Non-prescribed Surface Water Resources Assessment South Australian Murray-Darling Basin Natural Resources Management Region

DEWNR Technical report 2016/08

Government of South Australia
Department of Environment, Water and Natural Resources

Non-prescribed Surface Water Resources Assessment

South Australian Murray-Darling Basin Natural Resources Management Region

Daniel Penney
Department of Environment, Water and Natural Resources

July, 2016

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Department of Environment, Water and Natural Resources

GPO Box 1047, Adelaide SA 5001

Telephone	National (08) 8463 6946
	International +61 8 8463 6946
Fax	National (08) 8463 6999
	International +61 8 8463 6999
Website	www.environment.sa.gov.au

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Foreword

The Department of Environment, Water and Natural Resources (DEWNR) is responsible for the management of the State's natural resources, ranging from policy leadership to on-ground delivery in consultation with government, industry and communities.

High-quality science and effective monitoring provides the foundation for the successful management of our environment and natural resources. This is achieved through undertaking appropriate research, investigations, assessments, monitoring and evaluation.

DEWNR's strong partnerships with educational and research institutions, industries, government agencies, Natural Resources Management Boards and the community ensures that there is continual capacity building across the sector, and that the best skills and expertise are used to inform decision making.

Sandy Pitcher
CHIEF EXECUTIVE
DEPARTMENT OF ENVIRONMENT, WATER AND NATURAL RESOURCES

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1 Introduction

In an environment where water resources are increasingly scarce, a better understanding of water resource capacity and a proactive approach to management is required. The Government of South Australia (2009) in its Water for Good plan acknowledged the importance of establishing a baseline understanding of South Australia's (the state's) resources. Understanding the status of resources and their regular assessment are important to enhance sustainable development opportunities, avoid overuse and to respond to any significant quantitative changes. Water for Good supports this through an action to expand monitoring networks and increase the regularity of assessments for status and condition reporting of resources.

The Department of Environment, Water and Natural Resources (DEWNR) has the lead-agency responsibility for ensuring the sustainable management of groundwater and surface water resources of the state. As such, DEWNR has developed a program to fulfil responsibilities under the *Natural Resources Management Act 2004* and in response to water security issues facing the state. This report presents findings of the sub-program; Non-prescribed Surface Water Resources Assessment – South Australian Murray-Darling Basin Natural Resources Management Region.

Information of surface water resources in most non-prescribed regions across the state is limited. Current knowledge gaps regarding the quantity and quality of surface water resources present significant barriers to the management and potential future development of surface water systems. Addressing these gaps is especially important due to anticipated increases in demand for water, changes in land use and potential impacts associated with a changing climate.

This report aims to provide an overview of the available surface water information for the South Australian Murray-Darling Basin Natural Resources Region (the region). This includes collating and presenting existing data and information about the non-prescribed surface water resources of the Burra Creek, Coorong, Rangelands and Mallee parts of the region. The region is one of eight Natural Resources (NR) regions of the state (Fig. 1) established under the *NRM Act 2004*. It is recommended this report be read in conjunction with reports available on groundwater and environmental water requirements of the region, to gain a broader understanding of the water resources in the region.

1.1 Objective

Water resources are important for sustaining plants, animals, ecosystems, businesses and people, however non-prescribed regions have traditionally been poorly understood due to limited monitoring and investigation programs. A better understanding of non-prescribed water resources can assist with development of plans and policies for sustainable resource development in the region.

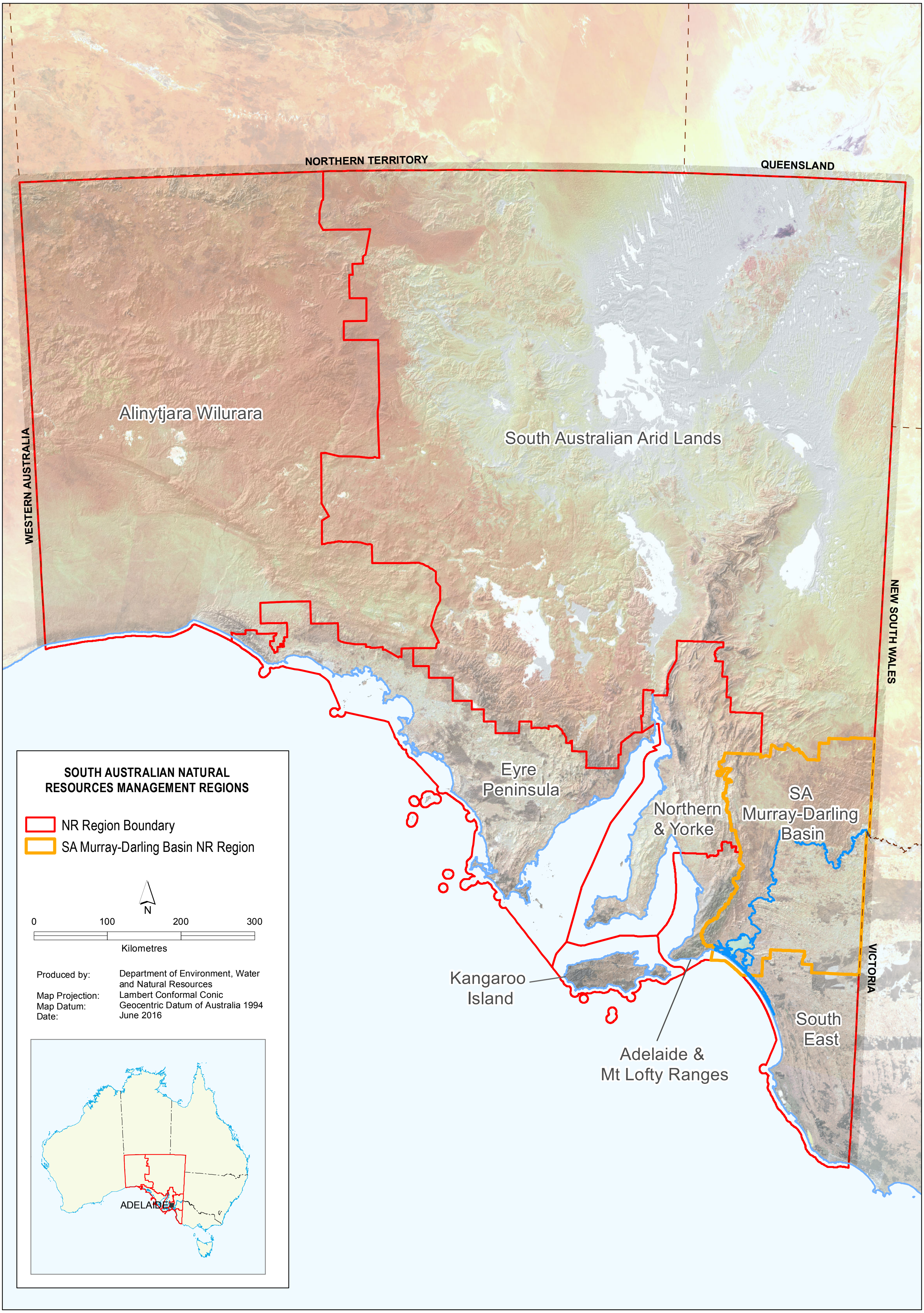

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Figure 1. Location of the South Australian Murray-Darling Basin NR Region

1.2 Earlier studies

A range of studies relating to water resources assessment has been undertaken within the region, encompassing climate change, monitoring, ecological studies and water management plans. Many of these reports have focused on the Eastern Mount Lofty Ranges Prescribed Water Resources Area (PWRA), the Marne Saunders PWRA and the River Murray Prescribed Watercourse (PWC). Some of the more recent reports and projects germane to the non-prescribed surface water part of the region are highlighted below:

Natural disaster risk management plan regional council of Goyder (Earth Tech 2004).

Red Banks Conservation Park management plan (DEH 2005).

Preliminary assessment of impacts of water resource development on Burra Creek catchment (Deane *et al*. 2006).

The AWE (2011) report prepared for the Goyder Regional Council as part of a desktop investigation of the water resources of the Burra Creek catchment.

The Goyder integrated water management plan for Burra (Goyder Regional Council, AWE 2012).

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BoM) have previously undertaken investigations, which project the impact of climate change across South Australia (Suppiah *et al*. 2006; CSIRO & BoM 2007). Models were developed to produce outputs based on 2030 and 2070 time horizons and high, medium and low greenhouse gas emission scenarios.

The South Australian Murray-Darling Basin Regional NRM Plan (the Plan) (SAMDBNRMB 2009) is a comprehensive document describing land use, threats to natural resources, soils and landscapes, water resources, biodiversity and key regional assets and risk factors. The purpose of the Plan is to ensure balance is achieved between stakeholder's collective needs for resources and the needs of the environment. First implemented in April 2009, the updated Plan contains two volumes; Volume A Strategic Plan (updated in 2014) and Volume B Business Plan (updated in 2016).

The AGT (2010) report prepared for the former Department for Water reviewed groundwater, surface water, ecological and dryland salinity monitoring networks in the region. The report seeks to identify whether existing networks and frequency of monitoring are adequate to reliably report on the state and condition of water resources.

Securing the future, a long–term plan for the Coorong, Lower Lakes and Murray Mouth (DEH 2010).

The Lower Lakes, Coorong and Murray Mouth environmental water management plan (MDBA 2014).

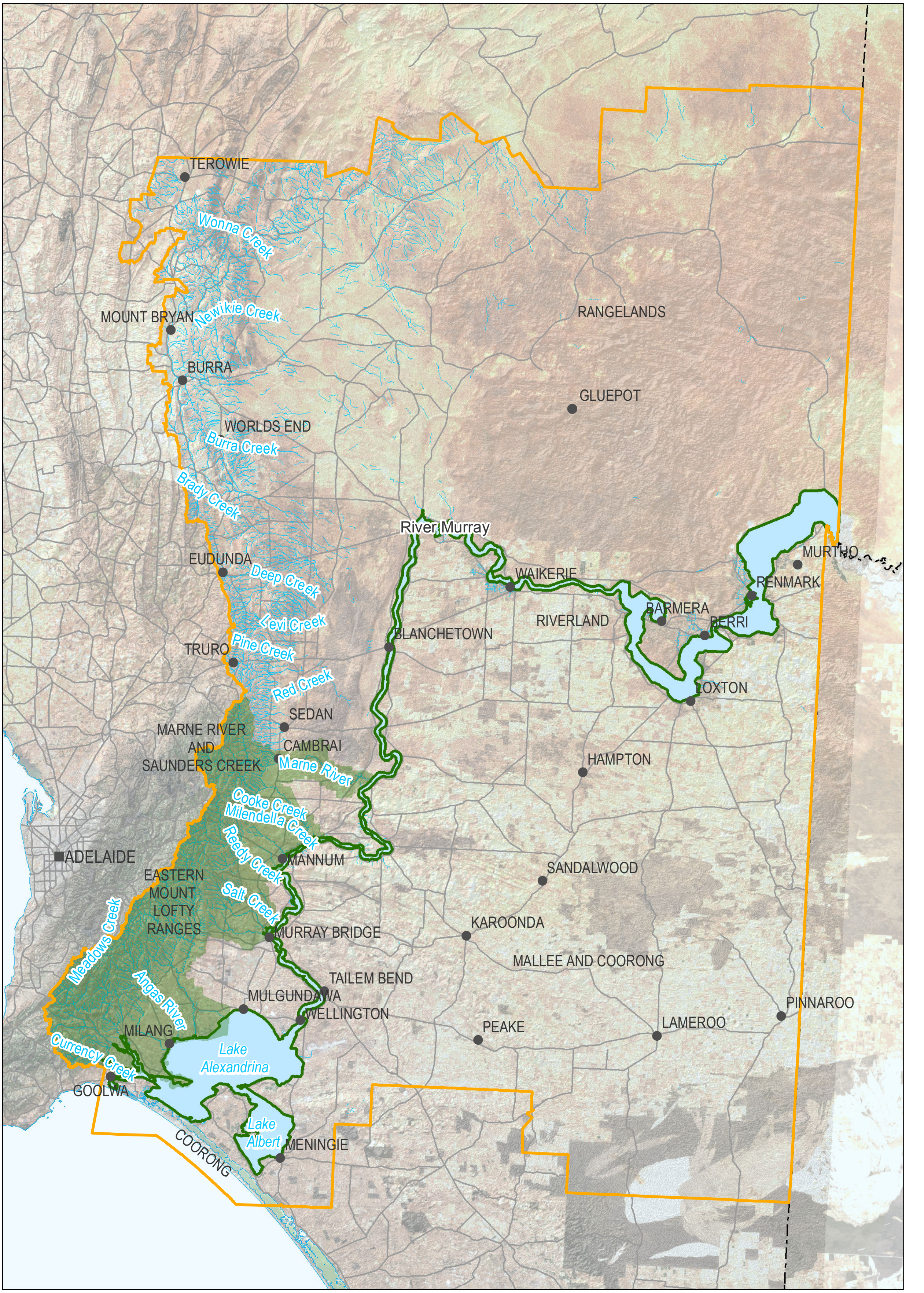
The South East Flows Restoration Project (SEFRP) is a $60m investment made by the Government of South Australian and the Australian Government (in 2014) to assist salinity management in the Coorong South Lagoon, enhance flows to wetlands in the Upper South East and reduce drainage outflow at Kingston Beach.

Danggali Wilderness Protection Area and Conservation Park management plan (DENR 2011).

A statewide risk assessment and prioritisation of water dependent ecosystems undertaken by Harding (2012). The prioritisation of water dependent ecosystems is based on the potential risks posed by climate change.

The Murray–Darling Basin Authority has a basin–wide plan (MDBA 2012) that is changing the way water is allocated within and between states. It aims to provide more fresh water to protect and restore the region's environment. DEWNR (2013) prepared an Implementation Strategy for South Australia in response to the Plan.

Building resilience to a changing climate (Siebentritt *et al*. 2014) is a climate change adaptation plan for the South Australian Murray–Darling Basin. Key areas identified in the plan as a focus for adaptation actions include native vegetation, pest plants and animals, the Coorong and Lower Lakes, vulnerable members of the community, emergency services, essential services, irrigation, and dryland farming. The first climate change adaptation plan for the region provides decision-makers in the community with a more complete picture of the climate challenges ahead in the short and long-term. Climate change projections featured in the plan are based on the Intergovernmental Panel on Climate Change's Fourth Assessment Report, with projections information for this region summarised in SKM (2013).



NR Region Boundary
Prescribed Water Resource Area
River Murray Prescribed Watercourse
Town
Road

N

0 10 20 30 40 50
Kilometres

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Figure 2. Detailed map of the South Australian Murray-Darling Basin NR Region

2 Characterising the region's surface water hydrology

2.1 Topography

The region is South Australia's fourth largest NR region, with an area of approximately 56 700 km^2. It stretches 220 km from east to west and over 320 km from north to south, with the highest elevations located along the eastern boundary, particularly in the north-west corner around the Southern Flinders Ranges (900 m AHD). The Rangelands and Mallee and Coorong districts, which comprise the vast majority of the region, are relatively flat with elevations largely less than 100 m AHD. Commencing in the Rangelands at the New South Wales and Victorian borders, the region forms the south-west portion of the Murray–Darling Basin and includes the River Murray Prescribed Watercourse and prescribed tributary catchments of the Marne Saunders and Eastern Mount Lofty Ranges (Fig. 2). The main surface water features outside of the prescribed areas are the Coorong in the south and the Creeks of the Northern Mount Lofty Ranges in the north-west. Streams on the south-western side of the region drain in a south-easterly direction towards the River Murray.

2.2 Climate

The region has a Mediterranean climate in which hot dry summers are followed by cool, relatively wet winters. In the rain shadow of the Mount Lofty Ranges, the region has a marked reduction in rainfall compared to the country to the west (SAMDBNRMB 2009). In recent times, the region has endured significant drought. Widely known as the millennium drought, it began in 1995 and continued across much of Australia until late 2009. Climate change modelling suggests the region will become even hotter and drier (SKM 2013). This expected trend would see an increase in drought periods that may ultimately affect water resources and biodiversity in the region.

The BoM website (2016) provides temperature and evaporation statistics for the region. There is also a network of automatic weather stations funded and supported by the SAMDBNRMB (http://aws.naturalresources.sa.gov.au/). Meningie is located in the south-west of the region and has a mean summer (December to February) maximum temperature of 26.4 °C and a mean monthly minimum temperature during the winter months (June to August) of 6.7 °C. Eudunda in the region's west, has a mean summer maximum temperature of 29.3 °C and a mean monthly minimum temperature during the winter months of 5 °C. Lameroo is located in the south-east of the region and has a mean summer maximum temperature of 31 °C and a mean monthly minimum temperature during the winter months of 4.4 °C. Gluepot in the region's central north, has a mean summer maximum temperature of 33.8 °C and a mean monthly minimum temperature during the winter months of 3.6 °C. Maximum temperatures have risen faster in the state compared to other states of Australia, but a slower rise has been observed with minimum temperatures (Suppiah et al. 2006).

Average annual pan evaporation increases further to the north. The southern part of the region has an average annual pan evaporation of 1400 mm while evaporation exceeds 2200 mm in the northern part of the region, resulting in faster depletion of surface water resources, reduced effectiveness of rainfall and ability to sustain vegetation (fodder and biodiversity), and increasing demand for alternative water sources.

Based on SILO rainfall data from 1900–2015, higher annual rainfall is recorded in the north-east and south-east part of the region, between 400–500 mm. Small sections in the north north-west average more than 500 mm. The far northern part of the region is much drier, averaging 200–300 mm per annum, with small sections to the south-east of Terowie averaging less than 200 mm. Further information on SILO climate data is available at: http://www.longpaddock.qld.gov.au/silo/index.html.

The spatial distribution of rainfall over the region is shown in Figure 3 for:

- Long-term average annual rainfall for the period 1900–2015
- Short-term average annual rainfall for the period 2006–15.

The average annual rainfall for the period 2006–15 shows similarities with the long-term average but with a wider distribution of higher rainfall in the central part of the region around the township of Hampton (between 300–400 mm) in the past 10 years compared to the long-term average. Average rainfall to the south of Lameroo has been drier in the past 10 years compared to the long-term average.

Climate change projections for 2070 show an increase in temperature and a decrease in rainfall (SKM 2013). Median projections for the region are for temperature to increase by 1–3 ˚C and for rainfall to reduce by 5–20% by 2070.

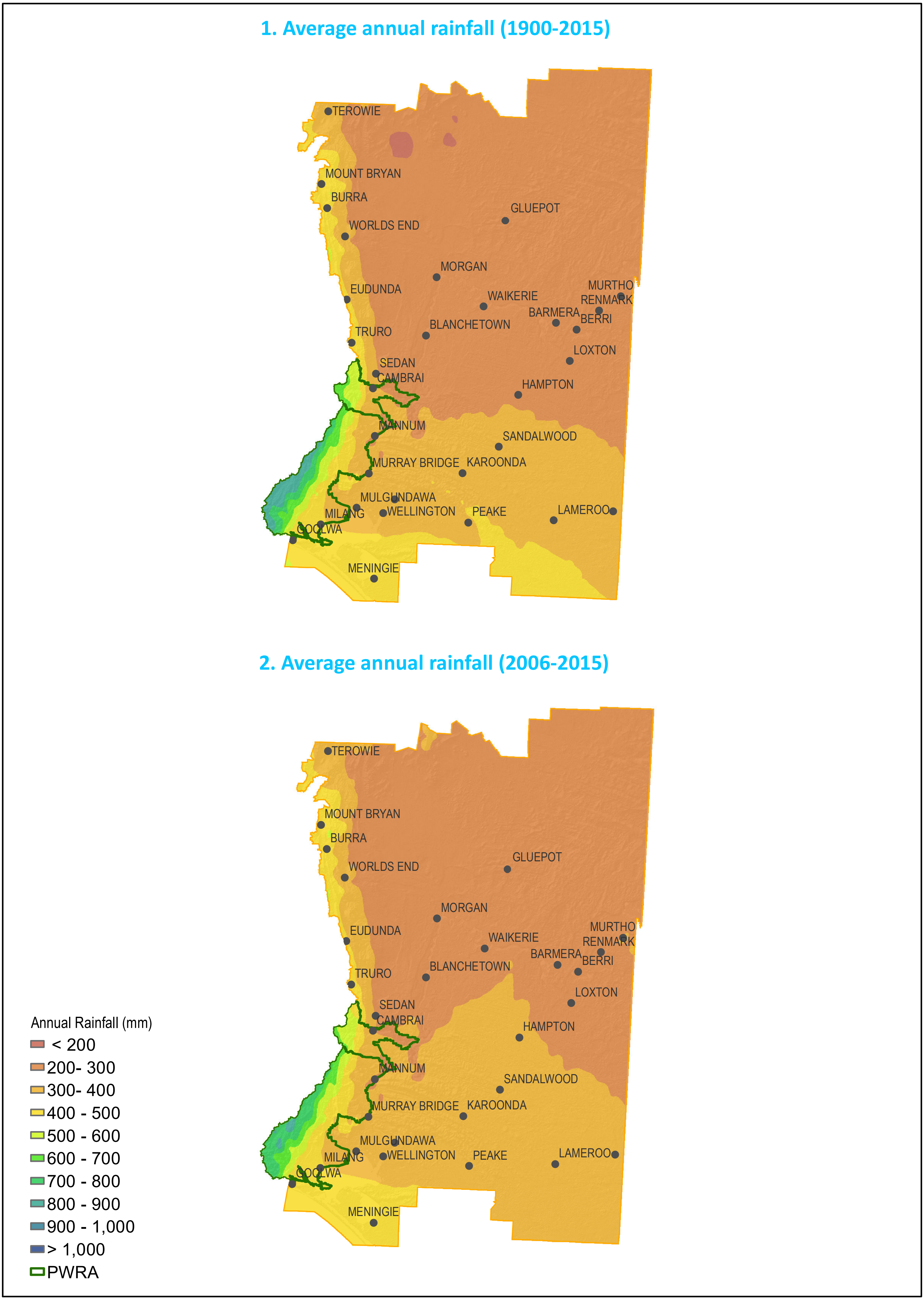


Figure 3. Annual rainfall trends over the South Australian Murray-Darling Basin NR Region

2.3 Drainage divisions and river basins

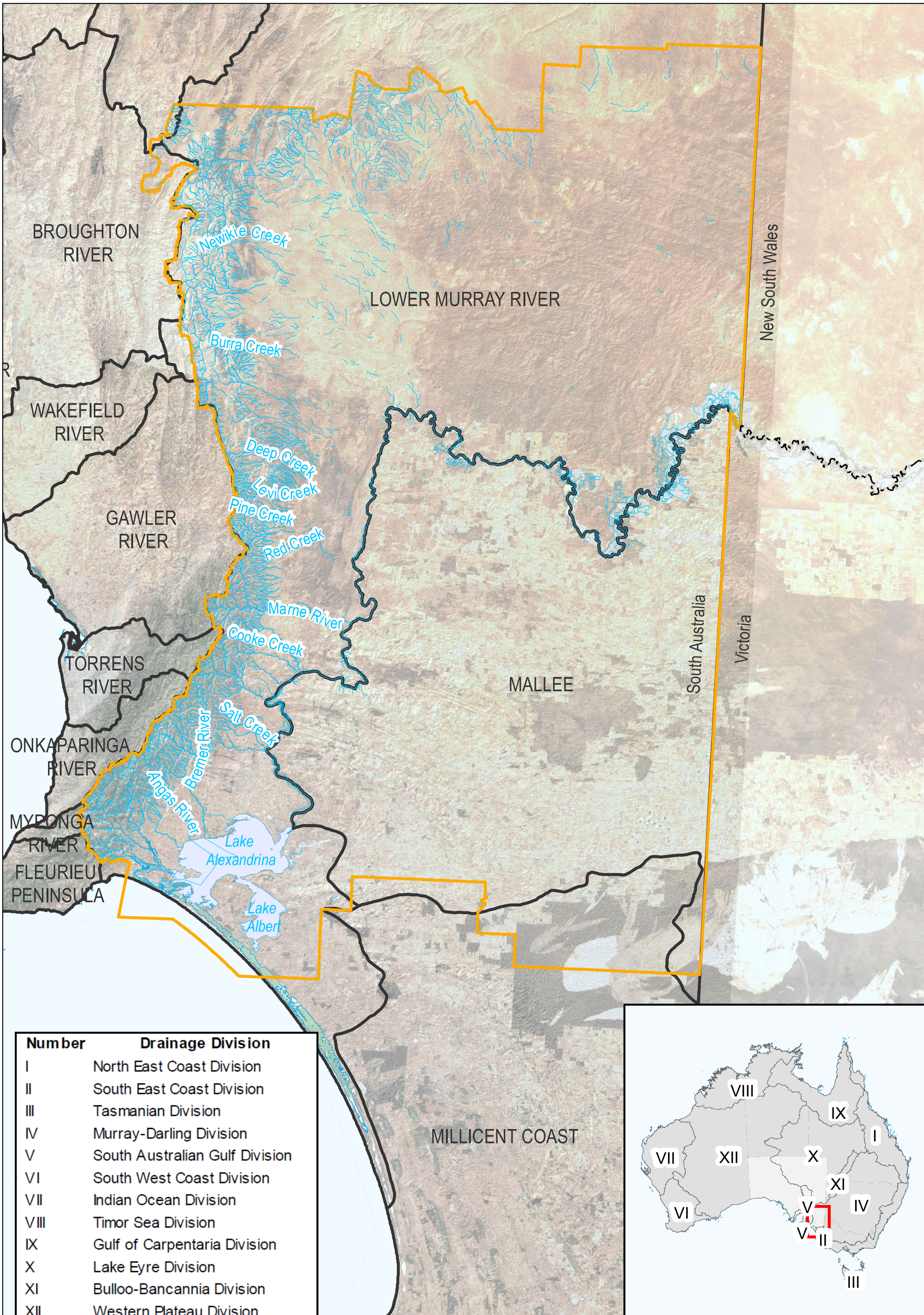
Australia's twelve drainage divisions and 246 river basins were defined by the Australian Water Resources Council in the early 1960s (Fig. 4). Drainage divisions were defined both by major topographic features and major climatic zones to demarcate broadly homogeneous hydrologic regions. This region is largely part of the Murray-Darling drainage division. A small portion in the south of the region is part of the South East Coast drainage division.

The Murray–Darling drainage division covers approximately 1.1 million km^2, almost one sixth of Australia. This drainage division covers the states of Queensland, New South Wales, ACT, Victoria and South Australia, with the River Murray being the major surface water feature discharging into the Lower Lakes in South Australia and then out to sea via the Murray Mouth. Most of the major watercourses draining into the River Murray from the western side of the region are prescribed and include the Marne River, Saunders Creek, Angas River, Bremer River, Currency Creek and Finniss River.

River basins are defined by major watershed boundaries. Three river basins lie in part within the region boundary, and include the Lower Murray River, the Mallee, and to a lesser extent the Millicent Coast.

Surface water catchments are limited in the region with Burra Creek the only defined catchment boundary in the non-prescribed area (Fig. 5). For the purpose of water affecting activity permits in the Regional NRM plan, subcatchments are defined adjacent, north and south to the Burra Creek catchment. All creeks, permanent pools, lagoons and wetlands are essential for the whole country side for the environment, stock water, households and recreation.

A summary of the key surface water features associated with the Burra Creek, Coorong, Rangelands and Mallee parts of the region follows.



Number	Drainage Division
I	North East Coast Division
II	South East Coast Division
III	Tasmanian Division
IV	Murray-Darling Division
V	South Australian Gulf Division
VI	South West Coast Division
VII	Indian Ocean Division
VIII	Timor Sea Division
IX	Gulf of Carpentaria Division
X	Lake Eyre Division
XI	Bulloo-Bancannia Division
XII	Western Plateau Division

Watercourse
NRM Region Boundary
River Basin Boundary

N

0 10 20 30 40 50
Kilometres

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Figure 4. Drainage divisions and river basins

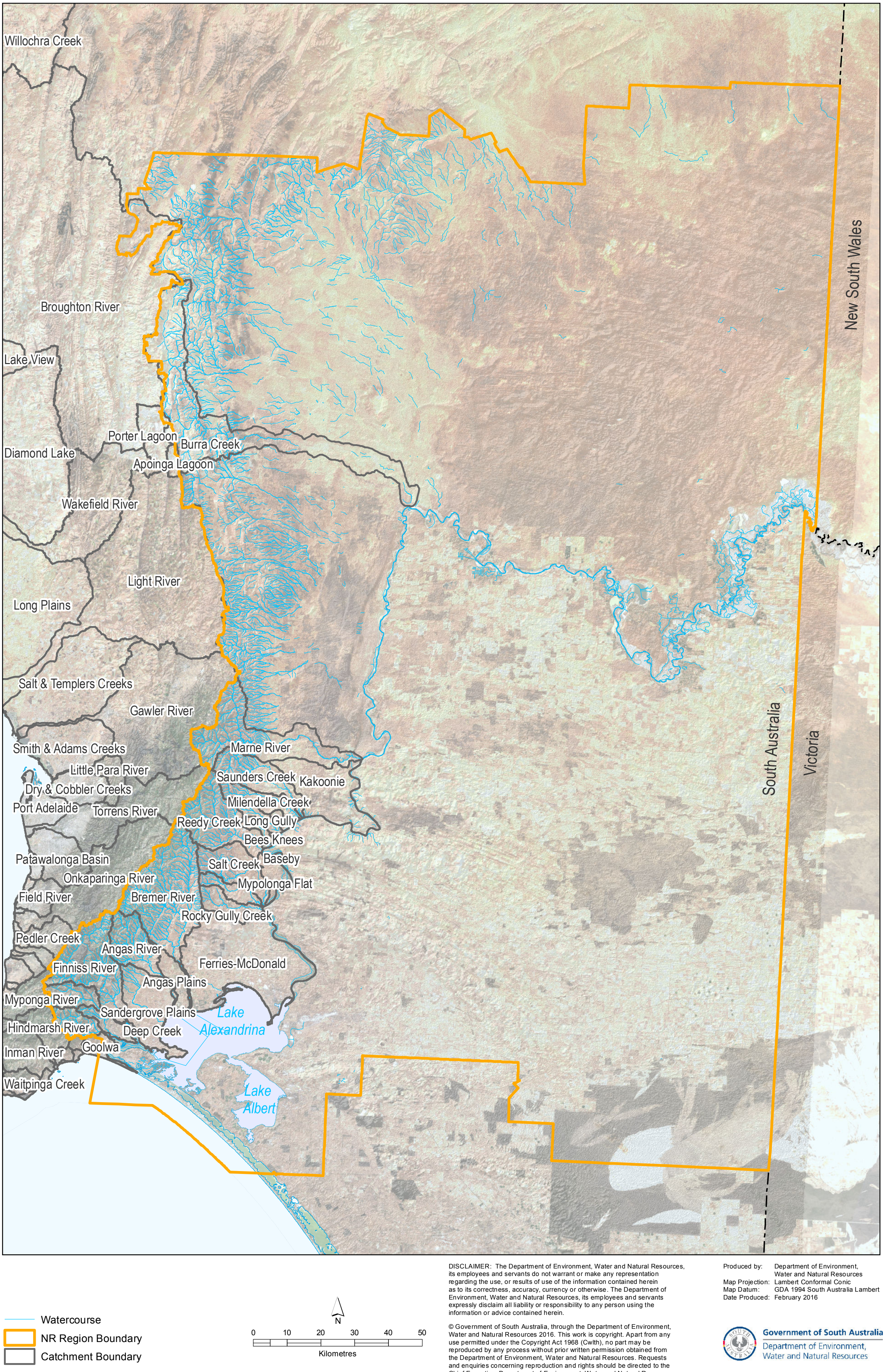

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Figure 5. Surface water catchments in the South Australian Murray-Darling Basin NR Region

2.3.1 Burra Creek catchment

The semi-arid Burra Creek catchment is located in the north-west part of the region, adjacent the Southern Flinders Ranges (Fig. 6). The Burra Creek headwaters commence just north of Mount Bryan and flow in a southerly direction towards Worlds End, before changing direction to the east and flowing to its discharge point at the River Murray.

Climate in the Burra Creek catchment generally consists of hot, dry summers and cool, relatively wet winters. Although the predominant wet period is during winter–spring, summer storms can deliver large volumes of water during a short period of time (Deane *et al.* 2006). Based on SILO rainfall data for the period 1900–2015, the average annual rainfall across the Burra Creek catchment is between 400–500 mm from the top of the catchment to Logan Creek, before reducing to 300–400 mm between Logan Creek and Worlds End, and 200–300 mm from Worlds End to the River Murray. Small sections of the catchment north–east of Burra and around the south–west corner average over 500 mm. Compared to the long-term average, rainfall for the recent period 2006–15 has been largely similar across the catchment.

Topography in the Burra Creek catchment varies from just above sea level at its discharge point to the River Murray, to elevations of 900 m AHD in the north of the catchment. Flows from Burra Creek to the River Murray are rare with the last time this occurred estimated to be around 1941 (Deane *et al.* 2006). Burra Creek is well known for the Burra Gorge (also known as Worlds End) and is a popular recreational site.

The Burra Creek catchment has three current surface water monitoring data logging sites in the central part of the catchment and many community surface water monitoring sites. Burra Creek upstream Logan Creek and Burra Creek at St Just Street Ford were established in 2008 and monitor water level and EC. Burra Creek at St Just Street Ford was decommissioned in 2010 before being reopened in late 2014. Burra Creek at Worlds End (low flows) was designed to monitor low flows due to the strong groundwater discharges (baseflow) that occur within the creek. A historic surface water monitoring station, Burra Creek at Worlds End; A4260536, monitored streamflow from 1974 to 2009 and did not cease to flow during this period, due to baseflow maintaining the perennial reaches of the central catchment (Deane *et al.* 2006).

Table 1. Characteristics of the Burra Creek catchment

Catchment area	934 km^2
Rainfall	200–500 mm
Topography	3–900 m AHD
Surface water monitoring	3 surface water monitoring stations (Fig. 6) Burra Creek upstream Logan Creek (A4261147; 2008-present; monitors water level/EC) Burra Creek at Worlds End (low flows) (A4261148; 2008-10 then late-2014–present; monitors water level/EC) – only station with a rating to convert water level to flow Burra Creek at St Just Street Ford (A4261149; 2008-10 then late-2014–present; monitors water level/EC)

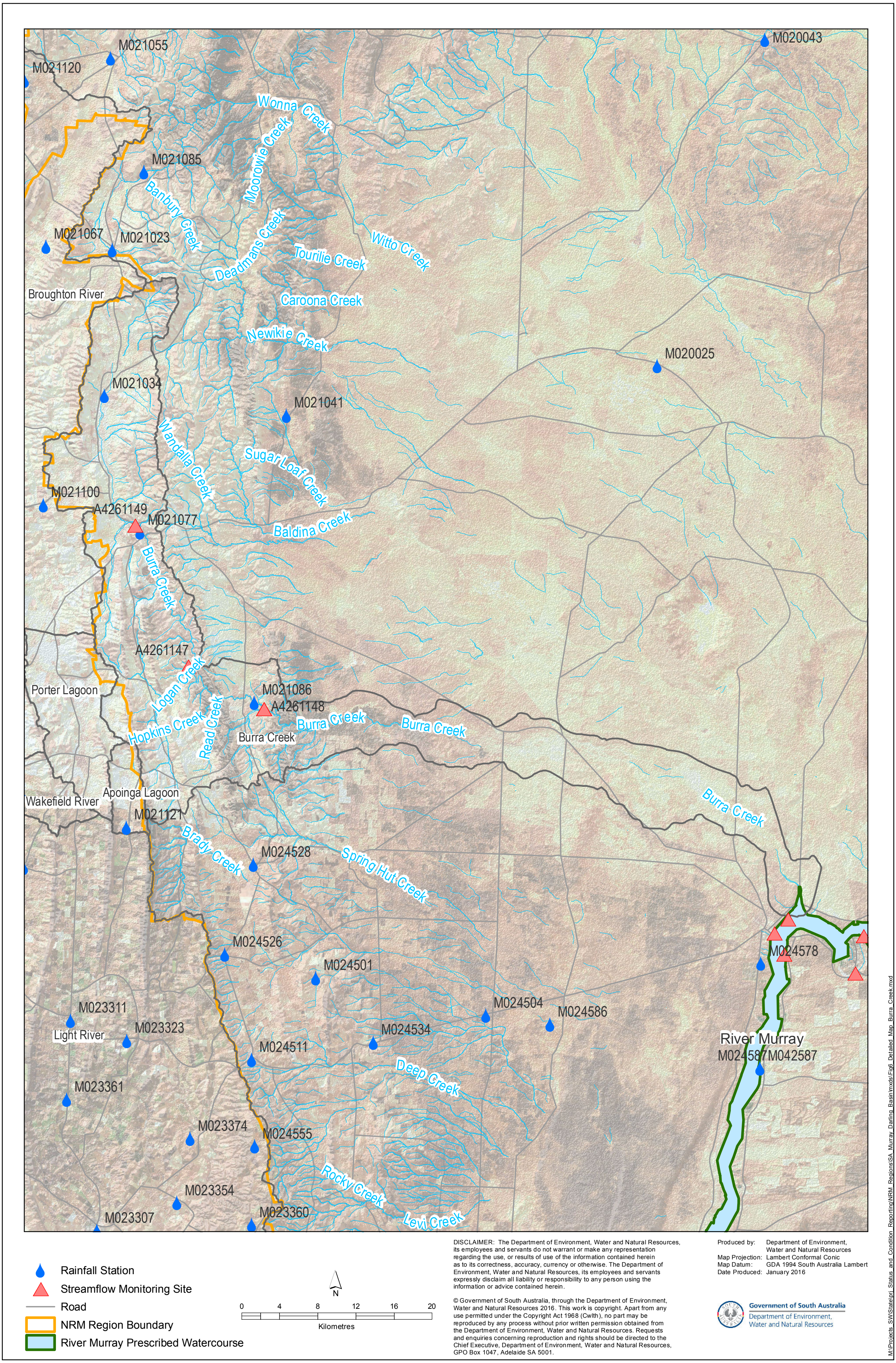

Figure 6. Detailed map of the Burra Creek catchment

2.3.2 Coorong

The Coorong, is located in the south of the region between the Lower Lakes and the sea, and is part of a Ramsar-listed wetland of international importance extending 140 km towards the south-east (Fig. 7). The Murray Mouth is the discharge point to the sea and to prevent this closing, it requires ongoing dredging to minimise siltation build-up. The non-prescribed area between the prescribed Lower Lakes and the sea is approximately 500 km^2.

In 1985 the Coorong, Lakes Alexandrina and Albert site was designated as a Wetland of International Importance, commonly referred to as a 'Ramsar wetland' (DEH 2010). The volume of the North Lagoon ranges from just under 80 GL to 160 GL, the south Lagoon varies from just under 100 GL to approximately 190 GL, and the estuary varies between approximately 20 GL and 40 GL (DEH 2010).

Based on SILO rainfall data for the period 1900–2015, the average annual rainfall across the Coorong is between 400–500 mm. Rainfall is closer to 500 mm towards the west of the Coorong, in the higher rainfall area of the Eastern Mount Lofty Ranges. Compared to the long-term average, rainfall for the recent period 2006–15 has been largely similar (between 400–500 mm) across the Coorong.

Topography in the Coorong varies from sea level to elevations of 40 m AHD. It features low-lying alluvial and coastal plains overlain by low sand ridges, with some outwash fans and isolated remnant hills to the west, and dunes up to 40 m high adjacent the Coorong (SAMDBNRMB 2009).

Inflow to the Coorong comes from flows over the barrages of Lake Alexandrina and also from the south-east via the Upper South East Drainage Scheme via Salt Creek. Salinity in the Coorong increases towards the south-east. The Coorong has numerous surface water monitoring sites monitoring water level and EC (Table 2).

Table 2. Characteristics of the Coorong

Area	Approximately 500 km^2
Rainfall	400–500 mm
Topography	Sea level–40 m AHD
Surface water monitoring (Select sites: not all sites covered in the table)	Goolwa Channel at Goolwa Barrage (A4260525; 1976–present; monitors water level/EC/rain) Goolwa Channel at Beacon 12 (A4261036; 2002–present; monitors water level/EC) Mundoo Channel at Channel Drive Boat Ramp (A4261128; 2007–present; monitors water level/EC) Coorong Channel adjacent Barker Knoll (A4261039; 2002–present; monitors water level/EC) Coorong Channel near Beacon 1 (A4261043; 2002–present; monitors water level/EC) Boundary Creek downstream Boundary Creek Barrage (A4261044; 2002–present; monitors water level/EC) Coorong at Ewe Island Barrage (A4261046; 2002–present; monitors water level/EC) Tauwitchere Channel at Tauwitchere Barrage (A4261048; 1980–present; monitors water level/EC) The Coorong at Pelican Point (A4261134; 2008–present; monitors water level/EC) The Coorong at Long Point (A4261135; 2007–present; monitors water level/EC)

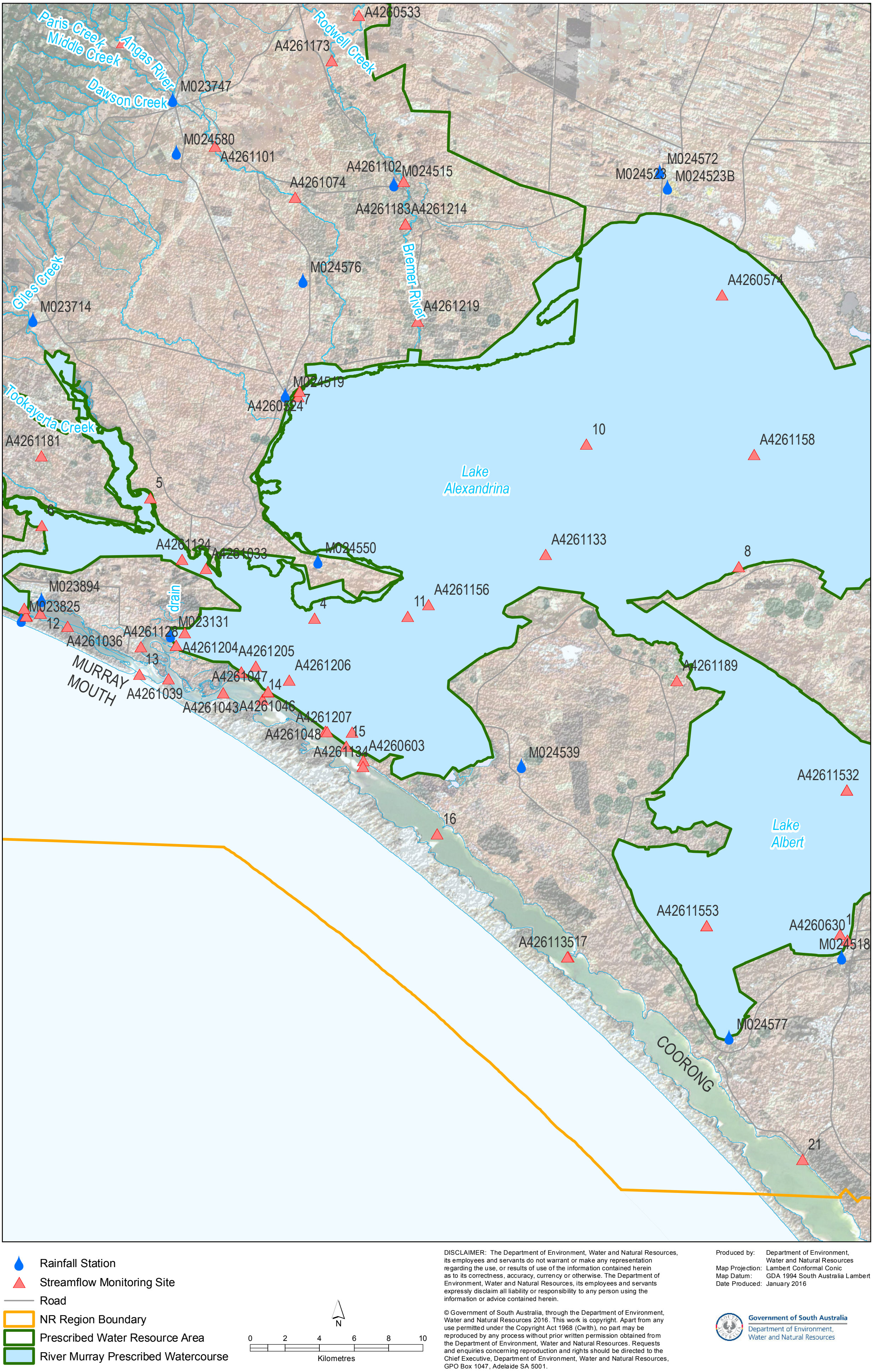

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Figure 7. Detailed map of the Lower Lakes and Coorong in the South Australian Murray-Darling Basin NR Region

2.3.3 Rangelands

The Rangelands are located north of the River Murray PWC and extend to the region's northern boundary (Fig. 8). Approximately half of the Rangelands area is for conservation and includes the Chowilla Game Reserve, Chowilla Regional Reserve, Danggali Wilderness Protection Area and Conservation Park. Chowilla receives water from the River Murray PWC, thus is not maintained by non-prescribed surface water resources. The non-prescribed area west of the conservation areas, known as the pastoral country, captures surface water in dams and utilises the water from the flat, dry, rivers which do occasionally flow a long way in flood events. Most of the region is too dry for agriculture, although there are some dryland cropping areas in the south adjacent to the river. The rangelands feature mallee, woodlands and chenopod shrubland vegetation, the majority of which remain uncleared (SAMDBNRMB 2009), other than native animal, goat, sheep and cattle grazing areas. There are some areas north of the River Murray which are utilised for horticultural crops where infrastructure supplies River Murray water for irrigation.

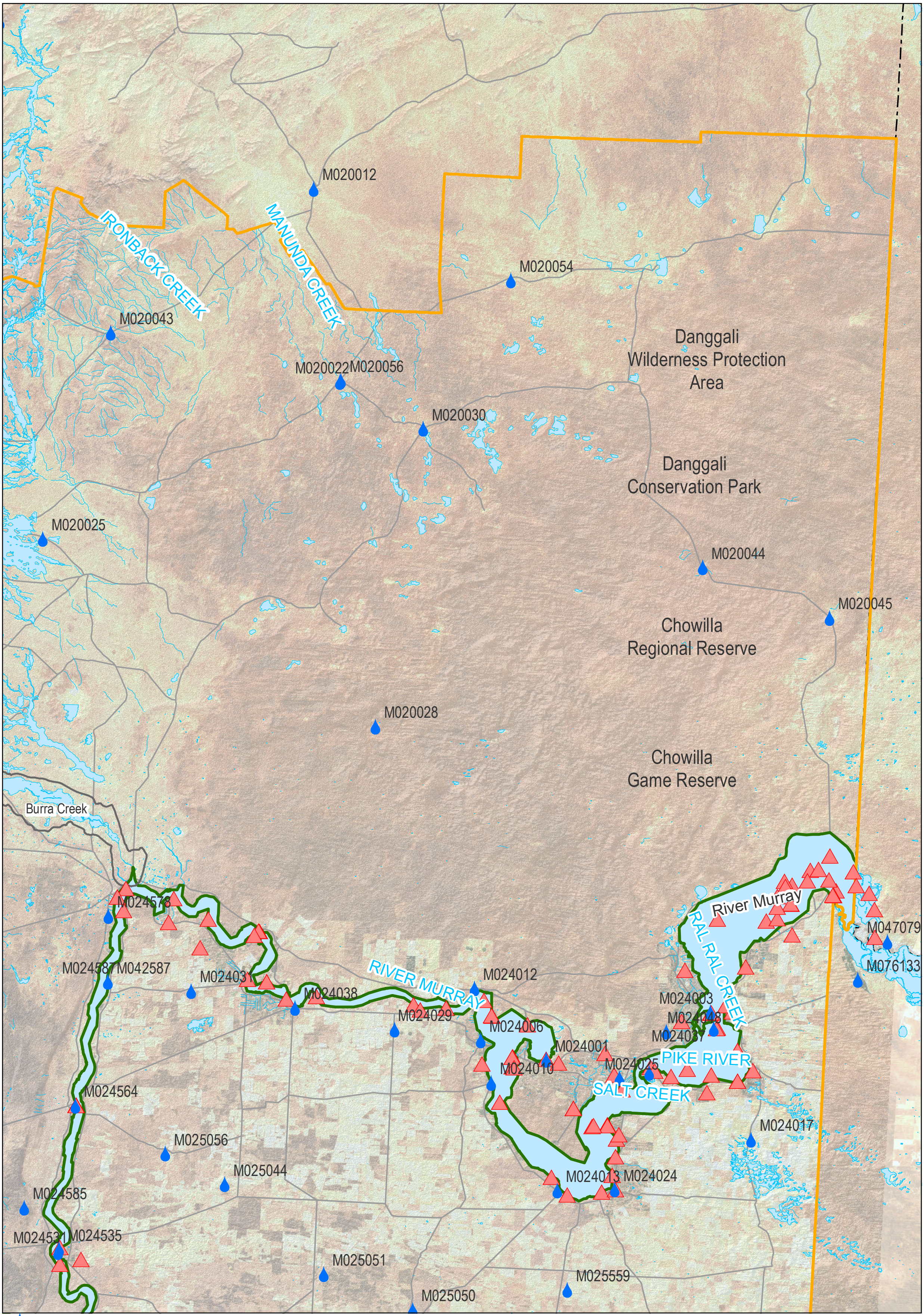
Based on SILO rainfall data for the period 1900–2015, the average annual rainfall across the Rangelands is between 200–300 mm. Compared to the long-term average, rainfall for the recent period 2006–15 has been largely similar (between 200–300 mm) across the Rangelands.

Topography in the Rangelands is typically between 5–150 m AHD across 95% of the area. Small areas to the west of Manunda Creek approach 300 m AHD.

Small permanent waterbodies are scattered throughout the northern half of the Rangelands and Ironback Creek and Manunda Creek are two of the many small ephemeral creeks in the north of the Rangelands. Due to stock no longer being kept on most properties many dams have become disused. The creeks of the Rangelands tend to gain water from the hills to the north but on the plains they lose water to groundwater (SAMDBNRMB 2009). The majority of these creeks terminate as they fan out onto the Murray Plains. This ephemeral nature is the reason why surface water monitoring isn't undertaken in the Rangelands, as flows are intermittent and often short lived.

Table 3. Characteristics of the Rangelands

Area	Approximately 18 000 km^2
Rainfall	200–300 mm
Topography	5–150 m AHD
Surface water monitoring	No streamflow monitoring stations but numerous rainfall and automatic weather stations (Fig. 8)



Rainfall Station
Streamflow Monitoring Site
Watercourse
Waterbody
Road
NRM Region Boundary
River Murray Prescribed Watercourse

N

0 6 12 18 24 30
Kilometres

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Figure 8. Detailed map of the Rangelands

2.3.4 Mallee

The Mallee is located south of the River Murray PWC and extend to the region's southern boundary (Fig. 9). The Mallee includes the majority of the region's agricultural area and consists predominantly of mallee and shrubland communities (SAMDBNRMB 2009).

Based on SILO rainfall data for the period 1900–2015, the average annual rainfall across the Mallee is between 250 mm in the north, increasing up to 500 mm in the south. Average annual rainfall in the Mallee can be classed as 250–300 mm between the River Murray PWC in the north and the township of Karoonda, 300–400 mm between Hampton and Peake, and greater than 400 mm south of Peake. Compared to the long-term average, rainfall for the recent period 2006–15 has seen a wider distribution of rainfall between 300–400 mm, indicating wetter than average rainfall in the north of the Mallee and drier than average rainfall in the south of the Mallee.

Topography in the Mallee is an expansive and gently undulating plain with generally east–west trending sand ridges transitioning to the ranges to the west (SAMDBNRMB 2009).

Surface water run-off from the Murray Mallee region is practically non-existent due to the flat terrain, low rainfall and highly permeable soils. Inflows to the River Murray from the Mallee are from groundwater drainage, which follows a general north-westerly flow path (SAMDBNRMB 2009). No streamflow monitoring stations are established in the Mallee, but the area has numerous rainfall and automatic weather stations and groundwater monitoring network.

Table 4. Characteristics of the Mallee

Area	Approximately 22 000 km^2
Rainfall	250–500 mm
Topography	5–120 m AHD
Surface water monitoring	No streamflow monitoring stations but numerous rainfall and automatic weather stations (Fig. 9)

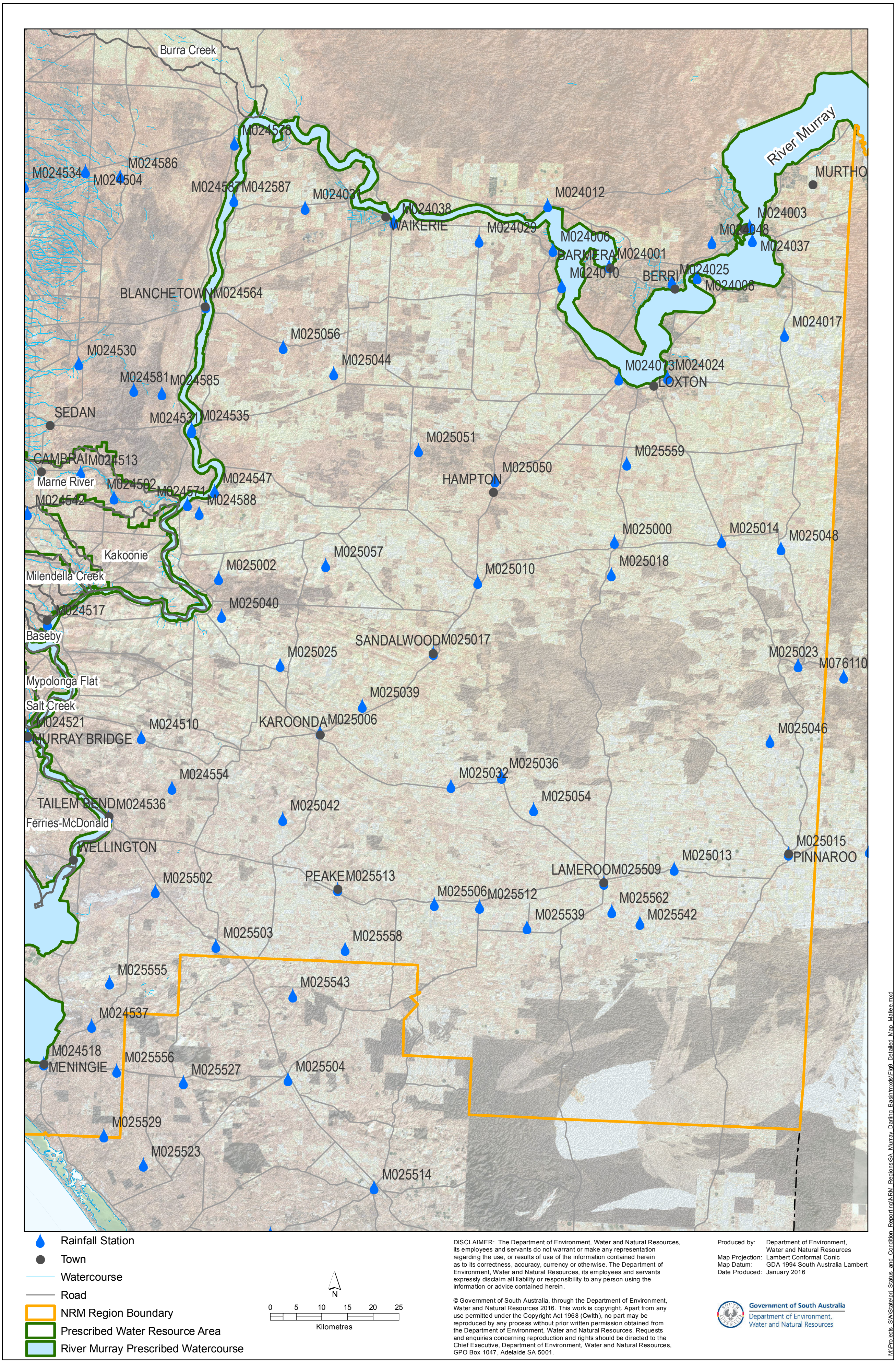

Figure 9. Detailed map of the Mallee

2.4 Land use

The predominant land use across the region includes (Fig. 10):

- Production from dryland agriculture and plantations
- Production from relatively natural environments
- Conservation and natural environments.

Primary production utilises about 82% of the land area of the region consisting mostly of pastoral lands (43%) and dryland cropping and higher rainfall pasture areas (38%) (SAMDBNRMB 2009). Grazing of the Rangelands (apart from designated conservation areas) is the main land use north of the River Murray, while production from dryland agriculture and plantations is the main land use south of the River Murray and throughout the Eastern Hills to the west.

Areas of dairy production are located around the lower River Murray and the Lower Lakes (SAMDBNRMB 2009). Broad-hectare agricultural production is largely mixed cereal and livestock grazing, although pulse and oilseed crops are increasing as cropping intensifies, particularly in the more reliable rainfall areas of the south (SAMDBNRMB 2009).

Agricultural land use in the Mallee is mainly dryland agriculture with a number of crops grown and grazing for wool and meat production, with an established and expanding irrigation industry as River Murray users seek alternative sources of water and land to develop (SAMDBNRMB 2009).

DEWNR manages a number of parks and reserves throughout the region for biodiversity conservation. Joint Indigenous Land Use Agreements (ILUA) and cooperative management agreements are now in place over parts of the region and are binding agreements under the *Native Title Act 1993* between Native Title claimants and others who have a legal interest in the subject land. Conservation areas include Danggali Wilderness Protection Area, Danggali, Ngarkat, Billiat, Karte, Red Banks, Mokota, Peebinga, Caroona Creek and Scorpion Springs Conservation Parks, Gluepot, Bookmark Biosphere and Worlds End Reserves, Chowilla Regional Reserve and Chowilla Game Reserve. The conservation areas feature an array of land types including dense mallee scrubland in Danggali that provides habitat to many semi-arid land birds, to the floodplains, wetlands, mallee woodland, black oak and bluebush shrublands of Chowilla (DEWNR 2014).

Although much smaller in area occupied, mining industries have become an increasingly significant land use in the region. Current mining production leases in the region are for construction materials and industrial minerals and include mineral extraction of calcrete, clay, gold, granite, gypsum, limestone, quartzite, zircon, salt and sand.

A broad description of the soils in the region is provided in the Regional NRM Plan (SAMDBNRMB 2009).

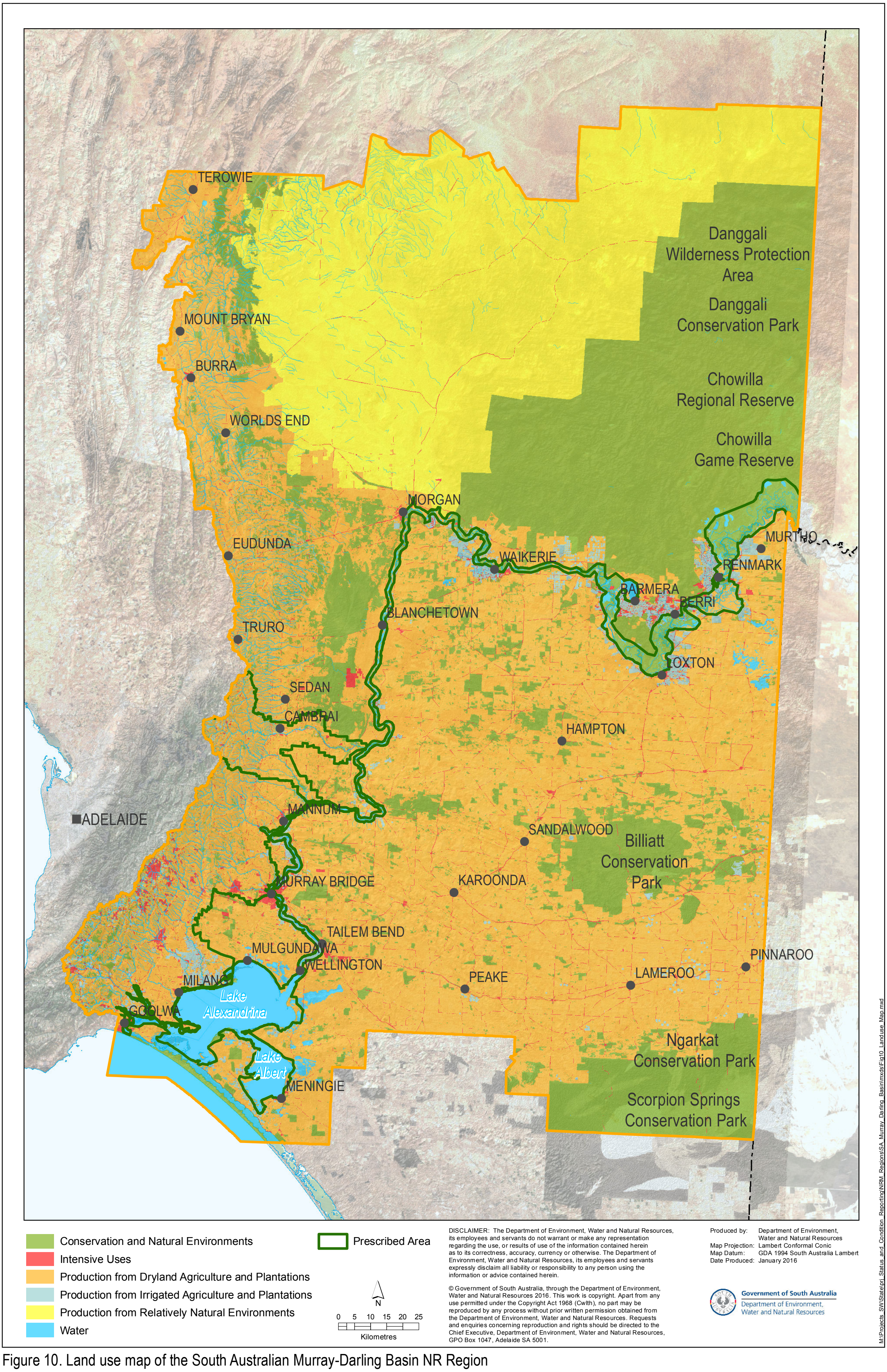

Figure 10. Land use map of the South Australian Murray-Darling Basin NR Region

2.5 Demand for water resources

Demand for water resources in the non-prescribed area is largely supplied from prescribed River Murray water and prescribed groundwater through reticulated supply by SA Water. As this report focuses on non-prescribed surface water resources, the below information is supplied in a general sense as it includes description of non-prescribed surface water.

The non-prescribed area south-east of the River Murray is largely comprised of the Coorong District Council (DC), Southern Mallee DC and the DC of Karoonda East Murray. In 2010, the before mentioned DCs received funding under the Australian Government's *Strengthening Basin Communities (SBC) Program – Planning Component*, and engaged Kellogg Brown and Root to prepare a joint Integrated Water Management Plan (IWMP) covering the townships of Tailem Bend, Meningie, Wellington East and Raukkan (KBR 2011a), Pinnaroo and Lameroo (KBR 2011b) and Karoonda (KBR 2011c). To the north-west of the River Murray, the Goyder Regional Council engaged Australian Water Environments to develop IWMP's for the townships of Burra (AWE 2012) and Eudunda (AWE 2012a).

2.5.1 Coorong District Council

The following information was extracted from the Coorong DC IWMP (KBR 2011a).

Water resources available to the DC includes potable water supply, wastewater collection and treatment, stormwater drainage, and groundwater. The towns of Tailem Bend and Meningie are supplied with potable water from the River Murray through SA Water's Water Filtration Plant at Tailem Bend. Potable water provided by SA Water accounts for approximately 63 % and 42 % of water used in the townships of Tailem Bend and Meningie respectively, with the remainder entirely from direct water extractions from the River Murray and Lower Lakes. A summary of water use in these towns is provided in Table 5.

Table 5. Summary of average annual water use in the Coorong District Council

Town	Residential water use (ML/y)	Golf Club water use (ML/y)	Irrigation water use (ML/y)	Commercial water use (ML/y)	Council water use (ML/y)	TOTAL (ML)
Tailem Bend	119	52	31	20	4	226
Meningie	90	135	19	25	4	273

A small reticulation system in Wellington East supplies water from the River Murray for non-potable use in Wellington East. The Council holds a domestic River Murray license of 40 ML for this purpose, with an average of 10.7 ML being used. An estimated 1.9 ML of rainwater is also used.

2.5.2 Southern Mallee District Council

The following information was extracted from the Southern Mallee DC IWMP (KBR 2011b).

Water resources available to the DC include treated and untreated groundwater, rainwater, stormwater drainage, and treated wastewater. The towns of Lameroo and Pinnaroo extract groundwater for both potable and non-potable uses. SA Water supply potable water to both towns, while untreated groundwater is used for irrigation of public open spaces. Treated groundwater supplied by SA Water accounts for approximately 58 % of water used in Pinnaroo and 45 % of water used in Lameroo. The remainder of water use in these towns is from untreated groundwater extraction or rainwater collected from homes. Both towns have stormwater harvesting and reuse systems that supplement groundwater irrigation supplies across parts of the towns. A summary of water use in these towns is provided in Table 6.

Table 6. Summary of average annual water use in the Southern Mallee District Council

Town	Residential water use (ML/y)	Non-residential water use (ML/y)	Golf Club water use (ML/y)	Council water use (ML/y)	TOTAL (ML)
Pinnaroo	101	32	54	65	252
Lameroo	77	14	65	52	208

2.5.3 District Council of Karoonda East Murray

The following information was extracted from the DC of Karoonda East Murray IWMP (KBR 2011c).

Water resources available to the township of Karoonda include potable water supply, wastewater collection and treatment, stormwater drainage, groundwater and rainwater. Karoonda is supplied with potable water from the River Murray through SA Water's treatment plant at Tailem Bend. Average potable water consumption is approximately 65 ML/y and is used for residential, commercial/industrial, public utilities, vacant land, recreation, and institutional (table not provided). A Community Wastewater Management System generates approximately 100 kL/d and is discharged to evaporation lagoons to the north of the township.

2.5.4 Alexandrina Council

The following information was extracted from the Goolwa and Hindmarsh Island IWMP (SKM 2012).

Current water resources in the Goolwa and Hindmarsh Island townships include natural watercourses, stormwater, groundwater, potable mains water, rainwater tanks, and wastewater. Mains water is supplied to Goolwa by SA Water from the Myponga reservoir catchment after treatment at the Myponga water treatment plant. Rainwater is a main source of water to Hindmarsh Island but use numbers are not available. River Murray water is pumped from the Goolwa Channel for irrigation of council reserves and part of the South Lakes Golf Course. Treated wastewater is used at a turf farm to the west of Goolwa. A summary of water use by source is provided in Table 7.

Table 7. Summary of average annual water use in Goolwa and Hindmarsh Island

Household mains water use (ML/y)	Irrigation mains water use (ML/y)	Treated stormwater use (ML/y)	River Murray water use (ML/y)	Wastewater reuse (ML/y)	TOTAL (ML)
535	8	50	85	180	858

2.5.5 Goyder Regional Council

The following information was extracted from the Burra IWMP (AWE 2012) and the Eudunda IWMP (AWE 2012a).

Council engaged Australian Water Environments (AWE) to develop an IWMP for the townships of Burra and Eudunda, with the Council and community committed to becoming more sustainable with its water use. Treated potable water is delivered to Burra via SA Water branch main from the Morgan–Whyalla pipeline and to Eudunda via SA Water reticulation main from the Swan Reach–Yorke Peninsula pipeline. Industry and council accounts for 70 % of potable water use in Burra, while almost 70 % of potable water use in Eudunda is for residential purposes. A summary of water use by source is provided in Table 8.

Table 8. Summary of average annual water use in the Goyder Regional Council

Town	Potable water use (ML/y)	Stormwater reuse (ML/y)	Wastewater reuse (ML/y)	TOTAL (ML)
Burra	414	0	20	434
Eudunda	117	<5	27	149

3 Data summary

3.1 Rainfall

The region receives variable rainfall, increasing from north to south. Rain tends to fall predominantly in the late autumn, winter and early spring months across the southern and western parts of the region, whereas places such as Yunta in the north receive an even distribution of monthly rainfall. The higher magnitude of rain tends to fall across the western and southern part of the region, particularly around the higher-elevated Mount Lofty Ranges and Southern Flinders Ranges, where annual rainfall can be higher than 800 mm/y. The Mount Lofty Ranges and Southern Flinders Ranges are the source for many streams that flow east to the River Murray. The northern part of the region experiences the least amount of rainfall, typically less than 250 mm/y.

3.1.1 Spatial and temporal variation

The distribution of rainfall monitoring stations in the region varies, with a larger number of stations being located in the southern half of the region (Fig. 11). Length of data available from these sites varies, however, more than 40 rainfall stations scattered across the region have more than 50 years of data, while 20 of those have more than 100 years of data.

To analyse the spatial variation of rainfall in the region, four stations were selected to represent the rainfall patterns and trends across the region. These stations are highlighted as red raindrops in Figure 11. The stations are located in the northern part of the region at Yunta, in the north-west at Burra, in the south at Karoonda, and in the south-west at Meningie. The selected stations have well over 125 years of extended SILO patch point data and show the rainfall variation representative of the region. The period of record at each station has been summarised from 1889-2015 to ensure a consistent comparison of years (Table 9). The long-term trend in annual rainfall varies across all rainfall analysis sites.

Table 9. Selected rainfall analysis sites in the South Australian Murray-Darling Basin NRM Region

Rainfall station name	Station no.	Period of record	Average annual rainfall (mm)
Yunta	M02022	1889–2015	208
Karoonda	M025006	1889–2015	339
Burra	M021077	1889–2015	448
Meningie	M024537	1889–2015	449

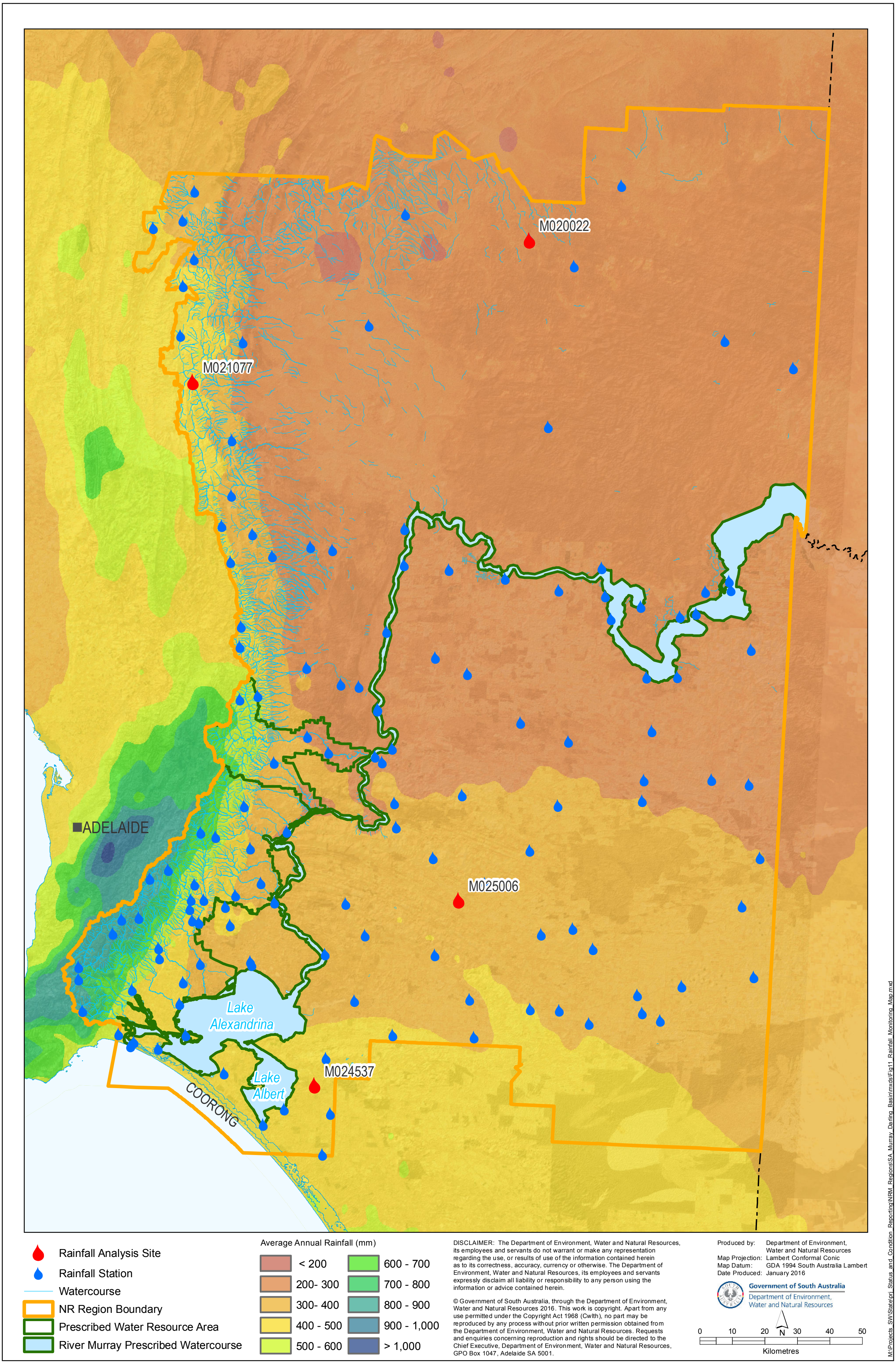

Figure 11. Rainfall monitoring map of the South Australian Murray-Darling Basin NR Region

The cumulative deviation from mean annual rainfall (residual mass curve) identifies periods of above and below average trends. An upward slope in a residual mass curve indicates a period of wetter-than-average rainfall, while a downward slope indicates a period of drier-than-average rainfall.

SILO patch point data for Yunta BoM rainfall station (M020022) are summarised for the period 1889 to the end of 2015 in Figure 12. The 127 years of data have an average annual rainfall of 208 mm with an increasing trend in annual rainfall observed during the period. Distinct wetter-than-average and drier-than-average rainfall periods can be seen. From 1889 to the early 1900s, Yunta experienced drier-than-average rainfall with limited years above the long-term average. The period from the mid 1920s to 1950 shows a rapidly decreasing rainfall trend before periods of wetter-than-average rainfall in the mid 1970s, early 1990s and 2009 and 2010. The distribution of monthly rainfall at Yunta shows a relatively even distribution across all months (Fig. 13).

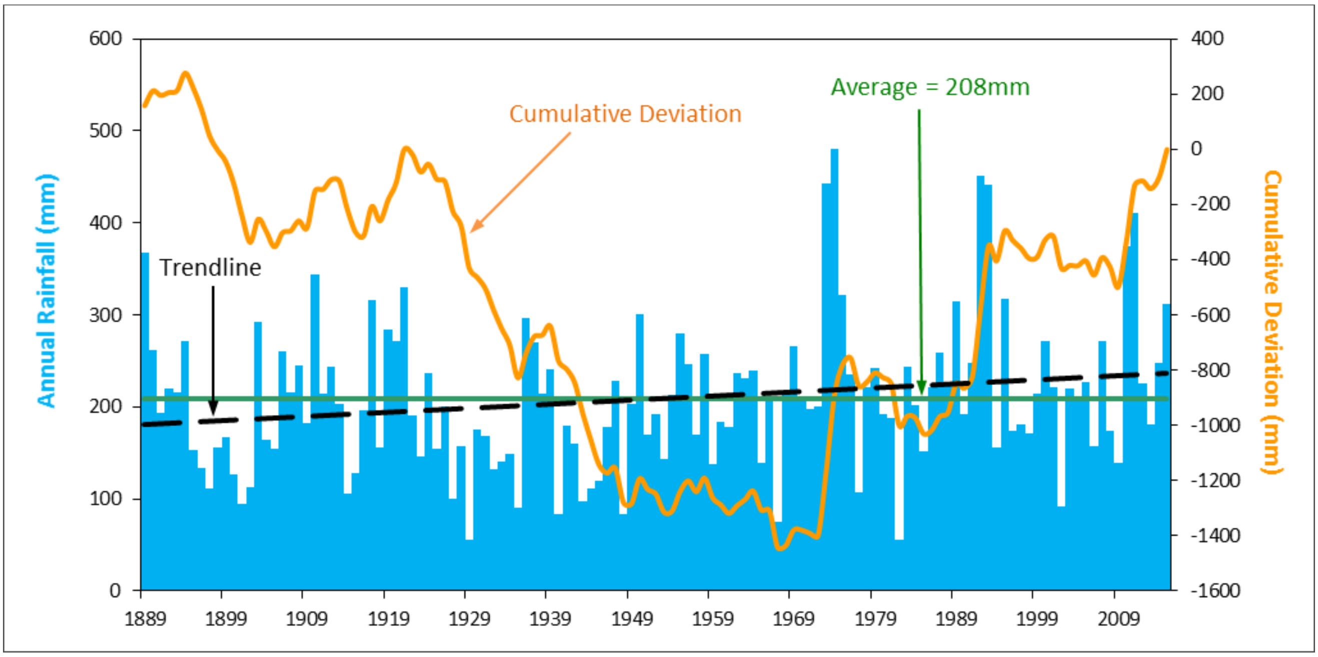

Figure 12. Annual rainfall: Yunta BoM rainfall station

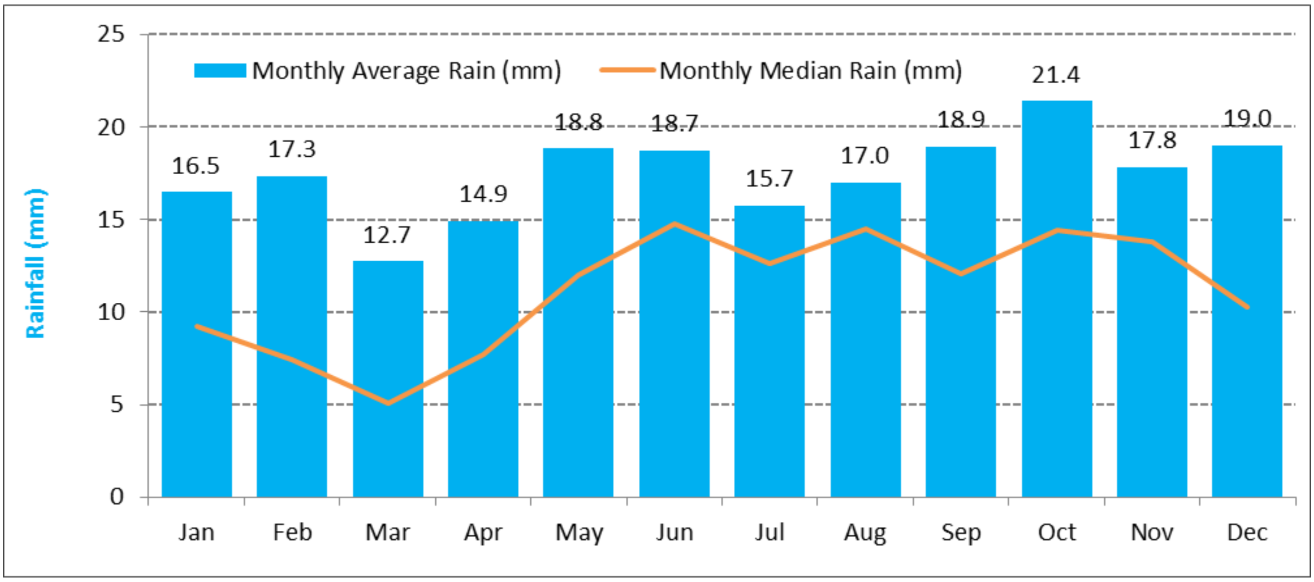

Figure 13. Mean and median monthly rainfall: Yunta BoM rainfall station

SILO patch point data for Karoonda BoM rainfall station (M025006) are summarised for the period 1889 to the end of 2015 in Figure 14. The 127 years of data have an average annual rainfall of 339 mm with a slightly decreasing trend in annual rainfall observed during the period. Karoonda is located in the south of the region and experiences higher average rainfall compared to Yunta. A series of wetter-than-average years from the early 1900s to the mid 1920s shows an increasing trend in annual rainfall, followed by a period of 35 years with equal number of above and below average rainfall years and a steady annual rainfall trend. A rapidly decreasing trend in annual rainfall is observed from the late 1950s to the early 1990s with limited years above the long-term average, followed by a gradually increasing trend to 2011. Annual rainfall for the past few years has been consistently below average. The distribution of monthly rainfall at Karoonda is presented in Figure 15 and displays a winter dominant rainfall trend.

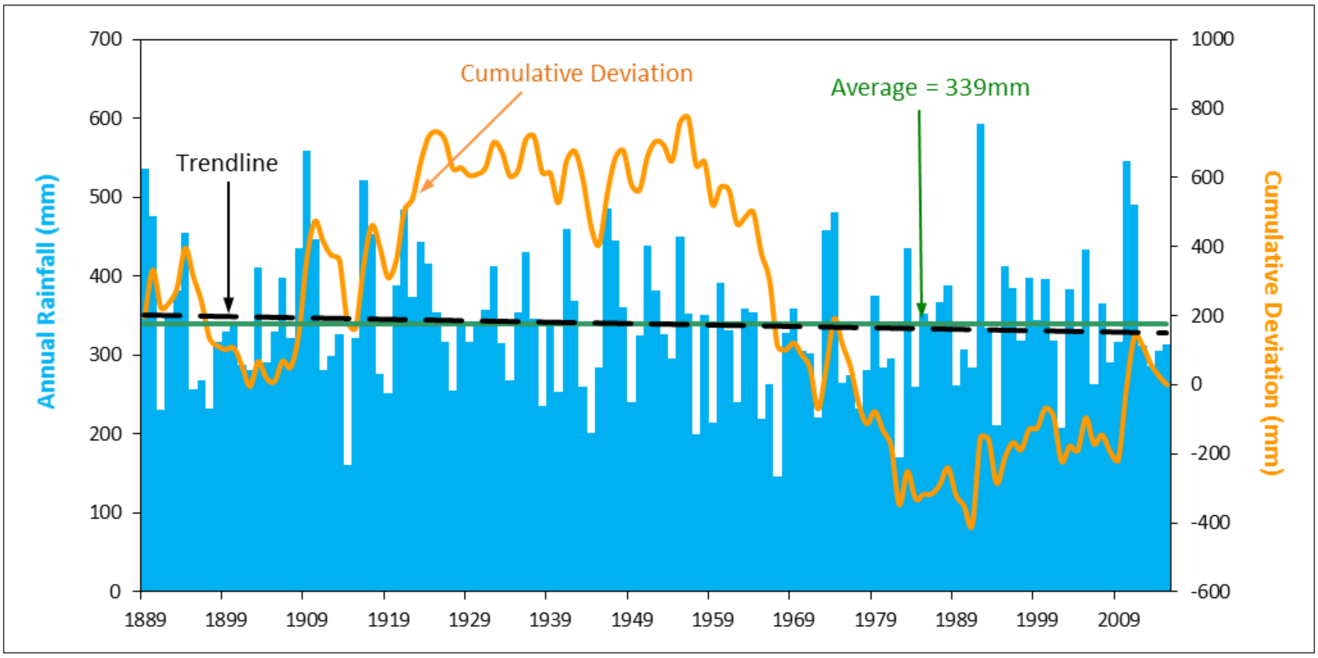

Figure 14. Annual rainfall: Karoonda BoM rainfall station

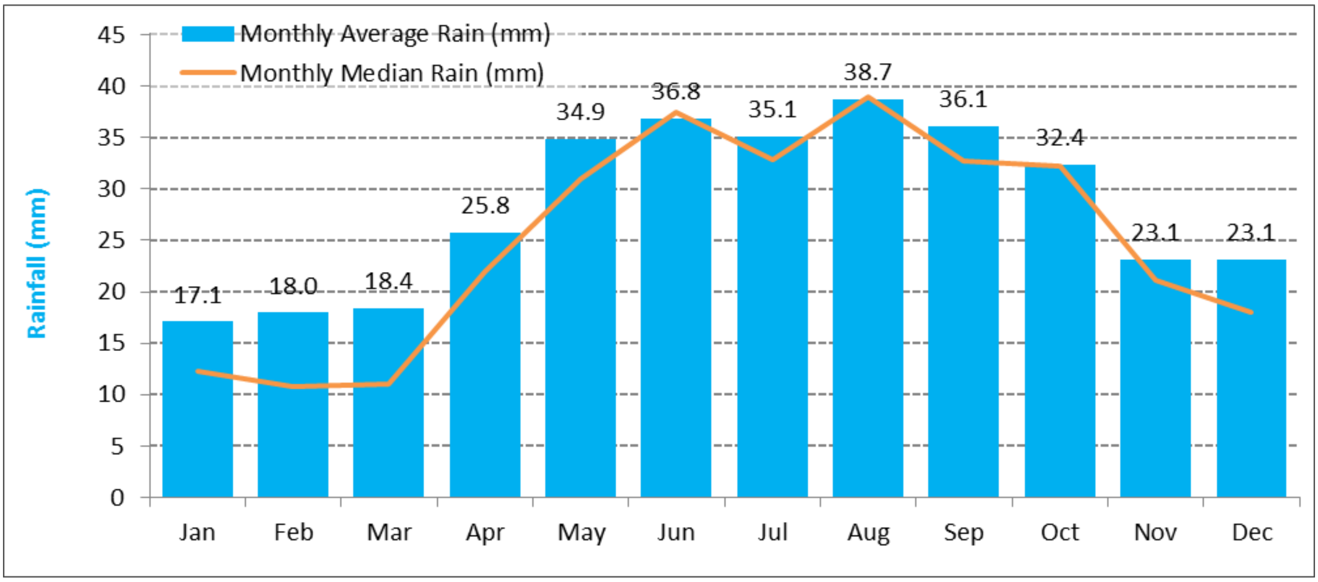

Figure 15. Mean and median monthly rainfall: Karoonda BoM rainfall station

SILO patch point data for Burra BoM rainfall station (M021077) are summarised for the period 1889 to the end of 2015 in Figure 16. The 127 years of data have an average annual rainfall of 448 mm with a decreasing trend in annual rainfall observed during the period. Located in the north-west of the region, Burra receives on average 140 mm more than Yunta. A rapidly increasing trend in annual rainfall is observed from the mid 1910s to mid-1920s. A steady trend in annual rainfall from the mid 1930s to late 1950s coincides with the trend observed at Karoonda. From the late 1950s to present there is a predominantly decreasing rainfall trend, apart from the early 1970s and early 1990s. Above average rainfall years have been observed 4 of the past 6 years. The distribution of monthly rainfall at Burra shows rainfall predominantly during the winter months (Fig. 17).

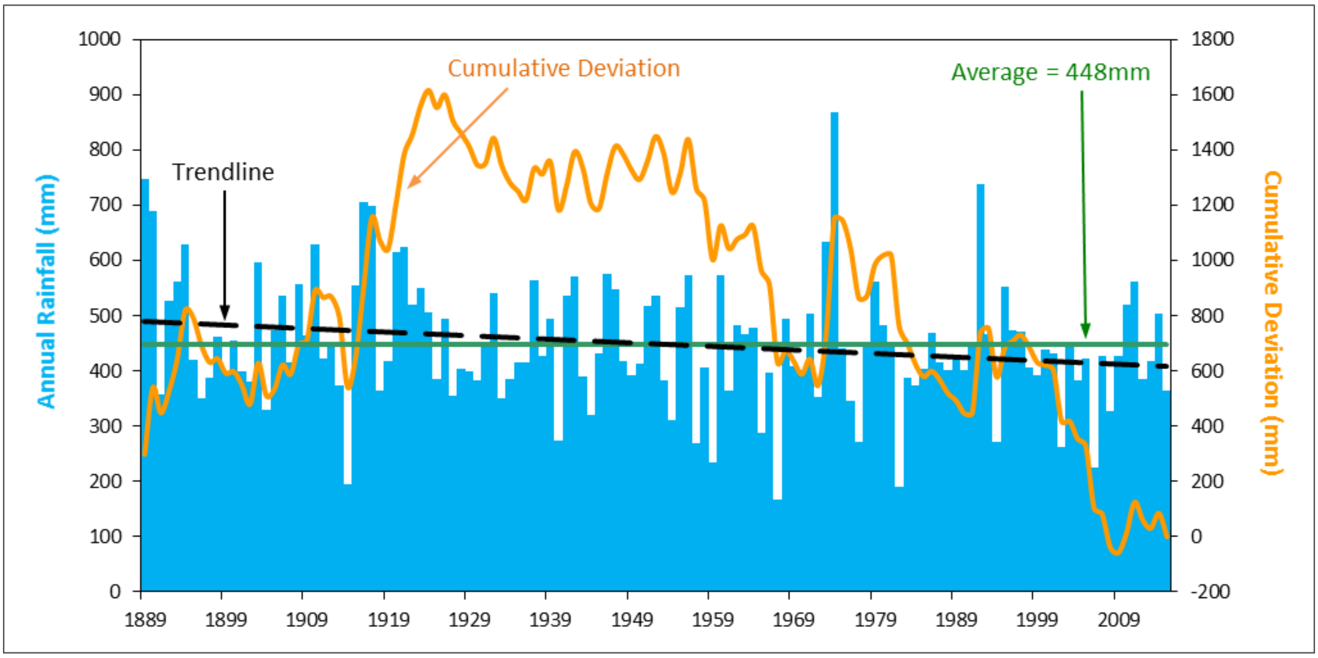

Figure 16. Annual rainfall: Burra BoM rainfall station

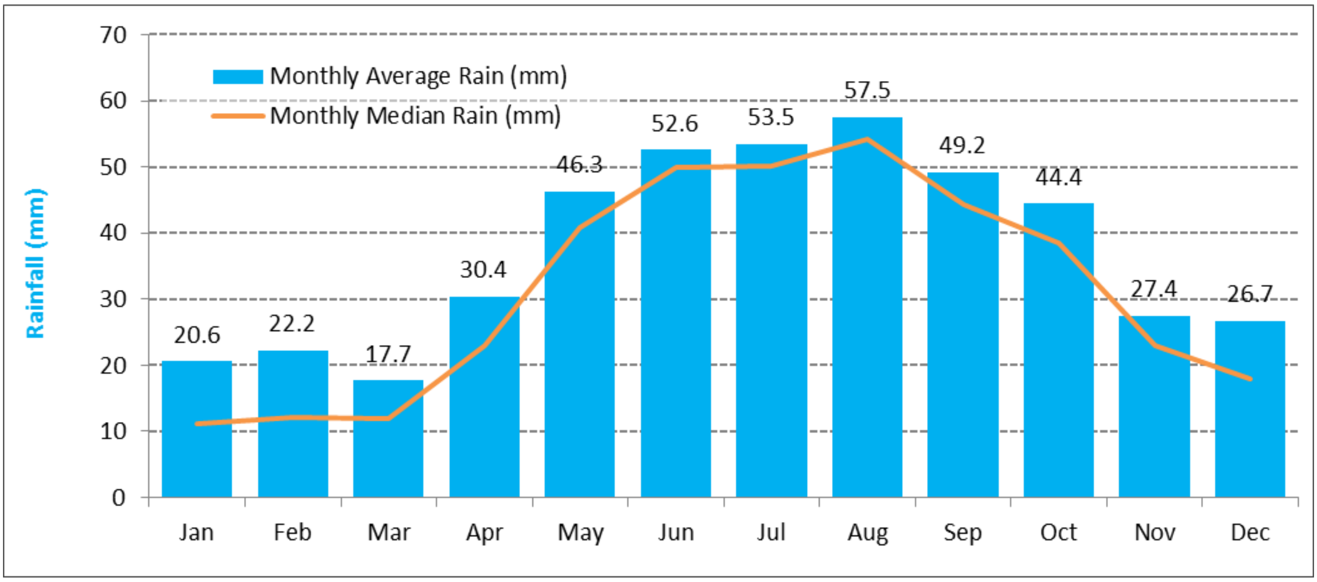

Figure 17. Mean and median monthly rainfall: Burra BoM rainfall station

SILO patch point data for Meningie BoM rainfall station (M024537) are summarised for the period 1889 to the end of 2015 in Figure 18. The 127 years of data have an average annual rainfall of 449 mm with a steady trend in annual rainfall observed during the period. Located in the south-west of the region at Lake Albert, Meningie receives the same average annual rainfall as Burra 220 km to the north. Meningie, from 1889 to the mid 1920s, received highly variable rainfall before an extensive period of drier-than-average years to the late 1960s. Wetter-than-average rainfall, highlighted by the increasing trend, is observed from the late 1960s to present apart from the early to late 2000s, which coincides with drought conditions experienced in the state during this time. The distribution of monthly rainfall at Meningie, like that of Karoonda and Burra, shows rainfall predominantly during the winter months (Fig. 19).

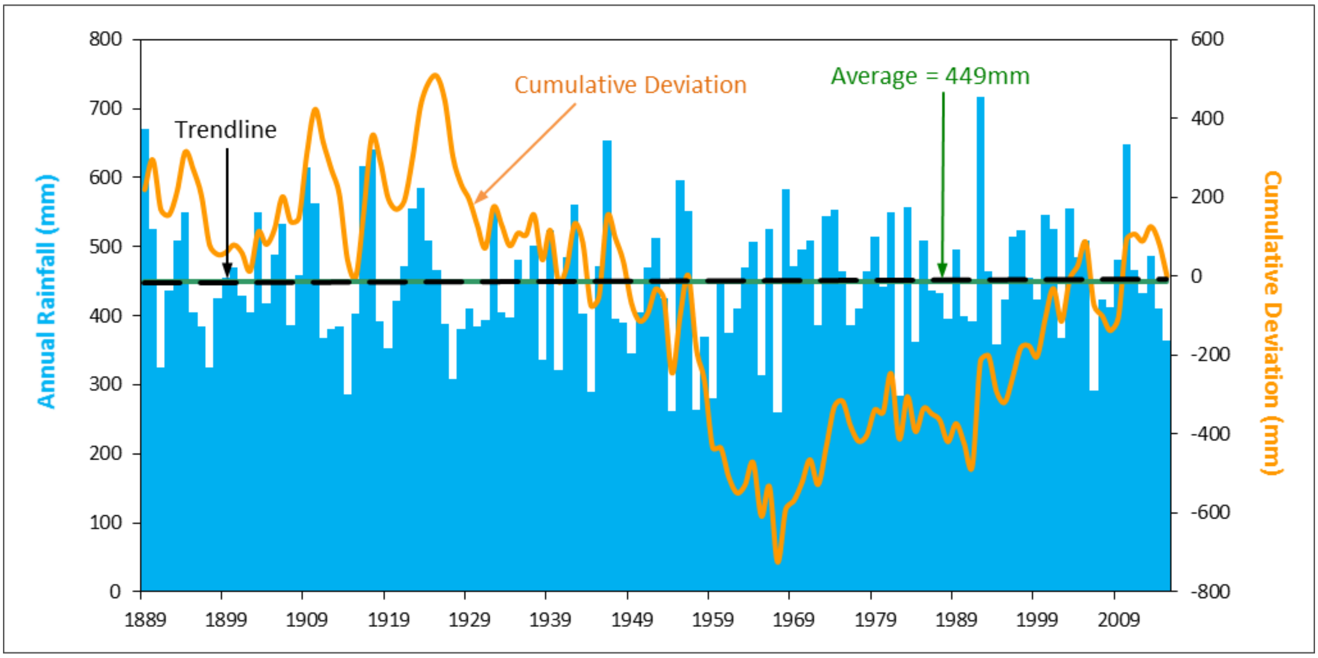

Figure 18. Annual rainfall: Meningie BoM rainfall station

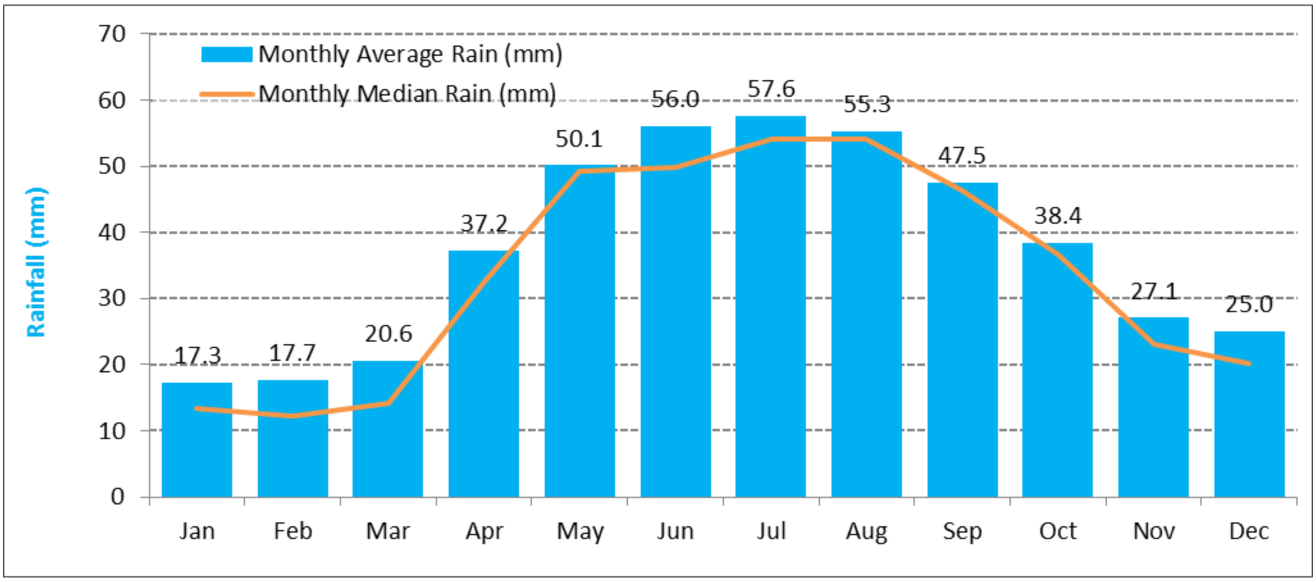

Figure 19. Mean and median monthly rainfall: Meningie BoM rainfall station

3.2 Streamflow

The majority of streams in the region are ephemeral and part of the Murray–Darling drainage division. Burra Creek is the largest surface water resource in the non-prescribed part of the region and connects to the River Murray during high flow events. Streamflow from Burra Creek to the River Murray is rare, as the lower reaches are essentially flood-out plains and lack defined drainage (SAMDBNRMB 2009). Streamflow is generated from local rainfall events, generally between April and September, in the higher elevated parts of the Mount Lofty Ranges and Southern Flinders Ranges. Many other creeks in the area supply farming families, business and the environment with water, but information on these is sparse compared to Burra Creek. In contrast to streams in the prescribed part of the region, streams in the north are highly ephemeral and require large rainfall events to commence flowing. The majority of the year stream beds are dry and many of these terminate as they fan out onto the Murray Plains (SAMDBNRMB 2009).

Surface water run-off from the Mallee region in the south is practically non-existent due to the flat terrain, low rainfall and highly permeable soils (SAMDNRMB 2009).

The CLLMM site is located where the Murray–Darling Basin meets the Southern Ocean. A South Lagoon estuary and North Lagoon make up the Coorong and are part of the South East and SAMDB NR Region's respectively. A series of five barrages: Goolwa, Mundoo, Boundary Creek, Ewe Island and Tauwitchere, separate the fresh waters of the River Murray and Lake Alexandrina from the more saline waters of the Murray Mouth estuary and Coorong lagoons. They were built to prevent seawater entering the Lower Lakes and to maintain freshwater conditions during times of low flows and ensure productivity in surrounding areas (DEH 2010). Surface water inflows from the Upper South East Drainage Scheme, often brackish to saline, contribute to the South Lagoon (14.3 GL/y on average from 2001-14 recorded at site A2390568 Salt Creek Outlet). Freshwater inflows to the South Lagoon in winter and spring have decreased enormously due to the extensive drainage networks in the South East which now direct surface water runoff directly to sea (MDBA 2014). The North Lagoon receives surface water inflow from the River Murray and tributary systems in the Eastern Mount Lofty Ranges (3.5 GL/y on average over the past 33 years recorded at the barrages). A minimum annual flow required to keep the Murray Mouth open is identified as between 730–1090 GL/y (MDBA 2014). A large variation in water levels is often observed in the Coorong (see Figs. 23-30), depending on seasonal factors, with 0 m and 1 m AHD representing the lowest and highest levels (DEH 2010).

Streamflow monitoring is limited in the region, with Burra Creek at Worlds End the only station that monitors streamflow. The remainder of stations presented in Table 10 are water level recorders only. Water level is a key environmental attribute that determines the availability of physical habitat for fish, birds, plants and other aquatic life in the CLLMM (MDBA 2014).

At the time of writing, all surface water monitoring stations listed below are currently active in the non-prescribed NR region, however, not all sites may have been captured.

Table 10. Active surface water monitoring stations

Monitoring station	Station no.	Catchment area (km²)	Period of record	Average annual streamflow	
				(ML)	(mm)
Burra Creek u/s Logan Creek*	A4261147	-	2008–10 and 2014–present	-	-
Burra Creek at Worlds End (low flow)	A4261148	541	2008–present	750	1.3
Burra Creek at St Just Street Ford*	A4261149	-	2008–10 and 2014–present	-	-
Coorong d/s Goolwa Barrage*	A4260525	-	1976– present	-	-
Goolwa Channel adjacent Reedy Island*	A4261036	-	2002– present	-	-
Coorong Channel adjacent Barker Knoll*	A4261039	-	2002– present	-	-
Coorong Channel at Beacon 1*	A4261043	-	2002– present	-	-
Coorong at Ewe Island Barrage*	A4261046	-	2002– present	-	-
Coorong at Channel Drive Boat Ramp*	A4261128	-	2007– present	-	-
Coorong at Pelican Point*	A4261134	-	2008– present	-	-
Coorong at Long Point*	A4261135	-	2007– present	-	-

*Water level site only

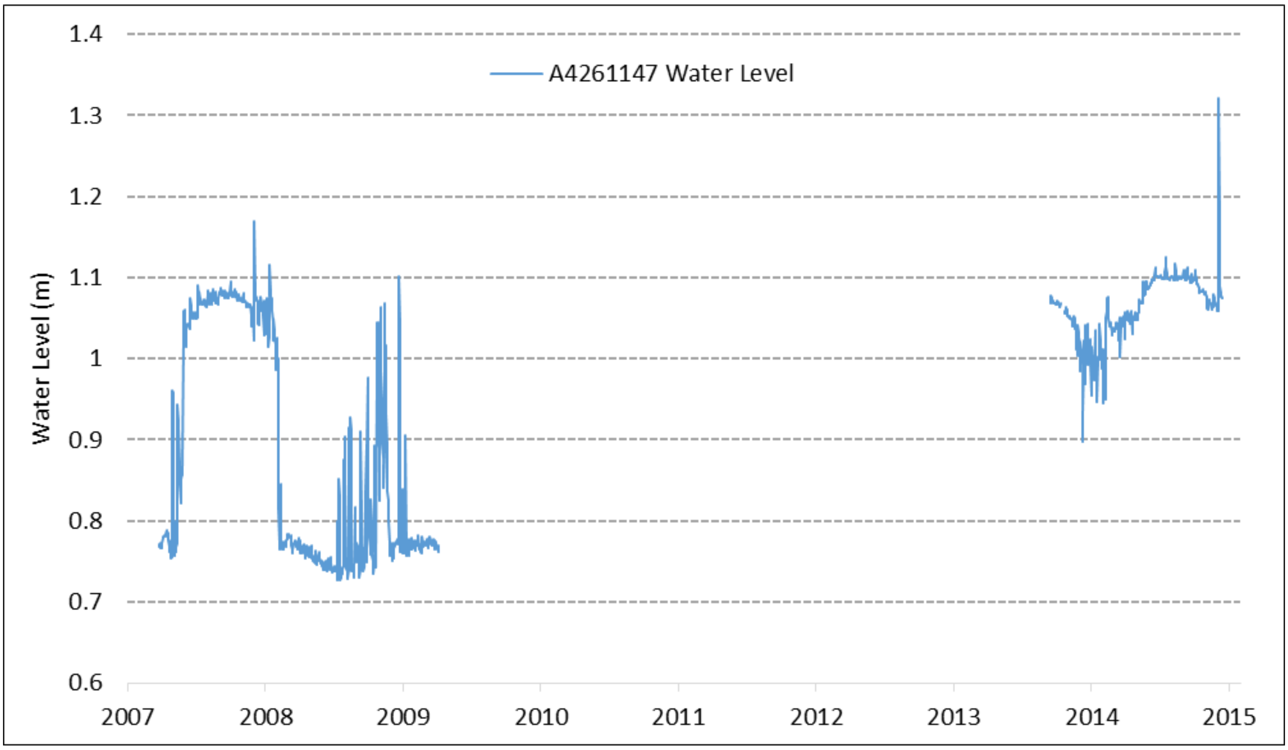

Figure 20. Water level: Burra Creek u/s Logan Creek

*Note: Rating change (change in the cease to flow level at the site) between 2009 and 2014

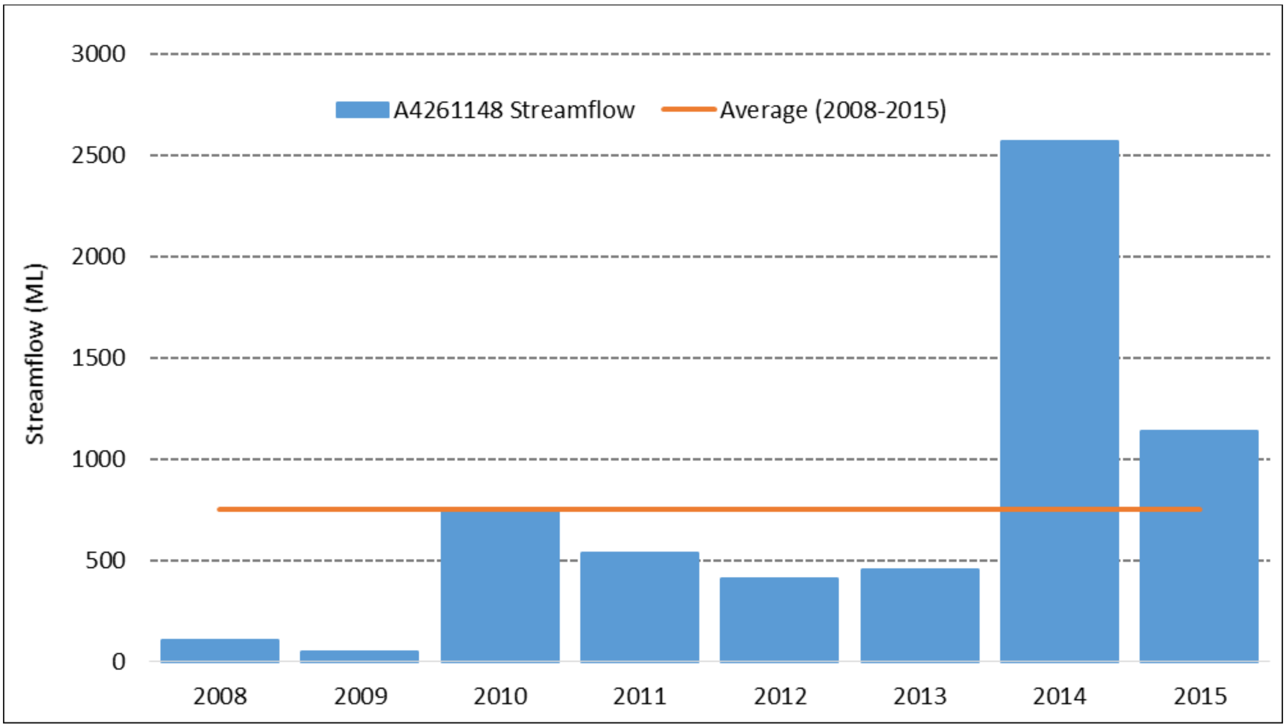

Figure 21. Annual streamflow: Burra Creek at Worlds End (low flow)

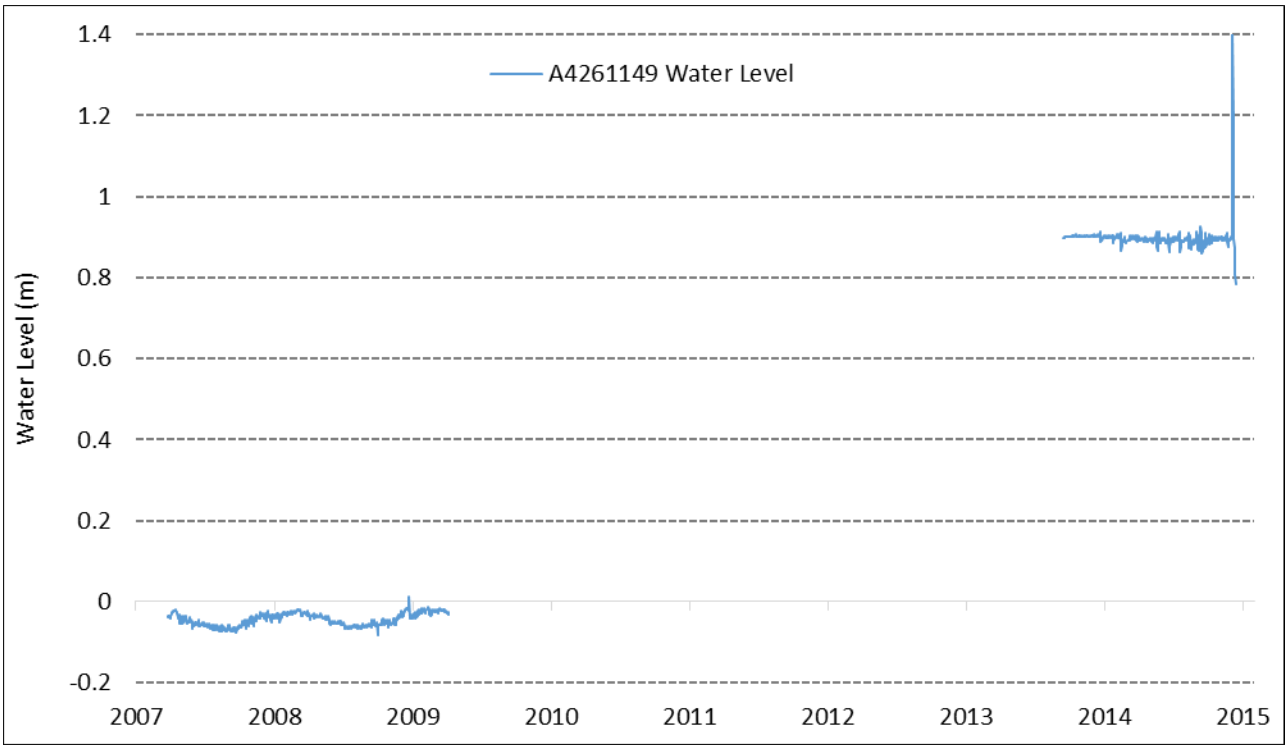

Figure 22. Water level: Burra Creek at St Just Street Ford

*Note: Rating change between 2009 and 2014

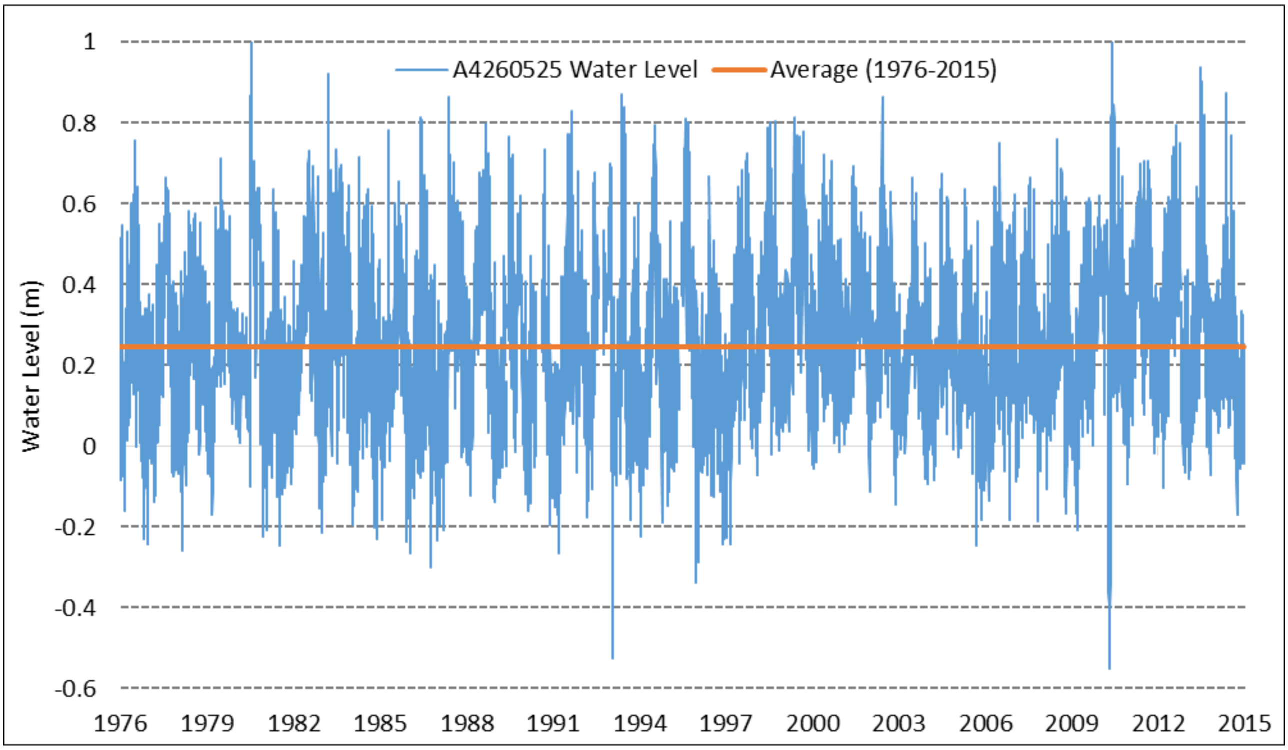

Figure 23. Water level: Coorong d/s Goolwa Barrage

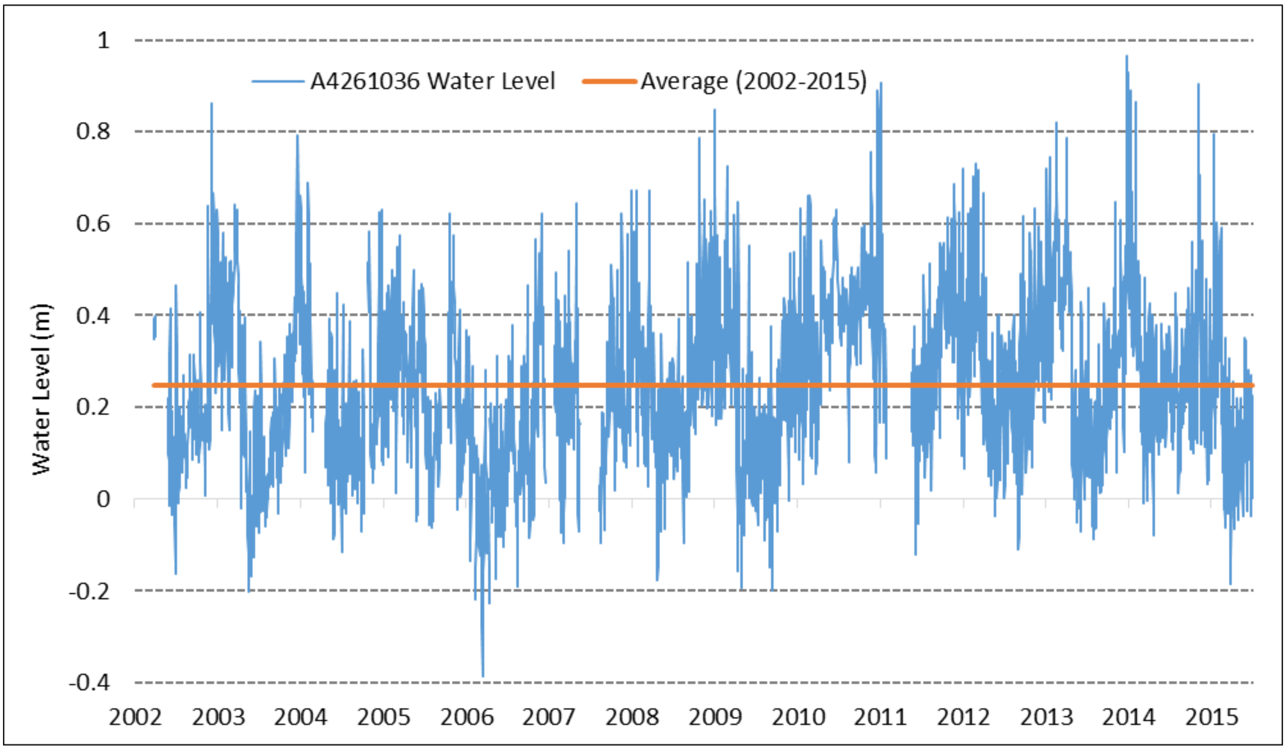

Figure 24. Water level: Goolwa Channel adjacent Reedy Island

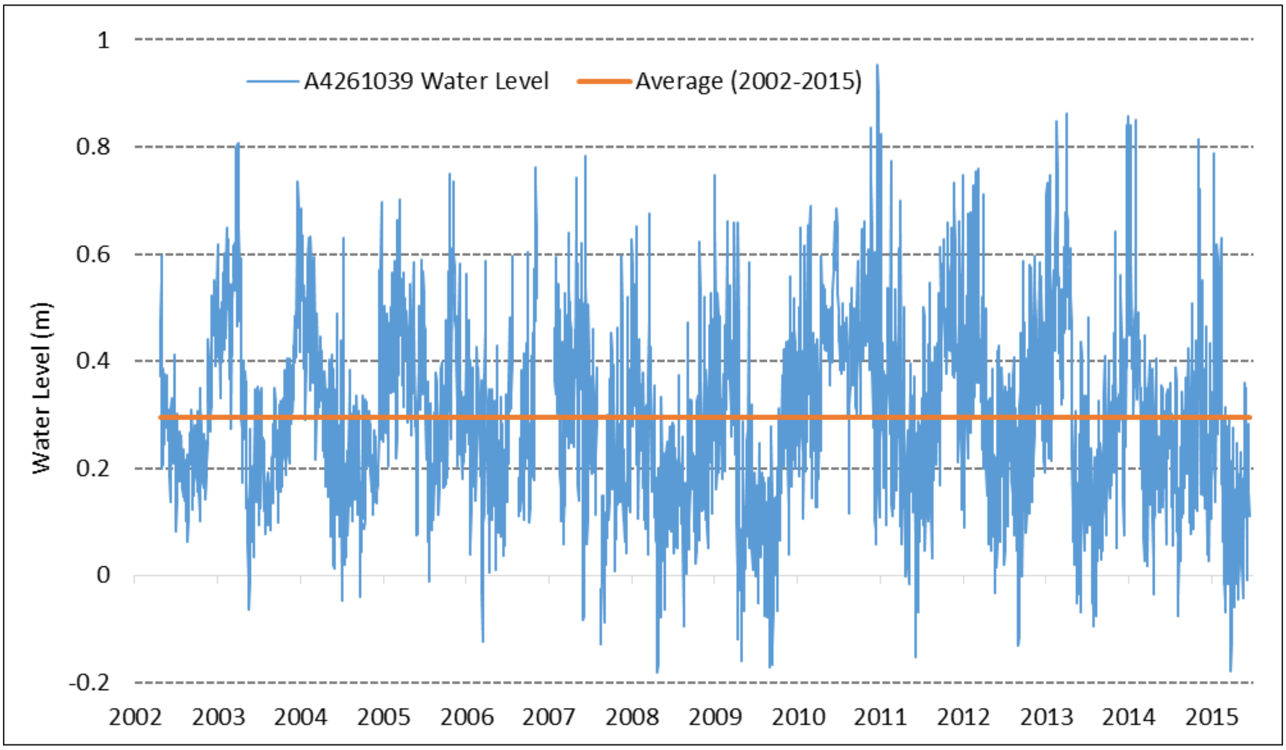

Figure 25. Water level: Coorong Channel adjacent Barker Knoll

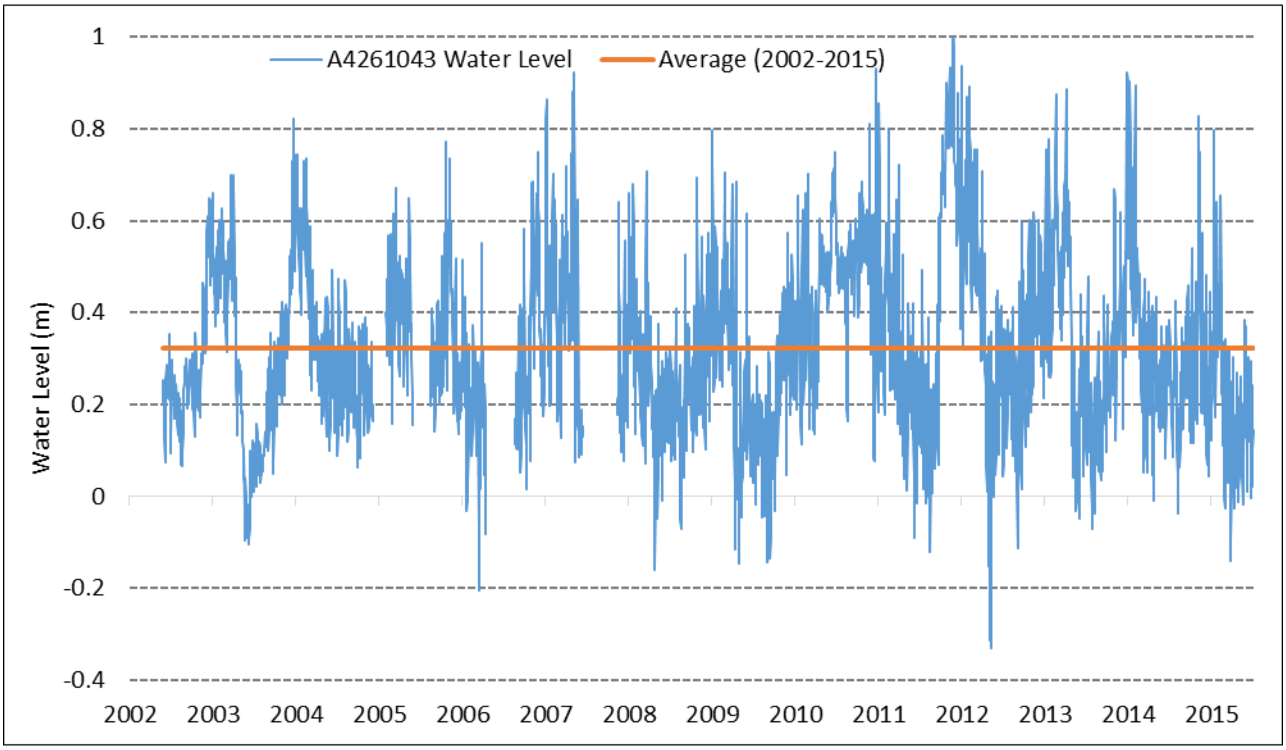

Figure 26. Water level: Coorong Channel at Beacon 1

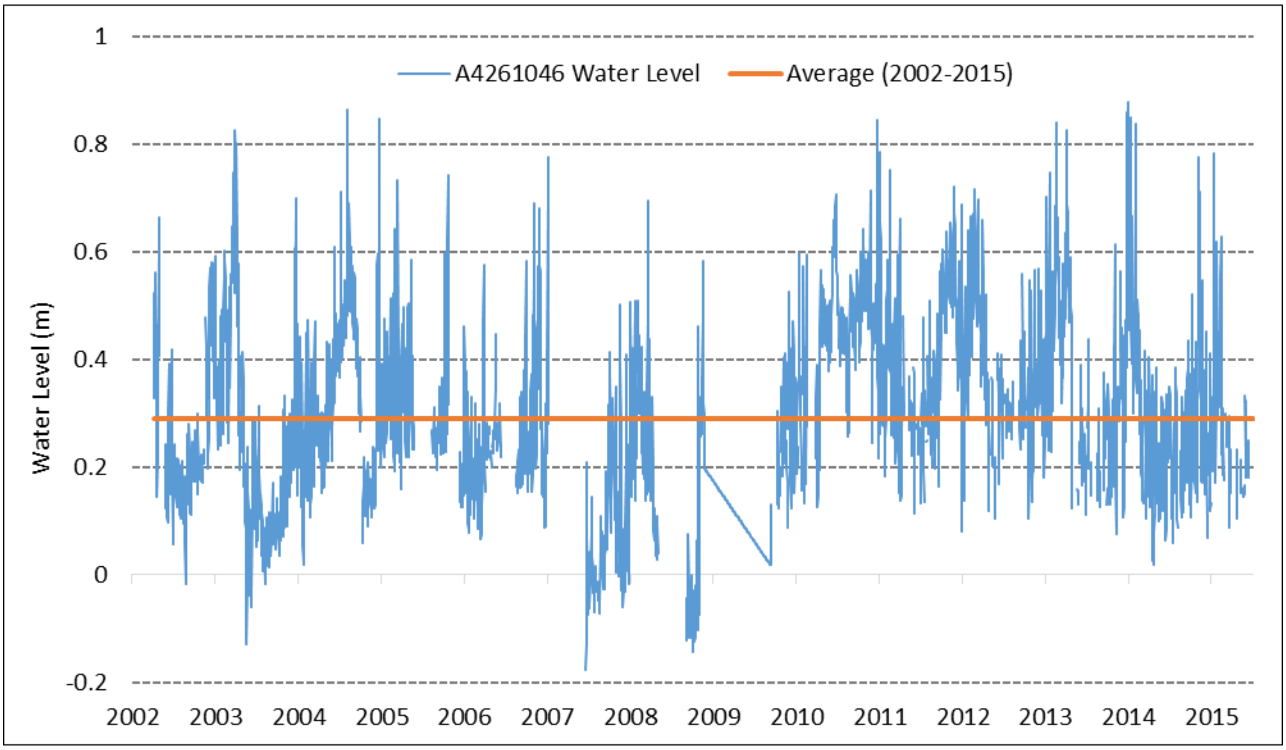

Figure 27. Water level: Coorong at Ewe Island Barrage

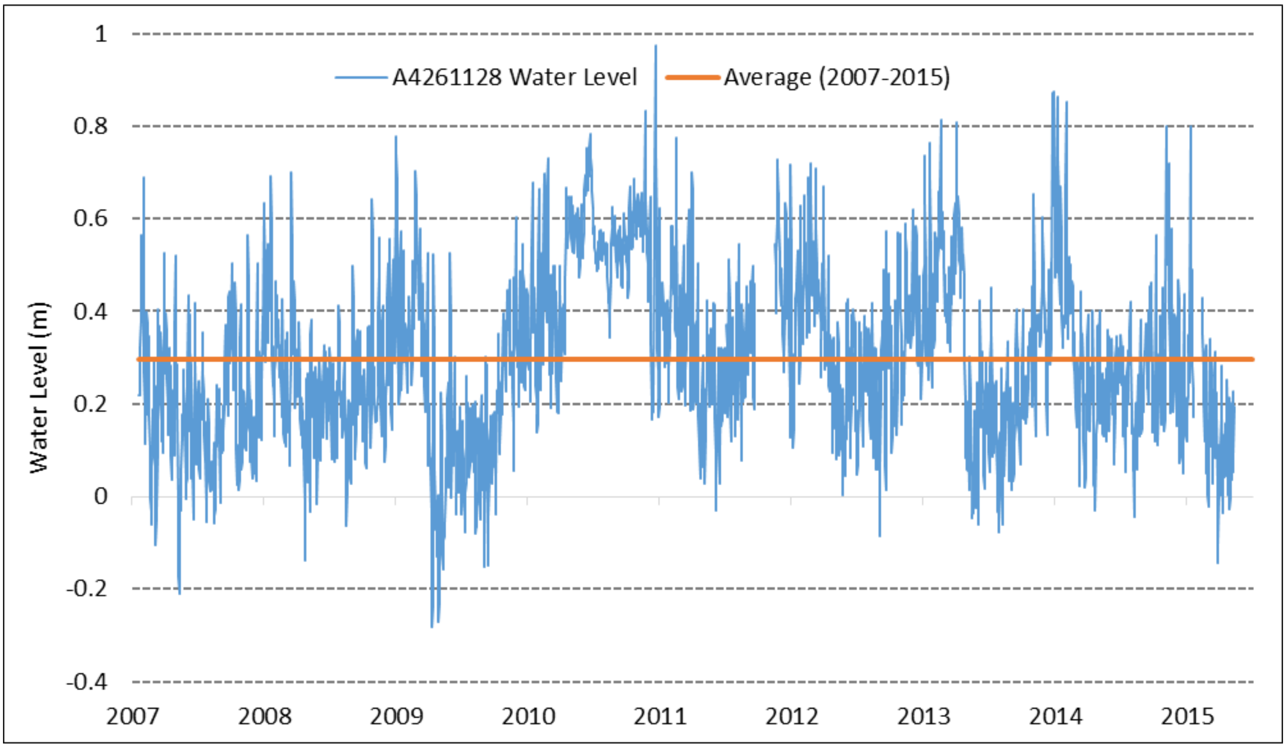

Figure 28. Water Level: Coorong at Channel Drive Boat Ramp

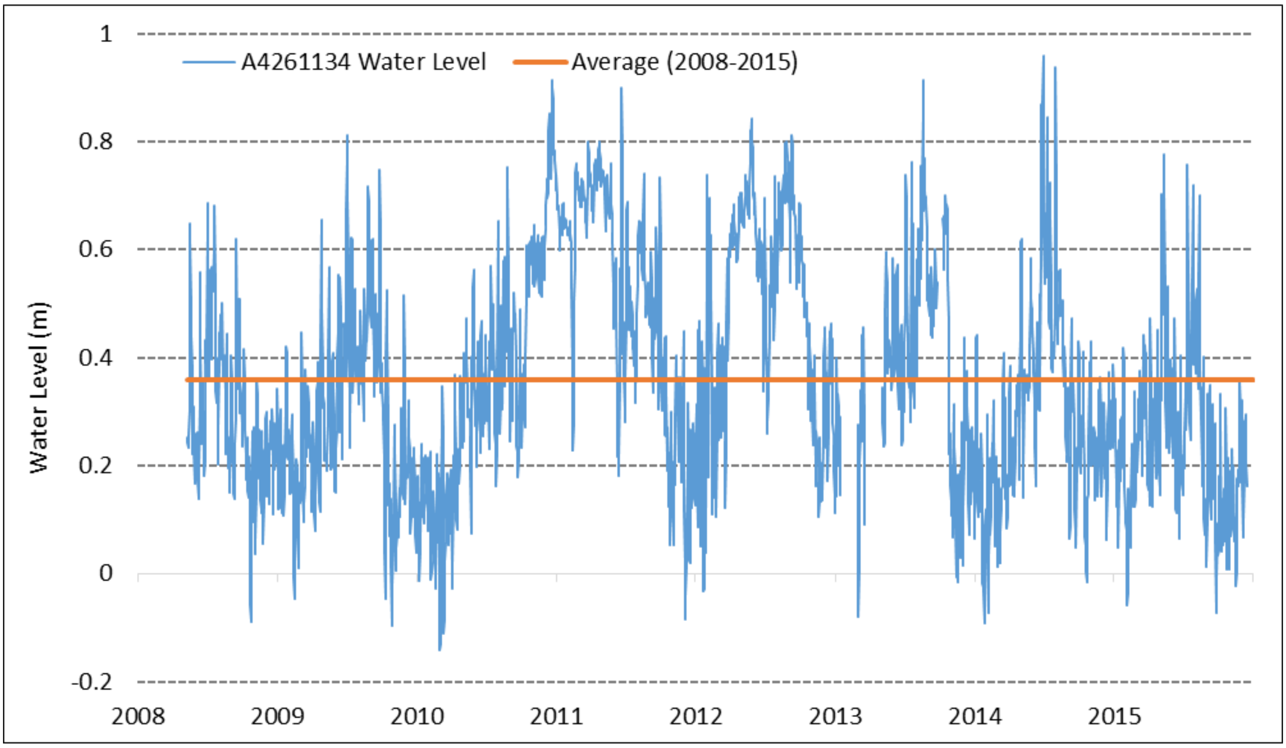

Figure 29. Water level: Coorong at Pelican Point

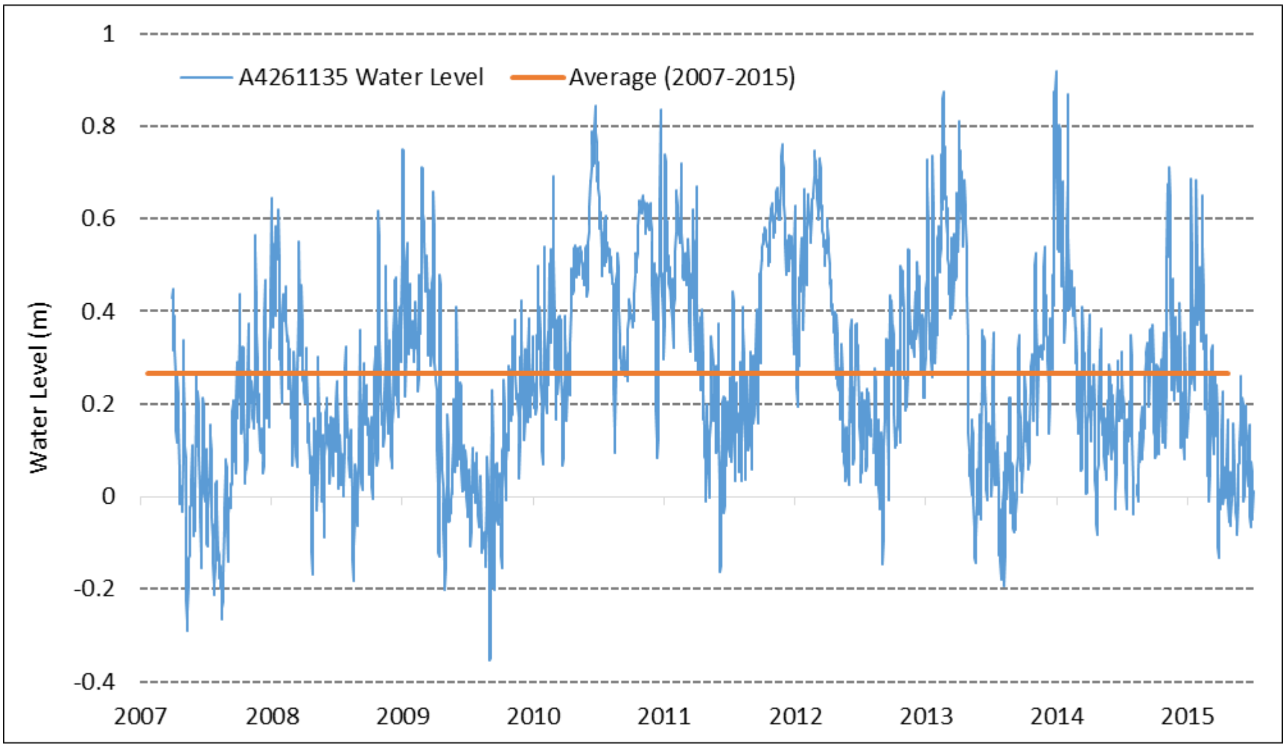

Figure 30. Water level: Coorong at Long Point

3.3 Water quality

The Environment Protection Authority (EPA) monitors the state's waterways, which include lakes, creeks, rivers and marine, in order to assess their condition and provide information that can be used to guide management decisions. The EPA website (2016) shows a total of seven sites were sampled throughout the non-prescribed region during 2010. All sites sampled were located on the western side of the region adjacent the northern Mount Lofty Ranges and Southern Flinders Ranges. Some key points about water quality data from the EPA website (2016) are:

- 71% of sites were assigned a Fair condition rating and 29% of sites were Poor; no sites were assessed to be Very Poor condition, or in the Good to Excellent range.
- Streams assigned a Fair condition include Burra Creek, Levi Creek, Pine Creek, Stone Chimney Creek and Truro Creek. Burra Creek and Stone Chimney Creek are located in the north-west of the region near the township of Burra—while Levi Creek, Pine Creek and Truro Creek are located in the northern Mount Lofty Ranges near the township of Truro. These sites showed moderate changes in ecosystem structure and some changes to the way the ecosystem functions.
- Streams assigned a Poor condition include Baldina Creek and Logan Creek. Both are located in the northern Mount Lofty Ranges near the township of Burra. Baldina Creek flows through Red Banks Conservation Park in an easterly direction before disappearing to groundwater in the Rangelands, while Logan Creek flows in a northerly direction and is a tributary to Burra Creek. These sites showed major changes in ecosystem structure and moderate changes to the way the ecosystem functions.
- Most streams showed evidence of considerable human disturbance including nutrient enrichment and sediment deposition, and degraded riparian zone.

NR SAMDB runs a school program called Waterwatch that provides hands-on learning for the community and an opportunity to make a difference in their local catchment (NR SAMDB website 2016). The program is a water quality monitoring and catchment education program and in return for education and training sessions provided by NR SAMDB, participants are asked to provide water testing snapshots, which are then entered onto the Waterwatch database. NR SAMDB have another Citizen Science program, which contributes to an online water quality monitoring database.

3.4 Surface water storages

The floodplains of the River Murray, which include numerous natural wetlands, are within the boundary of the River Murray PWC. Surface water storages in the non-prescribed NRM region are typically farm dams.

An extensive assessment on the impact of farm dams in the Burra Creek catchment was undertaken by Deane *et al.* (2006). Total storage of 609 dams was estimated to be 985 ML. Most were identified as small stock dams with a mean storage capacity of 1.6 ML. Ninety-five percent of dams were under 5 ML in size, but 23 % of total farm dam storage was estimated to be contained within the remaining 5 % of dams. Deane *et al.* (2006) also undertook modelling to assess the impact of farm dam development on streamflow, and dams were found to be having a major impact on streamflow in all but extreme years. Analysis of the adjusted runoff based on observed streamflow suggests dams intercept up to 70 % of total surface runoff during low rainfall years.

Fringing wetlands to Lake Alexandrina and Lake Albert include Narrung wetland, Waltowa wetland, Tolderol wetland and Hunters Creek. Although managed as part of the CLLMM Environmental Water Management Plan (MDBA 2014), these surface water features are within the non-prescribed NRM region. Many wetlands in the Lower River Murray, which were previously ephemeral, are now permanently inundated due to river regulation (MDBA 2014). Flow control structures have been installed at the above mentioned locations to replicate a more natural wetting and drying regime, or to hold water on the floodplain (MDBA 2014).

4 Investment opportunities

This report has collated surface water information and presents a regional description of recorded rainfall, streamflow and water level data from the non-prescribed surface water resources of the region.

In preparing this report, a number of opportunities have been identified to enhance surface water knowledge and data in the region, to inform decisions by water resource managers. These opportunities are detailed below to inform future investment planning:

1. With limited non-prescribed catchment area and numerous urban centres, the most noticeable opportunity for further water resources development is to further implement stormwater recycling and wastewater reuse schemes across the region.
2. Farm dam volumes are derived from volume–area relationships developed for the Mount Lofty Ranges in 2004 using a combination of survey data and aerial photography. The number of test sites located on the eastern-side of the Mount Lofty Ranges was however quite limited. Opportunity exists to investigate the validity of current volume–area relationships by assessing more sites specifically in the non-prescribed NR region north and east of the Mount Lofty Ranges. If there is evidence these volume-area relationships differ significantly, investigations could be undertaken to develop a specific farm dam volume–area relationship for the South Australian Murray-Darling Basin NR Region.
3. The Murray–Darling Basin loses a significant volume of water through the natural processes of evaporation and transpiration from river surface, floodplain and wetland systems. Evaporation data is a key input to understanding the regional water cycle. An increase of industry-standard evaporation monitoring in the non-prescribed NR region could assist in terms of monitoring impacts of, and planning responses to climate change and variability.
4. Maintain current data logging monitoring stations for water level and streamflow in accordance with the State Water Monitoring Operational Framework. Continuous and long-term data (and its subsequent surveillance) are important to calibrate and validate hydrological models and condition assessment frameworks used to inform water management and policy decision making.
5. The monitoring network in the non-prescribed region is limited and additional monitoring may be required in areas with potential for development and to better aid regional surface water resource assessments. This will assist in better understanding characteristics of non-prescribed surface water, trends in flow patterns and the effect of event-based streamflow events.
6. Modern hydrological models of major surface water systems such as Burra Creek would be of great benefit to water planners by providing a point of reference in the absence of continuous and long-term monitoring data. Hydrological models can be used to assess the flow regime and aid in hydro-ecological assessments in the region. Collecting detailed bathymetry, water level and flow data at significant locations will assist in better calibration of the models and improve the confidence of the outputs.
7. Conducting flow gaugings at strategic locations throughout the region would provide a measure of confidence in theoretical streamflow ratings and modelled flow volumes.
8. A better understanding of the current level of water use of non-prescribed surface water resources.

5 Summary

Some of the challenges associated with managing the State's natural resources include the increasing demand for resources, climate change impacts and making well-informed decisions with existing data. It is important to ensure access to sufficient and reliable fit-for-purpose water that can be used to support food and wine production, mining expansion, liveability in our towns and cities and the health of the environment. Our use of water resources must be sustainable for the long-term.

As such, this report has collated existing climate and surface water hydrology data in a consolidated and accessible manner, which seeks to support a broad understanding of non-prescribed surface water resources in the South Australian Murray-Darling Basin NRM Region, to underpin decision making on water resources management.

Climate change projections indicate a reduction in rainfall and increase in temperature for the region (SKM 2013). Rain tends to fall predominantly in the winter months across the region, with the higher magnitude of rain falling across the south-west part of the region. A reduction in rainfall would impact the communities in the region that utilise rainwater as a means of consumptive use and the numerous farm dams in the region used to water stock. At the regional scale, the drivers of increasing water demand may include agriculture, plantation production and tourism.

Surface water resources may be available for use after heavy rainfall events in streams, although these resources are generally short lived. To this end, communities largely rely on imported water and groundwater resources to service their needs. SA Water is responsible for the supply of water to numerous towns in the region, with supply sourced from groundwater aquifers or imported River Murray water from branches of the Morgan-Whyalla and Swan Reach-Yorke Peninsula pipelines.

The formulation of this report has highlighted potential investment opportunities to consider when planning for the sustainable management of surface water resources and include stormwater recycling and wastewater reuse, farm dam volume–area relationships, water resources monitoring, hydrological modelling and water use reporting.

6 Units of measurement

6.1 Units of measurement commonly used (SI and non-SI Australian legal)

Name of unit	Symbol	Definition in terms of other metric units	Quantity
day	d	24 h	time interval
gigalitre	GL	10^6 m^3	volume
gram	g	10^{-3} kg	mass
hectare	ha	10^4 m^2	area
hour	h	60 min	time interval
kilogram	kg	base unit	mass
kilolitre	kL	1 m^3	volume
kilometre	km	10^3 m	length
litre	L	10^{-3} m^3	volume
megalitre	ML	10^3 m^3	volume
metre	m	base unit	length
microgram	µg	10^{-6} g	mass
microlitre	µL	10^{-9} m^3	volume
milligram	mg	10^{-3} g	mass
millilitre	mL	10^{-6} m^3	volume
millimetre	mm	10^{-3} m	length
minute	min	60 s	time interval
second	s	base unit	time interval
tonne	t	1000 kg	mass
year	y	365 or 366 days	time interval

6.2 Shortened forms

EC electrical conductivity (µS/cm)

7 Glossary

Act (the) — In this document, refers to the Natural Resources Management (SA) Act 2004, which supersedes the Water Resources (SA) Act 1997

Aquatic ecosystem — The stream channel, lake or estuary bed, water and/or biotic communities and the habitat features that occur therein

Aquifer — An underground layer of rock or sediment that holds water

Arid lands — In South Australia, arid lands are usually considered to be areas with an average annual rainfall of less than 250 mm and support pastoral activities instead of broadacre cropping

Baseflow — The water in a stream that results from groundwater discharge to the stream; often maintains streamflow's during seasonal dry periods and has important ecological functions

Basin — The area drained by a major river and its tributaries

BoM — Bureau of Meteorology, Australia

Catchment — That area of land determined by topographic features within which rainfall will contribute to run-off at a particular point

CSIRO — Commonwealth Scientific and Industrial Research Organisation

Dams, off-stream dam — A dam, wall or other structure that is not constructed across a watercourse or drainage path and is designed to hold water diverted or pumped from a watercourse, a drainage path, an aquifer or from another source; may capture a limited volume of surface water from the catchment above the dam

Dams, on-stream dam — A dam, wall or other structure placed or constructed on, in or across a watercourse or drainage path for the purpose of holding and storing the natural streamflow of that watercourse or the surface water

DENR — former Department of Environment and Natural Resources

DEWNR — Department of Environment, Water and Natural Resources (Government of South Australia)

DFW — former Department for Water (Government of South Australia)

DWLBC — former Department of Water, Land and Biodiversity Conservation (Government of South Australia)

Ecology — The study of the relationships between living organisms and their environment

Ecosystem — Any system in which there is an interdependence upon, and interaction between, living organisms and their immediate physical, chemical and biological environment

Environmental water requirements — The water regimes needed to sustain the ecological values of aquatic ecosystems, including their processes and biological diversity, at a low level of risk

EPA — Environment Protection Authority (Government of South Australia)

Ephemeral streams or wetlands — Those streams or wetlands that usually contain water only on an occasional basis after rainfall events. Many arid zone streams and wetlands are ephemeral.

Flow regime — The character of the timing and amount of streamflow in a stream

GIS — Geographical Information System; computer software linking geographic data (for example land parcels) to textual data (soil type, land value, ownership). It allows for a range of features, from simple map production to complex data analysis

Groundwater — Water occurring naturally below ground level or water pumped, diverted and released into a well for storage underground

Hydrology — The study of the characteristics, occurrence, movement and utilisation of water on and below the Earth's surface and within its atmosphere

Lake — A natural lake, pond, lagoon, wetland or spring (whether modified or not) that includes part of a lake and a body of water declared by regulation to be a lake. A reference to a lake is a reference to the bed, banks and shores of the lake or the water for the time being held by the bed, banks and shores of the lake, or both, depending on the context.

Land — Whether under water or not, and includes an interest in land and any building or structure fixed to the land

m AHD — Defines elevation in metres (m) according to the Australian Height Datum (AHD)

Model — A conceptual or mathematical means of understanding elements of the real world that allows for predictions of outcomes given certain conditions. Examples include estimating catchment run-off, assessing the impacts of dams or predicting ecological response to environmental change

Natural resources — Soil, water and marine resources, geological features and landscapes, native vegetation, native animals and other native organisms and ecosystems

NRM — Natural Resources Management; caring for our natural resources – balancing people's needs with those of nature

Pasture — Grassland used for the production of grazing animals such as sheep and cattle

Population — For the purposes of natural resources planning, the set of individuals of the same species that occurs within the natural resource of interest

Potable water — Water suitable for human consumption such as drinking or cooking water

Prescribed water resource — A water resource declared by the Governor to be prescribed under the Act. Prescription of a water resource requires that future management of the resource be regulated via a licensing system.

SA Water — South Australian Water Corporation (Government of South Australia)

Stock use — The taking of water to provide drinking water for stock other than stock subject to intensive farming (as defined by the Act)

Sub-catchment — The area of land determined by topographical features within which rainfall will contribute to run-off at a particular point. A number of sub-catchments form a catchment.

Surface water — (a) water flowing over land (except in a watercourse), (i) after having fallen as rain or hail or having precipitated in any another manner, (ii) or after rising to the surface naturally from underground; (b) water of the kind referred to in paragraph (a) that has been collected in a dam or reservoir

Tributary — A river or creek that flows into a larger river

u/s — Upstream

WAP — Water Allocation Plan; a plan prepared by a NRM Board or water resources planning committee and adopted by the Minister in accordance with the Act

Water body — Includes watercourses, riparian zones, floodplains, wetlands, estuaries, lakes and groundwater aquifers

Watercourse — A river, creek or other natural watercourse (whether modified or not) and includes: a dam or reservoir that collects water flowing in a watercourse; a lake through which water streamflow's; a channel (but not a channel declared by regulation to be excluded from the this definition) into which the water of a watercourse has been diverted; and part of a watercourse

Water dependent ecosystems — Those parts of the environment, the species composition and natural ecological processes, that are determined by the permanent or temporary presence of flowing or standing water, above or below ground; the in-stream areas of rivers, riparian vegetation, springs, wetlands, floodplains, estuaries and lakes are all water-dependent ecosystems

Water plans — The State Water Plan, NRM plans, water allocation plans and local water management plans prepared under Part 7 of the Act

WDE — Water dependent ecosystem

Wetlands — Defined by the Act as a swamp or marsh and includes any land that is seasonally inundated with water. This definition encompasses a number of concepts that are more specifically described in the definition used in the Ramsar Convention on Wetlands of International Importance. This describes wetlands as areas of permanent or periodic to intermittent inundation, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tides does not exceed six metres.

WSS — Water Supply System

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