contamination in the township and high levels of blood lead in the local community.

The *tenby10* program, a five-year partnership between Nyrstar, the state government and the local council, concluded at the end of 2010. The Port Pirie monitoring site has recorded declining levels of lead (Figure 23). This program made significant progress in reducing the number of children with blood lead levels above 10 micrograms per decilitre from 60% to 25%; however, the blood lead levels of some children were still above the National Health and Medical Research Council recommended levels.

The EPA has continued to oversee Nyrstar's compliance with current lead emission reduction programs, to ensure that all available measures are in place to reduce emissions as far as practicable with the existing plant technology. During 2011–12, the EPA reviewed and strengthened Nystar's EPA licence by including additional challenging requirements for the company, with the aim of substantially reducing emissions from the smelter and the blood lead levels in the community. This was followed by an announcement that the South Australian Government and the Australian Government would support upgrades to the ageing smelter.

The EPA also conducts monitoring for sulfur dioxide at Port Pirie according to the requirements of the Air NEPM. Table 7 shows the trends in sulfur dioxide exceedances of the 1-hour and 24-hour NEPM standards. The goal for the 1-hour and 24-hour standards is that they should not be exceeded more than once per year.

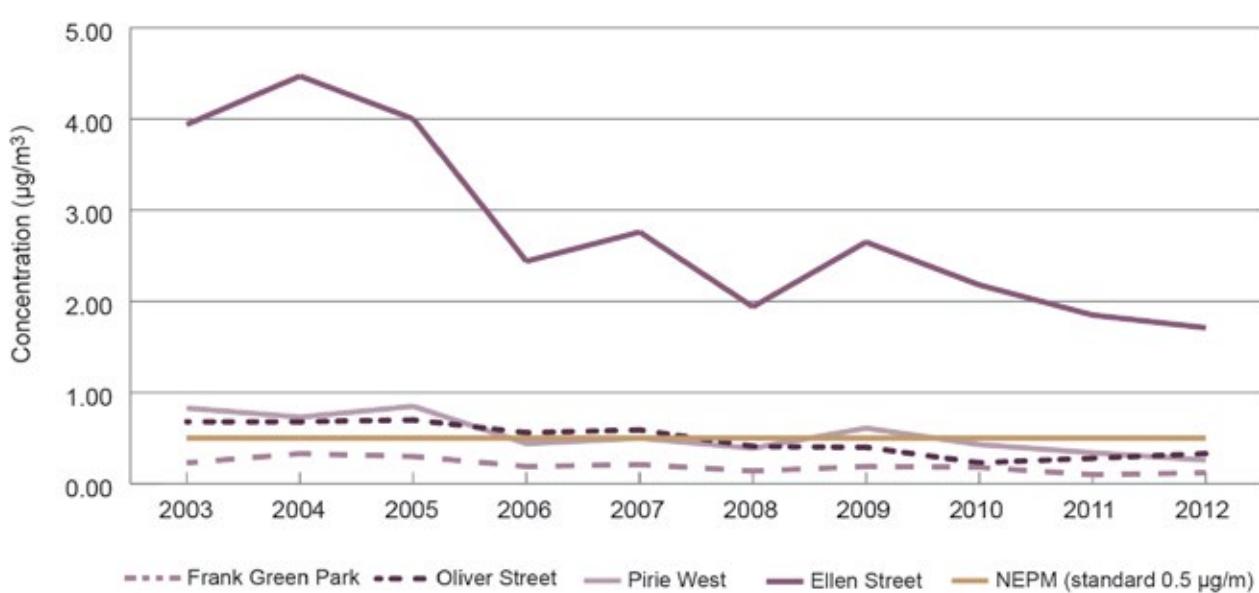
The annual average sulfur dioxide concentration at the monitoring station in Port Pirie does not exceed the Air NEPM standard of 0.02 parts per million (Figure 24).

Other significant industries with impacts on air quality include:

- OneSteel iron ore plant at Whyalla
- Shell Bitumen fuel storage and bitumen processing and blending at Birkenhead
- Penrice Quarry at Angaston
- Adelaide Brighton Cement at Port Adelaide.



Figure 22 South Australian air monitoring stations

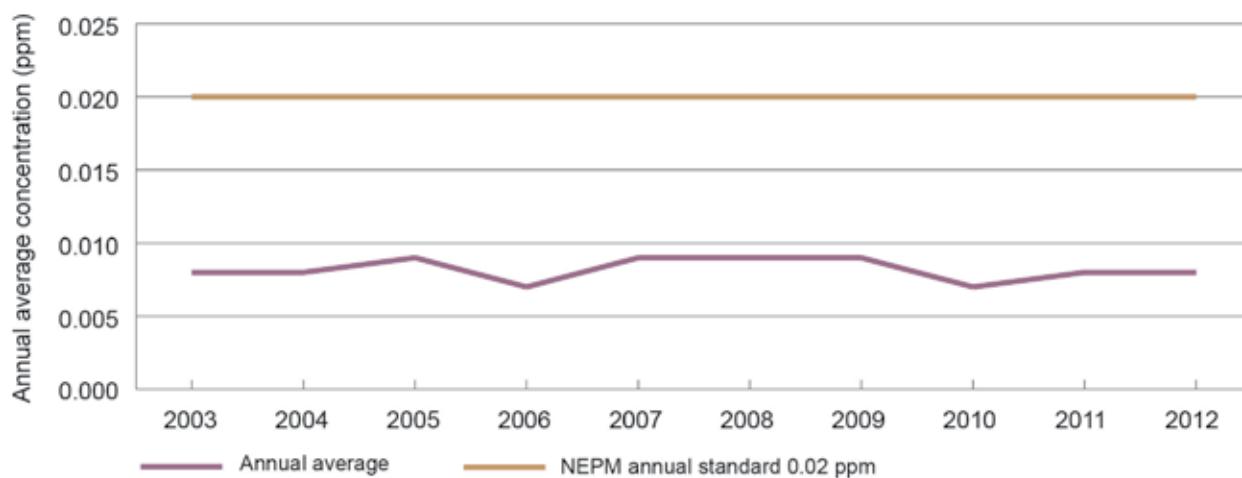


$\mu\text{g}/\text{m}^3$ = micrograms per cubic metre; NEPM = National Environment Protection (Ambient Air Quality) Measure

Note: Daily sampling commenced at the Ellen Street and Port Pirie West Primary School sites on 28 October 2010.

Source: Environment Protection Authority data

Figure 23 Annual lead concentrations at Port Pirie monitoring sites, 2003–12



Source: Environment Protection Authority data

Figure 24 Sulfur dioxide concentration against the National Environment Protection (Ambient Air Quality) Measure standard at the Environment Protection Authority Oliver Street site in Port Pirie, 2003–12

Table 7 Sulfur dioxide exceedences of the 1-hour and 24-hour National Environment Protection (Ambient Air Quality) Measure standards, 2003–12

Year	Number of exceedences of the 1-hour standard for sulfur dioxide (0.2 ppm)	Number of exceedences of the 24-hour standard for sulfur dioxide (0.08 ppm)
2003	21	1
2004	31	0
2005	29	0
2006	33	0
2007	35	0
2008	28	0
2009	29	2
2010	35	0
2011	40	0
2012	33	0

ppm = parts per million

4.3.5 Noise

South Australian Government agencies consider noise impacts when developing planning policy and assessing development applications from all significant industrial, transport and infrastructure projects. Construction occurs in accordance with noise and vibration management plans.

A draft Minister's Specification was developed in 2011 for construction requirements for the control of external sound, which mandates building standards for residential developments near major road and rail transport corridors. The intent of this specification is to protect the occupants of residential buildings from existing or future road and rail sound, and from mixed land-use sound sources. The specifications set minimum standards that the external walls, windows, external doors, roof, ceilings, ground floor and ventilation of a building must meet to prevent loss of amenity to the occupants against external sound intrusion from road and rail movements, and from people in public places and entertainment venues where music is played. The specifications set internal sound criteria (in decibels) for bedrooms and other habitable rooms that must not be exceeded.

The EPA has commenced a strategic noise monitoring program in the Greater Adelaide region, particularly in areas adjacent to major transport corridors such as the Bowden Urban Village.

The EPA takes into account the need for specific conditions relating to noise when licensing activities

under the *Environment Protection Act 1993*. The licensees are subject to strict environmental and noise impact rules, and the operations must meet requirements in the Environment Protection (Noise) Policy 2000. In addition to the policy, the EPA has developed guidelines, information sheets and other relevant documents to assist developers, planning authorities and other agencies to predict and assess environmental noise.

Despite the current lack of firm evidence that wind farms are sources of excessive infrasound, or that wind farm noise is deleterious to the health of nearby residents, in 2009 the EPA developed noise guidelines for wind farms to protect the community from excessive noise exposure.

Australian states and territories are working together to develop noise-labelling requirements for a range of household devices. The EPA is conducting research into improving methods and procedures for measuring and assessing noise to inform compliance and noise mitigation measures.

4.3.6 Site contamination

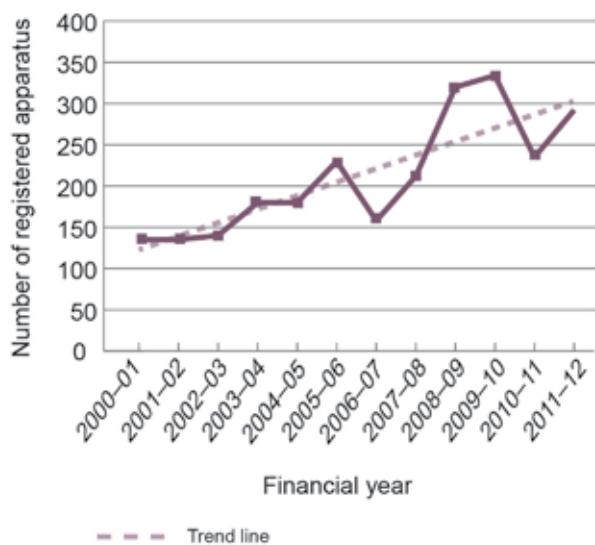
The EPA is continually improving available information of historical site contamination, and provides advice to ensure that site contamination is identified, assessed and managed for all new developments in South Australia.

The Adelaide-based Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC CARE) is developing new ways of dealing with and preventing contamination of soil,

water and air. The EPA is a shareholder of CRC CARE and participates in its research programs.

4.3.7 Radiation

South Australian radiation protection legislation (*Radiation Protection and Control Act 1982*) requires X-ray machines and radioactive sources to be registered. The number of radioactive sources to be registered has not significantly increased over the last decade; however, the number of X-ray apparatus has. Although applications for individual years vary according to factors such as the economy, machine replacement cycles and uptake of new technologies, there has been a significant upward trend in applications to register these apparatus (Figure 25), with an increase in the complexity and use of dental and medical imaging apparatus. Changes to the Medicare system flagged by the Australian Government (e.g. setting a lifespan of 10 years for apparatus) is likely to increase further applications for new apparatus in coming years.



Source: Environment Protection Authority data

Figure 25 Applications for registration of dental, medical and veterinary X-ray apparatus, 2000-01 to 2011-12

There were approximately 7500 radiation workers in South Australia in 2012, with approximately 75% required to hold an appropriate radiation licence to use or handle radioactive substances, or operate radiation apparatus. There is a shortage of radiation protection professionals across a wide range of industries, including in the medical, mining and scientific sectors. For example, South Australia has approximately half the required number of diagnostic imaging medical physicists (based on internationally accepted staffing level criteria).

Amendments to the *Radiation Protection and Control Act 1982* were proposed in 2013 that will incorporate modern administrative and enforcement provisions, as well as nationally agreed provisions aimed at ensuring the security of radioactive sources. In response to reported research on the adverse health impacts on users of tanning salons, legislation is also planned to ban the commercial use of cosmetic tanning units from 31 December 2014.

Employers of radiation workers, owners of X-ray apparatus or sealed radioactive sources, and occupiers of premises where unsealed radioactive substances are used or handled are required by law to report any radiation accidents to the EPA. Radiation accidents include situations where the control of a radiation source has been lost, or a person has or may have been accidentally exposed to ionising radiation. The EPA investigates radiation accidents and incidents to determine the cause and any remedial action that could be taken to prevent recurrence. More details about the nature of these incidents are available from EPA annual reports, and details of environmental spill events at uranium mines are available on the Department for Manufacturing, Innovation, Trade, Resources and Energy website (www.pir.sa.gov.au/minerals/licensing_and_regulation/mining_operations/uranium_mine_incident_reporting).

The South Australian Health and Medical Research Institute intend to install a cyclotron to produce nuclear medicine isotopes. It is anticipated that the cyclotron will be ready for commissioning in 2013.

4.4 Waste

South Australia signed the 2009 *National Waste Policy: less waste, more resources* (DEWHA 2009). The policy sets a 10-year framework of priorities and principles aimed at tackling problems such as electronic waste (e-waste), hazardous materials and product stewardship. A first priority under the policy was a national scheme for televisions and computers. The Product Stewardship Regulations (Televisions and Computers) 2011 came into effect on 3 November 2011 and provide for national, industry-run arrangements for collecting and recycling end-of-life televisions, computers and computer products under the National Television and Computer Recycling Scheme. This has led to the emergence of new industries that recycle these products and their components, and a decrease in the amount of e-waste going to landfill. Currently in South Australia, more than 50 local companies are reprocessing paper, metal, glass, plastics,

tyres, concrete, asphalt, timber, e-waste and garden organics.

For example, to assist in the reuse of contaminated soils, the EPA has developed a standard (released in January 2010) for the production and use of waste-derived fill. This details the information and processes required to support the beneficial reuse of a range of wastes that are specifically recovered for use as fill, including contaminated soils.

South Australia's Environment Protection (Waste to Resources) Policy 2010 (EPA 2010) came into operation on 1 September 2010. It progressively banned certain wastes from going to landfill and required waste (subject to specified exemptions) to be subject to approved resource recovery.

Implementation of South Australia's Waste Strategy (2005–10) included a range of programs such as:

- support for local councils to improve kerbside recycling by providing approximately 685 000 households with access to two or three-bin systems
- financial incentives to regional areas for upgrading or building new infrastructure that improves recovery and recycling of materials in all South Australian regional areas. As at November 2012, \$6.4 million has been awarded to 102 projects

under Zero Waste SA's Regional Implementation Program since 2005. Projects have been awarded in all regional local government areas—Central, Eyre Peninsula, South East, Murray Mallee, and Southern and Hills—to support infrastructure projects that improve the effectiveness of sorting processes. As at November 2012, \$4.5 million has been awarded for 20 metropolitan infrastructure projects, leveraging about \$10 million in industry investment under Zero Waste SA's Metropolitan Infrastructure Program since 2005. This has contributed to new ventures in the areas of e-waste, composting, recycling of construction and demolition waste, and improved regional waste planning and infrastructure. The Southern Hemisphere's first television and computer glass screen processing plant was funded under this program at Gepps Cross

- grants to schools and community groups to promote recycling
- incentives to improve and expand recycling in the business sector. For example, Zero Waste SA's Industry Program helps a diverse range of businesses and government agencies to improve resource efficiency practices. Since the inception of the program in 2007, 191 organisations across 436 sites have been directly engaged to participate in projects funded under the



Litter in creek
Zero Waste SA

program. A further 249 organisations have attended one or more of the 28 training programs offered

- a plastic bag ban
- household e-waste collections. For example, Zero Waste SA has provided funding to councils for a range of programs to help recover unwanted e-waste. These have included establishing 29 drop-off points in regional areas affected by the switchover from analogue to digital signalling from December 2010 to February 2011, and coordinating two-day e-waste collection events that were funded by a major brand owner in September 2010 and December 2011. A government free e-waste drop-off program held during May 2012 in partnership with 13 inner regional councils collected 1039 tonnes of e-waste, which included 16 583 televisions and 6196 computers. Nationally, the Australian Government and the television and computer industry are rolling out the National Television and Computer Recycling Scheme for the collection and recycling of end-of-life televisions and computers. As at December 2012, South Australia had 13 services under this scheme.

Other initiatives of the South Australian Government include:

- allocating more than \$930 000 to 17 organisations to assist projects that focus on sustainable markets for industry sectors, and to increase and support markets for recycled materials. These grants have targeted waste streams such as aggregate and soil products, composts, mulches and recycled organic products, plastics, alternatives to chromated copper arsenate-treated timber products, glass, reused or second-hand products, and products that use industrial residues and slags, and their associated recycling industries
- supporting recycling collection for small to medium businesses under Zero Waste SA's Recycling at Work program by working with waste collection companies to introduce source-separated commingled dry recycling and/or organics collection. From October 2008 to April 2012, 3274 new customers took up 3570 new recycling services. This yielded 19 612 tonnes of recycled materials
- establishing an illegal dumping unit to investigate and enforce illegal dumping of demolition and industrial waste, illegal waste operations, illegal recyclers and illegal waste transfer stations
- using the waste levy as a market-based incentive for reducing disposal of some materials to landfill, increase recycling, and to invest in waste management programs and projects.

A remaining area for improvement is to harmonise the regulatory requirements for waste and recycling between states and territories through common frameworks for waste assessment, data collection and measurement. This could further improve the efficiency of recycling.

4.5 Heritage

Specific legislation provides for the registration, conservation and development of places and areas of heritage significance. In support of the legislation, the South Australian Government released *Heritage directions 2012: a future for heritage in South Australia* (Government of South Australia 2012) as an update to the government's heritage policy framework released in 2003.

Since 2008, two South Australian places have been added to the National Heritage List, bringing the total number to five:

- Adelaide Park Lands and City Layout (new)
- Wiltjira-Dalhousie Springs (new)
- Australian Fossil Mammal Sites (Naracoorte)
- Ediacara Fossil Site, Nilpena
- Old and New Parliament Houses.

The Australian Fossil Mammal Site (Naracoorte) is also on the World Heritage List.

There are 17 state heritage areas (created under the provisions of the *Development Act 1993*) in South Australia. The number of local heritage places designated in council development plans has increased by 480 since 2008.

The total number of shipwrecks protected has increased by 13 since the last state of the environment report (from 392 to 405). Shipwrecks serve as artificial reefs and thus are important marine habitats. Conservation and protection of these sites is important not only for maintaining the heritage value of the site, but also for protecting the natural environment associated with the wreck. Increased development pressure on the marine environment has the potential to affect underwater cultural heritage sites.

The South Australian Government assists local government with desired character provisions, heritage policies and design guidelines in council development plans. The government provides funding and heritage advisers to assist local councils and owners of local heritage places to assess and manage heritage assets. The government also has an asset management program for maintaining its own heritage buildings; since the 2008 state of the environment report, the approximately

400 heritage sites have been reviewed to prioritise program funding.

As part of the new urban design being promoted by the South Australian Government, there will be increased opportunity to adaptively reuse heritage buildings. This protects the heritage of the building and the surrounding neighbourhood character, and reduces the need for new construction with the associated use of raw materials and energy. Guidelines on sympathetic development of state heritage places and within state heritage areas have been developed to assist owners in lodging well-considered applications that can be processed more quickly and efficiently, and improve consistency in assessment. The development of heritage works plans will enable owners to prioritise and plan the maintenance and repair of heritage places.

Developments in and near shipwrecks require the development application to be referred to the Department of Environment, Water and Natural Resources (DEWNR) under the provisions of the *Development Act 1993* and the Development Regulations 2008. In addition, the DEWNR undertakes an awareness program to reduce potential damage to shipwreck sites from anchors, recreational divers and boat owners.

The future of heritage places of world, national, state and local significance located in South Australia will rely on systematic ongoing assessments to inform a comprehensive register of heritage assets, and adequate resources (both funding and skills) for managing those assets. This requires periodic evaluation of the extent to which current systems succeed in identifying places of heritage value and the effectiveness with which heritage assets are managed.



Woodards House, Adelaide
Tobias Hills

5 What can we expect?

If current trends continue, South Australia's population and economy will continue to grow, waste generation and traffic congestion will increase (despite an increase in the use of public transport), and urban design will change to reflect the need for more efficient use of energy and natural resources, and to adapt to a changing climate, while providing appropriate protection of heritage places.

The most recent revision of the state's population projections (DPLG 2010b) and release of the 2011 rebased ERP figures suggest that population growth may be more restrained than suggested in earlier projections. However, planning for population growth and population ageing is essential to ensure that there is sufficient housing, infrastructure and services to support the changes. Implementation of the Planning Strategy for South Australia, alongside a range of other government initiatives, will play an important role in guiding the state's progress towards sustainable development.

Planning in South Australia must also position the state to be able to cope with possible future events such as accelerated global warming and associated sea level rises (which may be more rapid than predicted), arrival of climate refugees from island nations in the Pacific, increased coastal erosion, a higher frequency of more extreme weather events such as prolonged droughts and

extreme high temperature days, and a possible serious decrease in future economic growth rates. Australia and South Australia may also consider increasing mining of uranium resources to meet demand from developing countries that aim to reduce emissions associated with generating electricity. In the face of challenging future events such as these, it is essential that South Australians design maximum resilience and flexibility into our built environments, and protect and enhance our natural ecosystems and biodiversity.

The *Australia state of the environment 2011* report considers the prospect of a changing climate as the major environmental challenge that we will have to face in the near future, followed by the risks posed by the impacts of population and economic growth. Although more people and more economic activity may well result in more resource use, 'the actual impact on the environment depends on where and how the growth occurs, and how we live our lives' (State of the Environment 2011 Committee 2011). The National Urban Policy (DIT 2011) emphasises that only by being mindful of the impacts of future development of Australian cities and regions on the physical environment will we be able to deliver the greatest net benefits of future growth to the community—a priority reflected in the policy interventions detailed in this chapter.



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Department of Planning, Transport and Infrastructure

6 References

- ABC (2012). *Struggling growers find fruits of labour in mining*, PM program, Australian Broadcasting Corporation, www.abc.net.au/news/2012-12-05/mining-boom-gives-growers-fruitful-sideline/4410440.
- ABS (2005). *Australian Standard Geographical Classification (ASGC)*, cat. no. 1216.0, Australian Bureau of Statistics, Canberra, www.abs.gov.au/AUSSTATS/abs@.nsf/66f306f503e529a5ca25697e0017661f/50F6E014E67EBB7CCA256F1900127934.
- ABS (2008). *Population projections, Australia*, cat. no. 3222.0, Series A for South Australia, Australian Bureau of Statistics, 53, Canberra, [www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/oE09CCC14E4C94F6CA2574B9001626FE/\\$file/32220_2006%20to%202101.pdf](http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/oE09CCC14E4C94F6CA2574B9001626FE/$file/32220_2006%20to%202101.pdf).
- ABS (2011). Dwelling type by statistical local area [Statistical local area, by dwelling type, 2006 Census, 2011 Census], retrieved 12 December 2012 from TableBuilder, Australian Bureau of Statistics, Canberra. www.abs.gov.au/websitedbs/censushome.nsf/home/tablebuilder?opendocument&navpos=240
- ABS (2012a). *Australian demographic statistics, December quarter 2011*, cat. no. 3101.0, Australian Bureau of Statistics, Canberra, www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/81C5AE743DDCF8FoCA257A850013DF4C?opendocument.
- ABS (2012b). Feature article 4: advice on the use of 2011 preliminary rebased ERP. In: *Australian demographic statistics, March quarter 2012*, cat. no. 3101.0, Australian Bureau of Statistics, Canberra, [www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/BEC1AAE4C2BED109CA257A8500206850/\\$File/31010_Mar%202012.pdf](http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/BEC1AAE4C2BED109CA257A8500206850/$File/31010_Mar%202012.pdf).
- ABS (2012c). Technical note: the impact of improvements to the 2011 PES on measuring population growth (2006–2011). In: *Australian demographic statistics, March quarter 2012*, cat. no. 3101.0, Australian Bureau of Statistics, Canberra, 63–66 [www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/BEC1AAE4C2BED109CA257A8500206850/\\$File/31010_Mar%202012.pdf](http://www.ausstats.abs.gov.au/ausstats/subscriber.nsf/0/BEC1AAE4C2BED109CA257A8500206850/$File/31010_Mar%202012.pdf).
- ABS (2012d). Table 54: Estimated resident population by single year of age, South Australia. In: *Australian demographic statistics, March quarter 2012*, cat. no. 3101.0, Australian Bureau of Statistics, Canberra, [www.ausstats.abs.gov.au/ausstats/ABS@Archive.nsf/0/8FE9547FDA1990C2CA257AD7000D1346/\\$File/3101054.xls](http://www.ausstats.abs.gov.au/ausstats/ABS@Archive.nsf/0/8FE9547FDA1990C2CA257AD7000D1346/$File/3101054.xls).
- ABS (2012e). *Regional population growth, Australia, 2011: South Australia*, cat. no. 3218.0, Australian Bureau of Statistics, Canberra, www.abs.gov.au/ausstats/abs@.nsf/Products/3218.0~2011~Main+Features~South+Australia?OpenDocument.
- ABS (2012f). *Motor vehicle census, Australia, 31 January 2012*, cat.no. 9309.0, special tabulations (erp 2006-2011 uclsx.xlsx) provided by the Australian Bureau of Statistics to the South Australian Department of Planning, Transport and Infrastructure on 19 October 2012, www.abs.gov.au/ausstats/abs@.nsf/mf/9309.0.
- Adelaide City Council (2013). *Noise initiatives*, Adelaide City Council, Adelaide, www.adelaidecitycouncil.com/environment/noise-initiatives.
- Beer T, Grant T, Morgan G, Lapszewicz J, Anyon P, Edwards J, Nelson P, Watson H and Williams D (2001). *Comparison of transport fuels*, final report to the Australian Greenhouse Office on the Stage 2 study of life-cycle emissions analysis of alternative fuels for heavy vehicles, Commonwealth Scientific and Industrial Research Organisation, Melbourne, www.environment.gov.au/archive/settlements/transport/comparison/pubs/comparison.pdf.
- COAG (2012). *National Plan for Clean Air*, Council of Australian Governments Standing Council on Environment and Water, Canberra, www.scew.gov.au/strategic-priorities/national-plan-for-clean-air.html.
- CTEE (2011). *South Australian transport facts 2011*, The Centre for Transport, Energy and the Environment, Adelaide.
- DEWHA (2009). *National Waste Policy: less waste, more resources*, Australian Government Department of the Environment, Water, Heritage and the Arts, Canberra, www.scew.gov.au/sites/www.scew.gov.au/files/resources/906ao4da-bad6-c554-1dod-45216011370d/files/wastemgt-rpt-national-waste-policy-framework-less-waste-more-resources-print-ver-200911.pdf

- DIT (2011). *Our cities, our future: a national urban policy for a productive, sustainable and liveable future*, Australian Government Department of Infrastructure and Transport, Canberra, www.infrastructure.gov.au/infrastructure/mcu/files/Our_Cities_National_Urban_Policy_Paper_2011.pdf.
- DIT (2012a). *State of Australian cities 2012*, Australian Government Department of Infrastructure and Transport, Major Cities Unit, Canberra, www.infrastructure.gov.au/infrastructure/mcu/soac/files/2012_00_INFRA1360 MCU SOAC_FULL_WEB_FA.pdf.
- DIT (2012b). *Green vehicle guide*, Australian Government Department of Infrastructure and Transport, Canberra, www.greenvehicleguide.gov.au/gvgpublicui/Information.aspx?type=VehicleEmissions#1.
- DMITRE (2012). *Uranium in South Australia*, South Australia earth resources information sheet M50 (February 2012), South Australian Department for Manufacturing, Trade, Resources and Energy, Adelaide.
- DPC (2012). *Seven strategic priorities*, South Australia's Strategic Plan, South Australian Department of the Premier and Cabinet, Adelaide, <http://saplan.org.au/pages/seven-strategic-priorities>.
- DPLG (2010a). *The 30-Year Plan for Greater Adelaide: a volume of the South Australian Planning Strategy*, South Australian Department of Planning and Local Government, Adelaide, www.dplg.sa.gov.au/plan4adelaide/index.cfm.
- DPLG (2010b). *Population projections for South Australia and statistical divisions, 2006–36*, South Australian Department of Planning and Local Government, Adelaide.
- DPTI (2011). *Public transport services 2010/2011 financial year patronage report*, South Australian Department of Planning, Transport and Infrastructure, Adelaide.
- EPA (2006). *Air quality impact assessment: using design ground level pollutant concentrations (DGLCs)*, updated January 2006. EPA guidelines. Environment Protection Authority South Australia, Adelaide, www.epa.sa.gov.au/xstd_files/Air/Guideline/guide_airquality.pdf.
- EPA (2008). *State of the environment report for South Australia 2008*, Environment Protection Authority South Australia, Adelaide, www.epa.sa.gov.au/soe/home.
- EPA (2008–12). Environment Protection Authority annual reports 2008–09 to 2011–12, Environment Protection Authority South Australia, Adelaide.
- EPA (2010). *Legislation: Waste to Resources Policy*, Environment Protection Authority South Australia, Adelaide, www.epa.sa.gov.au/environmental_info/waste/legislation/waste_to_resources_policy.
- EPA (2012). *SmokeWatch in Mount Gambier*, Environment Protection Authority, Adelaide, www.epa.sa.gov.au/environmental_info/air_quality/working_with_the_community/smokewatch/smokewatch_in_mount_gambier.
- Equilibrium (2012). *An assessment of television and computer recycling experience and capacity in South Australia: waste estimates and recovery and processing capacity*, report prepared for Zero Waste SA by Equilibrium, Melbourne, www.zerowaste.sa.gov.au/upload/resource-centre/publications/reuse-recovery-and-recycling/Television%20and%20Computer%20Recycling%20Estimates%20and%20Capacity%20Report%20April%202012.pdf.
- Government of South Australia (2010). *Population projections for South Australia and statistical divisions 2006–36*, South Australian Department of Planning and Local Government, Adelaide.
- Government of South Australia (2011a). *The planning strategy for South Australia*, Government of South Australia, Adelaide, www.sa.gov.au/subject/Housing,+property+and+land/Building+and+development/South+Australia's+land+supply+and+planning+system/The+planning+strategy+for+South+Australia.
- Government of South Australia (2011b). *Healthy connected communities: creating healthy urban villages for the future—transit-oriented developments through a health lens*, Government of South Australia, Adelaide, www.sahealth.sa.gov.au/wps/wcm/connect/ecb6570048ab3d3c8b45ff7675638bd8/HealthyConnectedCommunities-PHCS-HiAP-2011013.pdf?MOD=AJPERES&CACHEID=ecb6570048ab3d3c8b45ff7675638bd8
- Government of South Australia (2012). *Heritage directions 2012: a future for heritage in South Australia*, Government of South Australia, Adelaide, www.environment.sa.gov.au/files/3eb89fd9-e587-4013-b858-aoe6ooba5929/her-gen-heritagedirections2012.pdf.
- Gray R, Gleeson B and Burke M (2010). Urban consolidation, household greenhouse emissions and the role of planning. *Urban Policy and Research* 28(3):335–346.
- Hardege L (2005). *Environmental radioactivity monitoring in Australia 2003 and 2004*, technical report no. 143, Australian Government Australian Radiation Protection and Nuclear Safety Agency, Yallambie, Victoria, www.arpansa.gov.au/pubs/technicalreports/tr143.pdf.
- HIA Economics Group (2011). *HIA-rpdata.com residential land report*, September 2011 quarter, Appendix C, HIA Economics Group, http://economics.hia.com.au/publications/land_report.aspx.

- Hyder Consulting and PricewaterhouseCoopers (2009). *Environment Protection and Heritage Council: consultation regulatory impact statement—televisions and computers*, prepared for the Environment Protection and Heritage Council, www.scew.gov.au/sites/www.scew.gov.au/files/resources/oc513e54-d968-aco4-758b-3b7613afodo7/files/ps-tv-comp-consultation-ris-televisions-and-computers-200907.pdf
- idblog (2012). *Has the tide turned on coastal growth?*, Informed Decisions blog, <http://blog.id.com.au/2012/australian-demographic-trends/has-the-tide-turned-on-coastal-growth>.
- idblog (2013). *2011 census—our expanding households*, Informed Decisions blog, <http://blog.id.com.au/2012/australian-housing-trends/2011-census-our-expanding-households>.
- Newman P (1999). Sustainability and Australian cities. *Australian Planner* 36(2):93–100.
- Newman P and Kenworthy J (1989). *Cities and automobile dependence: an international sourcebook*, Gower Publishing, Brookfield.
- NHMRC (2010). *Wind turbines and health: a rapid review of the evidence*, National Health and Medical Research Council, Canberra.
- Pekol A (2011). *South Australian transport facts*, The Centre for Transport, Energy and the Environment, Spring Hill.
- Rawtec (2012). *South Australia's recycling activity report 2010–11*, Zero Waste SA, Glenelg, South Australia.
- South Australian Active Living Coalition (2012a). *South Australian Active Living Coalition*, <http://saactivelivingcoalition.com.au/wp-content/uploads/2012/05/SA-Active-Living-Coalition-Brochure.pdf>.
- South Australian Active Living Coalition (2012b). *Streets for people: compendium for South Australian practice*, South Australian Active Living Coalition, http://saactivelivingcoalition.com.au/wp-content/uploads/2012/09/StreetsforPeople_FactSheet_Sept-2012.pdf.
- SASP Audit Committee (2012). *Targets*, South Australia's Strategic Plan Audit Committee, Adelaide, <http://saplan.org.au/targets>.
- State of the Environment 2011 Committee (2011). Summary. In: *Australia state of the environment 2011*, independent report to the Australian Government Minister for Sustainability, Environment, Water, Population and Communities, Canberra.
- Trubka R, Newman P and Bilsborough D (2007). *Assessing costs of alternative development paths in Australian cities*, Parsons Brinckerhoff and Sustainability Policy Institute, Curtin University, Fremantle.
- Zero Waste SA (2011). *South Australia's Waste Strategy 2011–2015*, Zero Waste SA, Adelaide, www.zerowaste.sa.gov.au/About-Us/waste-strategy.