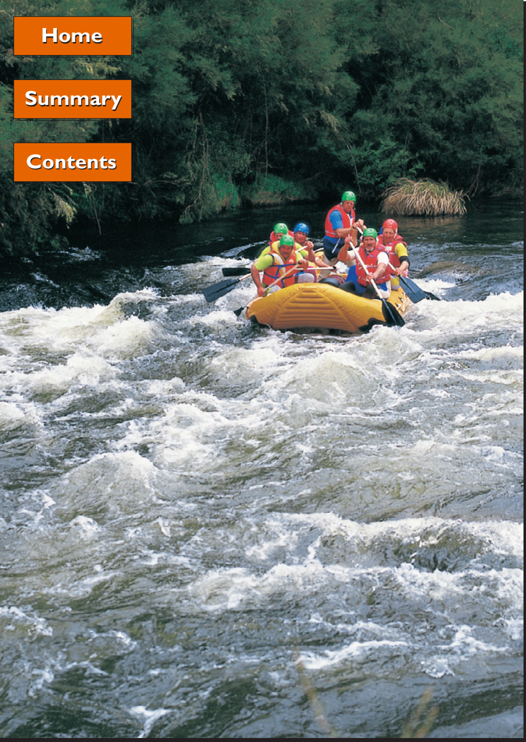

Natural Heritage Trust
Helping Communities
Helping Australia
A Commonwealth Government Initiative

AUSTRALIAN WATER RESOURCES ASSESSMENT 2000

National Land and Water Resources Audit
A program of the Natural Heritage Trust

NATIONAL LAND AND WATER RESOURCES AUDIT

Providing nationwide assessments

The National Land and Water Resources Audit (Audit) is facilitating improved natural resource management decision making by:

Providing a clear understanding of the status of, and changes in, the nation's land, vegetation and water resources and implications for their sustainable use.

Providing an interpretation of the costs and benefits (economic, environmental and social) of land and water resource change and any remedial actions.

Developing a national information system of compatible and readily accessible land and water data.

Producing national land and water (surface and groundwater) **assessments** as integrated components of the Audit.

Ensuring integration with, **and collaboration** between, other relevant initiatives.

Providing a framework for monitoring Australia's land and water resources in an ongoing and structured way.

In partnership with Commonwealth, and State and Territory agencies, and through its theme activities—Water Availability, Dryland Salinity, Vegetation, Rangelands Monitoring, Agricultural Productivity and Sustainability, Capacity for Change, Ecosystem Health and Information Management—the Audit has prepared:

Assessments of the status of and, where possible, recent changes in Australia's land, vegetation and water resources to assist decision makers achieve ecological sustainability. These assessments set a baseline or benchmark for monitoring change.

Integrated reports on the economic, environmental and social dimensions of land and water resource management, including recommendations for management action.

Australian Natural Resources Atlas to provide internet-based access to integrated national, State and regional data and information on key natural resource issues.

Guidelines and protocols for assessing and monitoring the health and management of Australia's land, vegetation and water resources to meet the needs of all major stakeholders.

This report presents the key findings for the contracts and activities detailed in the Theme 1 Water Availability Work Plan and part of Theme 7 Ecosystem Health Work Plan (surface water quality):

Australian Water Resources Assessment 2000: the quantity, quality, use, allocation (including environmental water provisions) and management of surface water and groundwater resources.

AUSTRALIAN WATER RESOURCES ASSESSMENT 2000

Surface water and groundwater — availability and quality

National Land & Water Resources Audit
A program of the Natural Heritage Trust

Published by:

National Land and Water Resources Audit
c/- Land & Water Australia
On behalf of the Commonwealth of Australia

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National Land & Water Resources Audit
A program of the Natural Heritage Trust

The Hon. Warren Truss MP
Minister for Agriculture, Fisheries and Forestry
Parliament House
Canberra, ACT 2600

Senator, the Hon. Robert Hill
Minister for Environment and Heritage
Parliament House
Canberra, ACT 2600

Dear Ministers,

I have pleasure in presenting to you *Australian Water Resource Assessment 2000 — surface and groundwater availability and quality,* a report of the National Land and Water Resources Audit (Audit). This report is Australia's fourth national assessment of Australia's water resources; it builds on but differs from previous water resource assessments. Unlike previous assessments, the report covers both water quantity and water quality. In partnership with the States and Territories, and the Australian State of the Environment Reporting Unit, it collates and provides information on trends in water quality and exceedance of water quality guidelines.

The report also reflects the changing information needs and requirements of decision makers. Building on a traditional assessment of water availability, in partnership with the States and Territories, the report details water use and, in analysing water availability and use, emphasises assessing and reporting on the sustainability of surface and groundwater management across Australia.

The report concludes with detailed data on each of Australia's surface water management areas and groundwater management units. This is underpinned by a much-improved specification of water management areas for Australia with—for the first time—an agreed breakdown of Australia's groundwater resources into management units.

The report also promotes an integrated approach to water resource assessment and reporting with information on water availability and quality being integrated with outputs from across the Audit (for example, the Assessment of River Condition and Catchment Condition Indices) to provide a comprehensive basis for natural resources management, supporting decisions at national, State and regional levels. This is achieved through rigorous project design across all Audit activities with findings then presented in an integrated fashion on the Audit's internet-based *Australian Natural Resources Atlas* at the best available scales.

Investment from Commonwealth, State and Territory agencies to deliver this assessment has been substantial and has only been achieved through the excellent cooperation of all parties. Capitalising on this investment is critical, for both application of the findings presented in this report to inform natural resources management, and routinely continuing information collection and assessment activities. This can be best achieved through the National Sponsor and partnership arrangements proposed in the report.

The Audit Advisory Council commends this report to you, together with the supporting information in the *Australian Natural Resources Atlas*, providing key inputs to natural resource management initiatives including the continued development, implementation and evaluation of the Council of Australian Governments' National Water Reform Framework.

I am pleased to present this report to the Natural Heritage Ministerial Board.

Yours sincerely,

Roy Green

Chair
National Land and Water Resources Audit Advisory Council
1 February 2001

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SUMMARY

Australian Water Resources Assessment 2000

Water is one of Australia's most valuable natural resources. *Australian Water Resources Assessment 2000* assesses the quantity, quality, use, allocation and management of our surface water and groundwater resources. As a part of this assessment and to provide information relevant for regionally based natural resources management, surface water resources have been divided into management areas, and groundwater resources into groundwater management units.

The detailed requirements for surface water management have meant that natural resource agencies have defined 325 surface water management areas for this assessment. These are based on the 246 river basins for Australia.

Groundwater systems may spatially overlay and interact with each other and reflect the various geological settings of the Australian landscape. Some 535 groundwater management units have been defined as part of this assessment.

Surface water quality monitoring systems provide information at specific locations. Data can then be aggregated back to the contributing catchment above the monitoring points to provide an overview of the status of water quality within each basin. Data collected during Australian Water Resources Assessment 2000 provide sufficient information to characterise the surface water quality of approximately 70 of Australia's 246 river basins, generally those basins more intensively used.

Based on these spatial aggregations of Australia's water resources, key findings of the National Land and Water Resources Audit's Australian Water Resources Assessment 2000 include:

Australia's surface water resources: 84 (26%) of 325 surface water management areas are either close to or overused when compared with sustainable flow regime requirements. These account for about 13 200 GL (a gigalitre is 1000 ML) or 55% of total water use in Australia and are the vast majority of Australia's areas where water resource development is a viable option. Continued effort by Australia's water resource managers to improve water use efficiency and ensure allocations to environmental purposes for these surface water management areas is essential. These highly and over-committed basins must continue to be given priority in surface water management activities and reassessed in terms of sustainability as additional information and improved methods and tools for determining ecological requirements become available.

Australia's surface water quality: water quality data are limited, with between 67 and 75 out of Australia's 246 river basins (about 28%) able to be assessed for any of the key variables—**turbidity**, **nutrients** or **salinity**. Sixty-five basins had major exceedances of State or Territory nominated surface water quality guidelines for nutrients, salinity or turbidity. Major **nutrients** exceedances were found to occur in 43 river basins, 61% of those able to be assessed. Major **turbidity** exceedances were found in 41 or 61% of the basins assessed. Major **salinity** exceedances were most prominent in basins within temperate south-western and south-eastern Australia particularly within the Murray–Darling and the South-West Coast Drainage Divisions and were found in 24 basins or 32% of the basins able to be assessed.

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Australia's groundwater resources: 161 (30%) of Australia's 535 groundwater management units are either close to or overused when compared with their estimated sustainable yield. In terms of licences for abstraction, 168 groundwater management units are either fully allocated or over-allocated when compared with estimated sustainable yield. Substantially increased effort by Australia's water resource managers is required to precisely define sustainable yield and improve management of Australia's groundwater management units. Priority must continue to be given to the highly- and over-committed groundwater management units.

Australia's water resource development: 241 surface water management areas and 265 groundwater management units are at low to medium levels of development. Many of these have limited capability for significant development—particularly the more arid basins of Australia. Development opportunities vary across Australia: in tropical Australia opportunities based on water capture (e.g. dams, bore fields, harvesting of overland flows) are still to be fully assessed and realised; in southern Australia development is approaching its extraction limits and caps are being introduced to finetune water use. Development opportunities in southern Australia, including much of New South Wales, South Australia, Victoria and Tasmania principally entail moving water to higher value uses through water trading and reallocating any water gained through water use efficiency measures.

Understanding water use: water use has increased to 24 000 GL (19 100 GL from surface water; 5000 GL from groundwater) in 1996/97 from 14 600 GL in 1983/84. This water use is equivalent to 47 times the volume of Sydney Harbour. The greatest increases by volume in water use are in New South Wales (3600 GL) and Queensland (2300 GL)—accounting for 25% of total annual water use. Water use and detailed knowledge of water use efficiency measures are often poorly recorded—31% of basins have no recorded use data. Of the water diverted for use on average only 77% actually reaches the customer with the remainder lost to seepage or evaporation. The percentage delivered varies between 41% and 100% and reflects delivery techniques ranging from open channels to fully piped reticulation systems. Water use and delivery efficiency, recycling, trading and pricing are increasingly becoming priorities and provide opportunities for development. To support and foster this shift in development emphasis, improved information on water use is essential.

An Australia-wide initiative in water resource management: water availability and quality are at the centre of economic development and environmental management for Australia. An Australia-wide initiative in partnership with State and Territory water management authorities could focus on improvements in groundwater characterisation, water use efficiency, increased and more scientifically based environmental water provisions, improvement to water quality monitoring and the understanding and managing of interactions between surface and groundwater quality and quantity.

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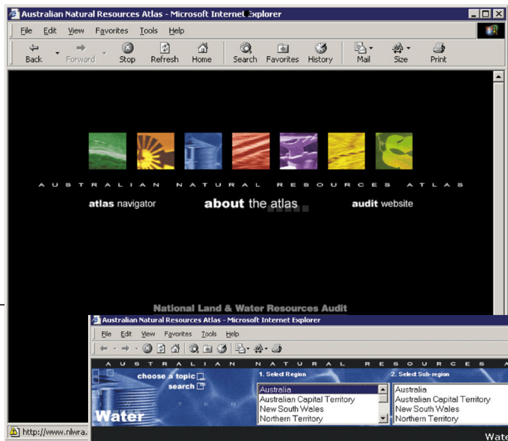
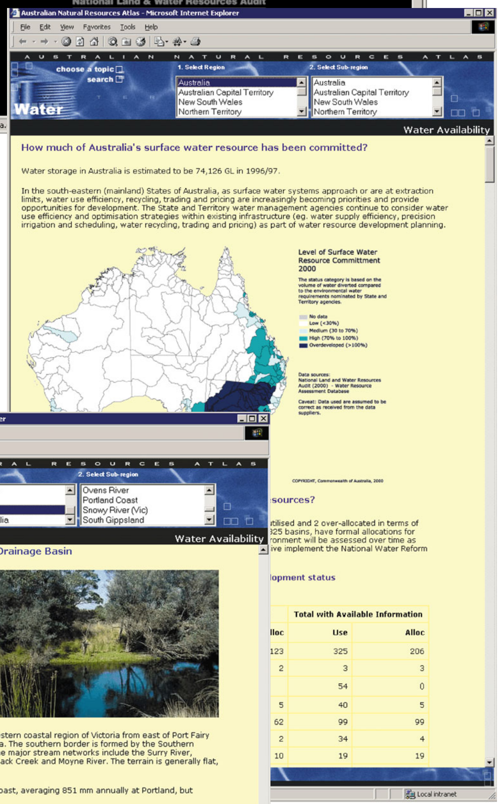


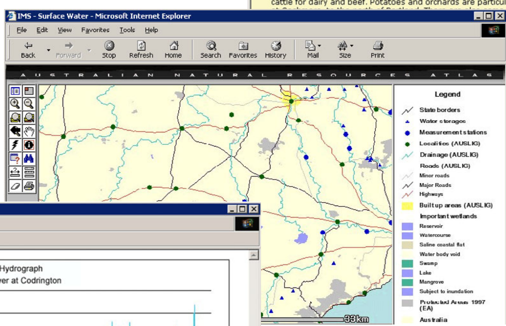
Making information readily available: it is essential that Australia capitalise on the data collection investment of States, Territories and this Audit, and put in place Australia-wide assessment and reporting systems. This can be achieved through existing agencies, and centrally coordinated and updated through the Audit's Australian Natural Resources Atlas. It will ensure Australia has access to contemporary water resources information—essential for natural resources decision making.

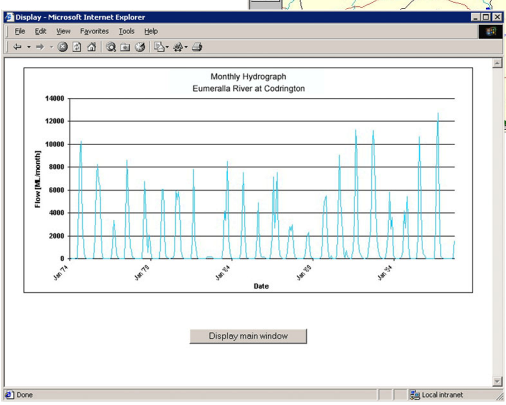
Australia-wide information



Link to basin-scale summaries

Explore the data and make a map





Link to monitoring data

Australian Natural Resources Atlas <www.nlwra.gov.au/atlas> making information readily accessible.

Wetlands: an important ecological asset

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Irrigation is a key water use

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ASSESSING AUSTRALIA'S WATER RESOURCES

Collation and availability of data, information and options for management, development and protection

Australian Water Resources Assessment 2000 is Australia's fourth water resources assessment. It:

- better defines Australia's surface and groundwater management units;
- details the quantity of water being used and allocated;
- details surface water quality and groundwater salinity;
- reports on environmental water allocations;
- reviews the potential for further development;
- highlights links between surface water and groundwater resources;
- provides access to summary data and information collated and presented at national, State/Territory and basin/ groundwater management unit levels through the Australian Natural Resources Atlas <www.nlwra.gov.au/atlas>; and
- identifies knowledge gaps and data collection deficiencies that need to be resolved to underpin Australia's water resources management and make it more effective.

Australian Water Resources Assessment 2000 was prepared in partnership with State and Territory water management agencies.

New South Wales
Department of Land and Water Conservation <www.dlwc.nsw.gov.au>

Victoria
Department of Natural Resources & Environment <www.nre.vic.gov.au>

Queensland
Department of Natural Resources, Queensland <www.dnr.qld.gov.au>

Western Australia
Water and Rivers Commission <www.wrc.wa.gov.au>

South Australia
Department of Water Resources (formerly parts of DEHAA and PIRSA) <www.dwr.sa.gov.au>

Tasmania
Department of Primary Industries, Water & Environment <www.dpiwe.tas.gov.au>

Northern Territory
Department of Lands, Planning & Environment <www.lpe.nt.gov.au>

Australian Capital Territory
Environment ACT <www.act.gov.au/environ>

Environment Australia
Australian State of Environment Reporting Unit—partners in surface water quality assessment <www.environment.gov.au/soe>

Catchments, rivers and estuaries are inextricably linked

WATER RESOURCES IN CONTEXT

Managing surface water and groundwater availability in an integrated natural resources context

This report on Australia's water availability and quality is a key input towards improved water resources management. Natural resource management requires integrated solutions and hence integrated assessments. Australian Water Resources Assessment 2000 assesses Australia's water resources and provides data and information to the broader natural resources issues assessed in other Audit activities.

Water is essential to support an increasing human population, and to sustain ecosystem health and biodiversity. Its sustainable management—both water quality and quantity—is critical to Australia's economic development. One of the greatest challenges for natural resource managers is to strike a balance between these competing needs.

- The status of river condition, estuary condition and catchment health will be presented as part of the Audit's Ecosystem Health theme report.

Water delivers impacts from land uses in the contributing catchment and transports materials. Integration of water quantity and quality, sediment and nutrient movements, and minimisation of downstream impacts of land use is a key issue for natural resource management.

- Sediment and nutrient load and movement to and down Australia's river systems and estuaries will be presented as part of the Audit's Ecosystem Health theme report.

Australia has major opportunities to increase economic activity, and at the same time enhance environmental and social benefits generated by water resources. These opportunities exist through water resource development and improved water use efficiency.

- Assessment of irrigated agricultural productivity and economic returns will be presented as part of the Audit's Capacity for Change theme report.

Increasingly, calls for resource protection across Australia are important policy issues. 'Resource protection' (used separately here from conservation) deals with the protection of natural resources as they are used in a catchment. As an example, if we are to address dryland salinity, Australia will require major changes in water balance in many catchments and therefore changes in land use pattern and land use activities to meet targets for protection of downslope land and water resources.

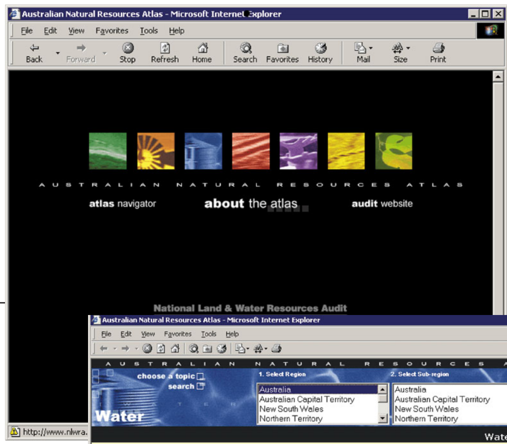
- Assessment of the extent of, and management options for, dryland salinity are presented as part of the Audit's Dryland Salinity theme report.

Government and public alike continually seek improved and more accessible information on our natural resources. Access to information increases opportunities for informed debate. As part of the Audit, access to natural resources information has been much improved through internet and database technology.

- The Australian Natural Resources Atlas will present the key findings, data and information summaries on water resources prepared as part of integrated natural resource information at scales from regional through to national. <www.nlwra.gov.au/atlas>.

To track progress and ensure natural resource management activity is effective and cost efficient Australia needs to adopt comparable approaches to water resource assessment, link monitoring of water quantity and quality with

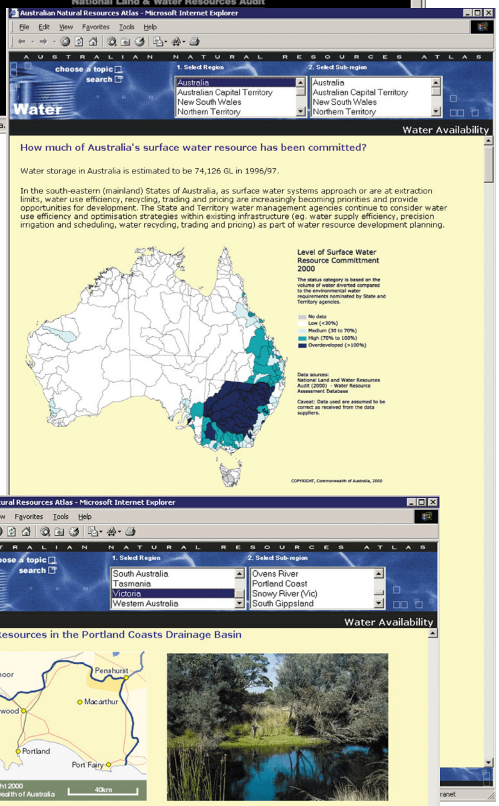
Atlas home page



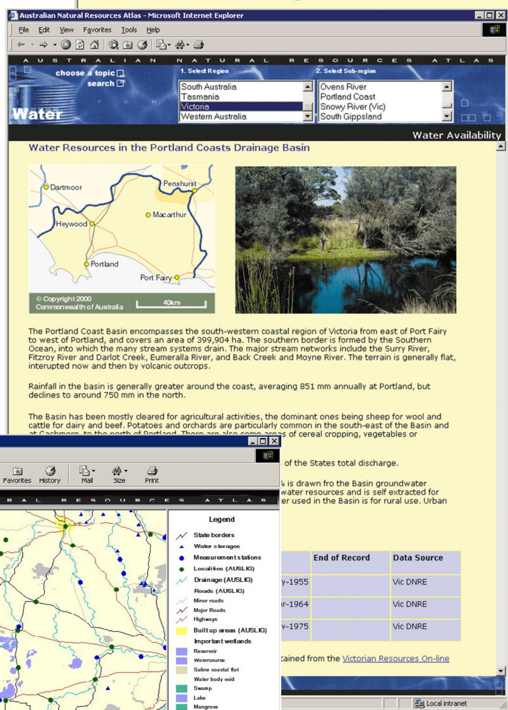
land use pattern and practices, and progressively upgrade and make accessible management orientated information on Australia's water resources.

- Database maintenance and information provision will be reported as part of the Audit's Information Management Report.

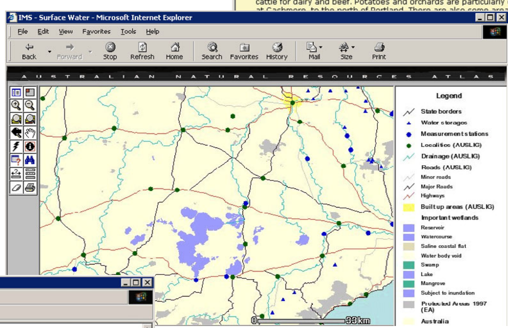
Australia-wide information



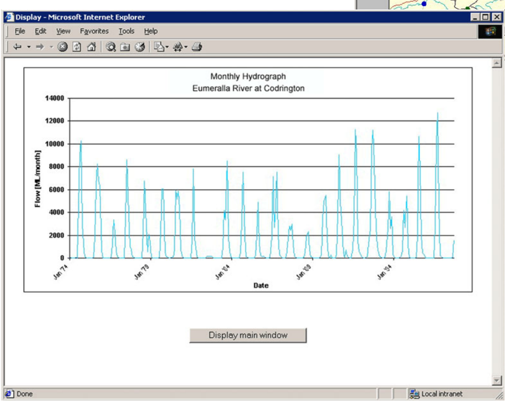
Link to basin-scale summaries



Explore the data and make a map



Link to monitoring data



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ASSESSMENT 2000: an overview

Trade-offs between ecological values and extraction needs

In 1994 the Council of Australian Governments agreed that action was needed to maximise the net value of the use and existence of the water resource and move to increase financial viability of the water industry. In addition it was needed to stop widespread degradation of natural resources and to minimise unsustainable use of water resources. They agreed to a strategic basis for action—the National Water Reform Framework—with the provision of water for the environment a key principle. Establishing environmental water provisions requires a multidisciplinary approach and is being undertaken with varying levels of sophistication across Australia.

Water reporting units

Australian Water Resources Assessment 2000 defined 325 **surface water management areas** and 535 **groundwater management units** as a basis for reporting on water quantity, use and allocation.

Surface water management areas refine the Australian Water Resources Council river basin definitions to better reflect the increasing need to intensively manage surface water systems.

For the first time, Australia has a spatially defined set of groundwater management units, an important basis for improved groundwater management.

Some 69 broadly defined groundwater provinces (defined by the former Australian Water Resources Council) have been used in this report as an aggregation unit for map representations of groundwater management data because groundwater management units can overlie each other and therefore cannot be represented in a compilation map form (see Figure 4b).

The 12 drainage divisions and 246 component river basins were defined by the former Australian Water Resources Council and have been used to present the results of the surface water quality assessment—with the exception of the Australian Capital Territory where monitoring stations have been used as the basis for reporting.

Table 1. Australian Water Resources Assessment 2000 reporting units.

	Groundwater[1] management units	Surface water management areas	River basins[2]
New South Wales	53	54	34
Victoria	79	32	29
Queensland	103	99	69
Western Australia	174	44	44
South Australia	53	34	21
Tasmania	17	19	19
Northern Territory	55	40	30
Australian Capital Territory	3	3	n/a
Total	**535**	**325**	**246**

1 Include the apportionment of the Great Artesian Basin components for each State or Territory.
2 In *Water Review '85* (DPIE, 1987) groundwater data were presented on a river basin basis.

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River basins

1. North-East Coast Drainage Division

101 Jacky Jacky Creek
102 Olive – Pascoe Rivers
103 Lockhart River
104 Stewart River
105 Normanby River
106 Jeannie River
107 Endeavour River
108 Daintree River
109 Mossman River
110 Barron River
111 Mulgrave – Russell River
112 Johnstone River
113 Tully River
114 Murray River (Qld)
115 Hinchinbrook Island
116 Herbert River
117 Black River
118 Ross River
119 Haughton River
120 Burdekin River
121 Don River
122 Proserpine River
123 Whitsunday Island
124 O'Connell River
125 Pioneer River
126 Plane Creek
127 Styx River
128 Shoalwater Creek
129 Water Park Creek
130 Fitzroy River (Qld)
131 Curtis Island
132 Calliope River
133 Boyne River
134 Baffle Creek
135 Kolan River
136 Burnett River
137 Burrum River
138 Mary River (Qld)
139 Fraser Island
140 Noosa River
141 Maroochy River
142 Pine River
143 Brisbane River
144 Stradbroke Island
145 Logan – Albert Rivers
146 South Coast

2. South-East Coast Drainage Division

201 Tweed River
202 Brunswick River
203 Richmond River
204 Clarence River
205 Bellinger River
206 Macleay River
207 Hastings River
208 Manning River
209 Karuah River
210 Hunter River
211 Macquarie – Tuggerah Lakes
212 Hawkesbury River
213 Sydney Coast – Georges River
214 Wollongong Coast
215 Shoalhaven River
216 Clyde River – Jervis Bay
217 Moruya River
218 Tuross River
219 Bega River
220 Towamba River
221 East Gippsland
222 Snowy River
223 Tambo River
224 Mitchell River
225 Thomson River
226 Latrobe River
227 South Gippsland
228 Bunyip River
229 Yarra River
230 Maribyrnong River
231 Werribee River
232 Moorabool River
233 Barwon River
234 Lake Corangamite
235 Otway Coast
236 Hopkins River
237 Portland Coast
238 Glenelg River
239 Millicent Coast

3. Tasmania Drainage Division

301 Flinders – Cape Barren Islands
302 East Coast
303 Coal River
304 Derwent River
305 Kingston Coast
306 Huon River
307 South-West Coast
308 Gordon River
309 King – Henty Rivers
310 Pieman River
311 Sandy Cape Coast
312 Arthur River
313 King Island
314 Smithton – Burnie Coast
315 Forth River
316 Mersey River
317 Rubicon River
318 Tamar River
319 Piper – Ringarooma Rivers

4. Murray–Darling Drainage Division

401 Upper Murray River
402 Kiewa River
403 Ovens River
404 Broken River
405 Goulburn River
406 Campaspe River
407 Loddon River
408 Avoca River
409 Murray – Riverina
410 Murrumbidgee River
411 Lake George
412 Lachlan River
413 Benanee
414 Mallee
415 Wimmera – Avon Rivers
416 Border Rivers
417 Moonie River
418 Gwydir River
419 Namoi River
420 Castlereagh River
421 Macquarie – Bogan Rivers
422 Condamine – Culgoa Rivers
423 Warrego River
424 Paroo River
425 Darling River
426 Lower Murray River
499 Barwon Darling Management Area

5. South Australian Gulf Drainage Division

501 Fleurieu Peninsula
502 Myponga River
503 Onkaparinga River
504 Torrens River
505 Gawler River
506 Wakefield River
507 Broughton River
508 Mambray Coast
509 Willochra Creek
510 Lake Torrens
511 Spencer Gulf
512 Eyre Peninsula
513 Kangaroo Island

6. South-West Coast Drainage Division

601 Esperance Coast
602 Albany Coast
603 Denmark River
604 Kent River
605 Frankland River
606 Shannon River
607 Warren River
608 Donnelly River
609 Blackwood River
610 Busselton Coast
611 Preston River
612 Collie River
613 Harvey River
614 Murray River (WA)
615 Avon River
616 Swan Coast
617 Moore – Hill Rivers
618 Yarra Yarra Lakes
619 Ninghan

7. Indian Ocean Drainage Division

701 Greenough River
702 Murchison River
703 Wooramel River
704 Gascoyne River
705 Lyndon – Minilya Rivers
706 Ashburton River
707 Onslow Coast
708 Fortescue River
709 Port Hedland Coast
710 De Grey River

River basins

8. Timor Sea Drainage Division

- 801 Cape Leveque Coast
- 802 Fitzroy River (WA)
- 803 Lennard River
- 804 Isdell River
- 805 Prince Regent River
- 806 King Edward River
- 807 Drysdale River
- 808 Pentecost River
- 809 Ord River
- 810 Keep River
- 811 Victoria River
- 812 Fitzmaurice River
- 813 Moyle River
- 814 Daly River
- 815 Finniss River
- 816 Bathurst and Melville Islands
- 817 Adelaide River
- 818 Mary River (WA)
- 819 Wildman River
- 820 South Alligator River
- 821 East Alligator River
- 822 Goomadeer River
- 823 Liverpool River
- 824 Blyth River
- 825 Goyder River
- 826 Buckingham River

9. Gulf of Carpentaria Drainage Division

- 901 Koolatong River
- 902 Walker River
- 903 Roper River
- 904 Towns River
- 905 Limmen Bight River
- 906 Rosie River
- 907 McArthur River
- 908 Robinson River
- 909 Calvert River
- 910 Settlement Creek
- 911 Mornington Island
- 912 Nicholson River
- 913 Leichhardt River
- 914 Morning Inlet
- 915 Flinders River
- 916 Norman River
- 917 Gilbert River
- 918 Staaten River
- 919 Mitchell River (Qld)
- 920 Coleman River
- 921 Holroyd River
- 922 Archer River
- 923 Watson River
- 924 Embley River
- 925 Wenlock River
- 926 Ducie River
- 927 Jardine River
- 928 Torres Strait Islands
- 929 Groote Eylandt

10. Lake Eyre Drainage Division

- 001 Georgina River
- 002 Diamantina River
- 003 Cooper Creek
- 004 Lake Frome
- 005 Finke River
- 006 Todd River
- 007 Hay River

11. Bulloo – Bancannia Drainage Division

- 011 Bulloo River
- 012 Lake Bancannia

12. Western Plateau Drainage Division

- 021 Gairdner
- 022 Nullarbor
- 023 Warburton
- 024 Salt Lake
- 025 Sandy Desert
- 026 Mackay
- 027 Burt
- 028 Wiso
- 029 Barkly

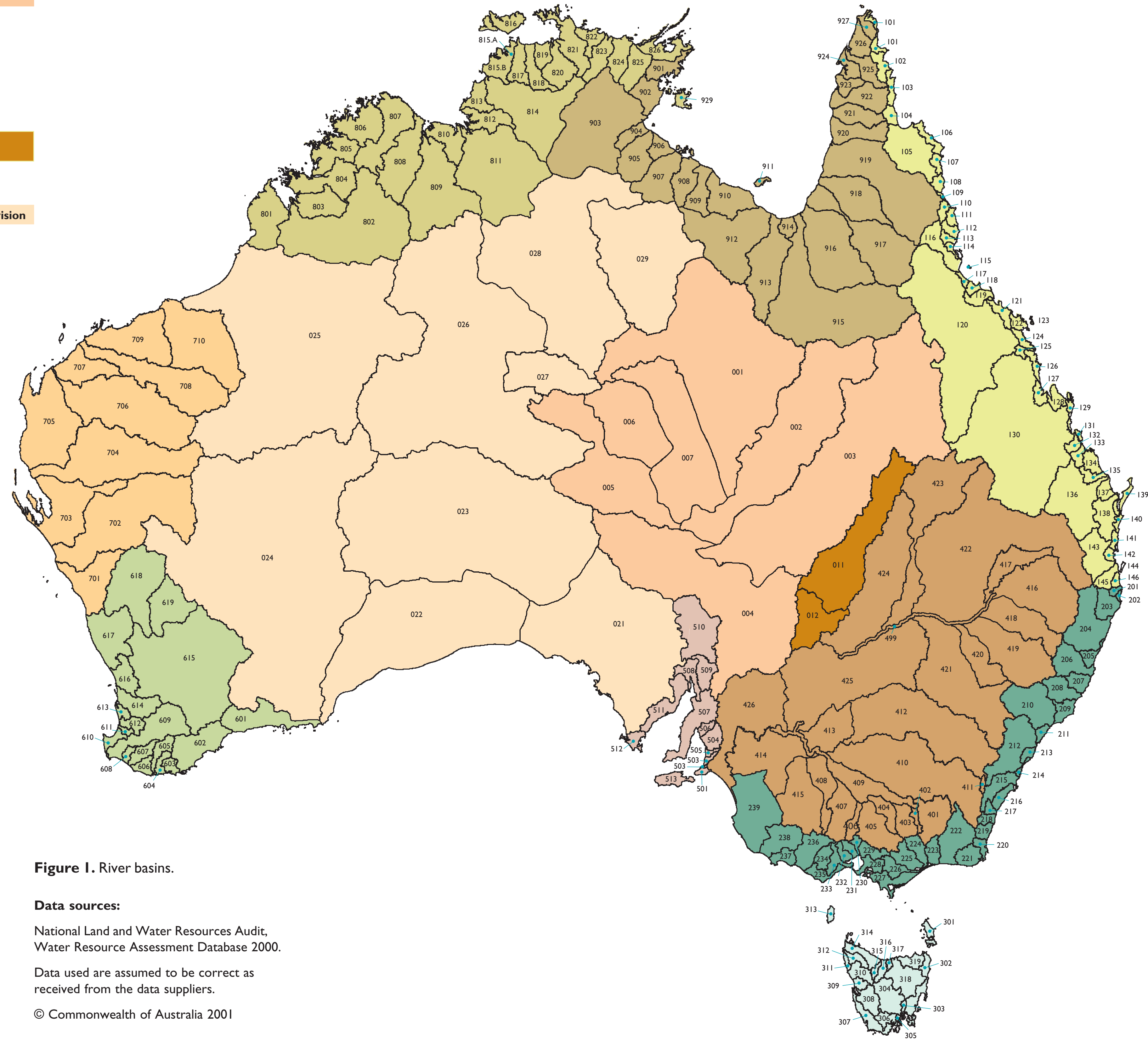


Figure 1. River basins.

Data sources:

National Land and Water Resources Audit, Water Resource Assessment Database 2000.

Data used are assumed to be correct as received from the data suppliers.

Surface water management areas

Surface water management areas

1. North-East Coast Drainage Division

Queensland

101	Jacky Jacky Creek
102	Olive – Pascoe Rivers
103	Lockhart River
104	Stewart River
105	Normanby River
106	Jeannie River
107	Endeavour River
108	Daintree River
109	Mossman River
110	Barron River
111.A	Mulgrave River
111.B	Russell River
112	Johnstone River
113	Tully River
114	Murray River (Qld)
115	Hinchinbrook Island
116	Herbert River
117	Black River
118	Ross River
119.A	Haughton River
119.B	Barratta
120.A	Burdekin River
120.B	Bowen – Broken
120.C	Belyando – Suttor
121	Don River
122	Proserpine River
123	Whitsunday Island
124	O'Connell River
125	Pioneer River
126	Plane Creek
127	Styx River
128	Shoalwater Creek
129	Water Park Creek
130.A	Fitzroy River (Qld)
130.B	Nogoa – Mackenzie
130.C	Dawson River
130.D	Callide
131	Curtis Island
132	Calliope River
133	Boyne River
134	Baffle Creek
135	Kolan River
136.A	Upper Burnett River
136.B	Bundaberg Irrigation Area
136.C	Boyne
136.D	Three Moon Creek
136.E	Barker – Barambah
137.A	Burrum River
137.B	Elliott
137.C	Gregory
137.D	Isis
138	Mary River (Qld)
139	Fraser Island
140	Noosa River
141	Maroochy River
142	Pine River
143.A	Brisbane River
143.B	Lockyer River
144	Stradbroke Island
145.A	Logan River
145.B	Albert River
146	South Coast

2. South-East Coast Drainage Division

New South Wales

201	Tweed River
202	Brunswick River
203.R	Richmond River – regulated
203.UR	Richmond River – unregulated
204	Clarence River
205	Bellinger River
206	Macleay River
207	Hastings River
208	Manning River
209	Karuah River
210.R	Hunter River – regulated
210.UR	Hunter River – unregulated
211	Macquarie – Tuggerah Lakes
212	Hawkesbury River
213	Sydney Coast – Georges River
214	Wollongong Coast
215	Shoalhaven River
216	Clyde River – Jervis Bay
217	Moruya River
218	Tuross River
219.R	Bega River – regulated
219.UR	Bega River – unregulated
220	Towamba River
221.NSW	East Gippsland (NSW)
222.NSW	Snowy River (NSW)

Victoria

221.VIC	East Gippsland (Vic)
222.VIC	Snowy River (Vic)
223	Tambo River
224	Mitchell River (Vic)
225.A	Avon River
225.B	Thomson – MacAlister Rivers
226	Latrobe River
227	South Gippsland
228	Bunyip River
229	Yarra River
230	Maribyrnong River
231	Werribee River
232	Moorabool River
233	Barwon River
234	Lake Corangamite
235	Otway Coast
236	Hopkins River
237	Portland Coast
238.VIC	Glenelg River (Vic)
239.VICD	Millicent Coast (Vic)

South Australia

238.SA	Glenelg River (SA)
239.SAA	Millicent Coast (SA) Sub Catchment 1
239.SAB	Millicent Coast (SA) Sub Catchment 2
239.SAC	Millicent Coast (SA) Sub Catchment 3
239.SAD	Millicent Coast (SA) Sub Catchment 4

3. Tasmania Drainage Division

Tasmania

301	Flinders – Cape Barren Islands
302	East Coast
303	Coal River
304	Derwent River
305	Kingston Coast
306	Huon River
307	South-West Coast
308	Gordon River
309	King – Henty Rivers
310	Pieman River
311	Sandy Cape Coast
312	Arthur River
313	King Island
314	Smithton – Burnie Coast
315	Forth River
316	Mersey River
317	Rubicon River
318	Tamar River
319	Piper – Ringarooma Rivers

4. Murray–Darling Drainage Division

New South Wales

401.NSW	Upper Murray River (NSW)
409.NSW	Murray (Hume to Border) regulated (NSW)
410.R	Murrumbidgee River – regulated
410.UR	Murrumbidgee River – unregulated
411	Lake George
412.R	Lachlan River – regulated
412.UR	Lachlan River – unregulated
413	Benanee
416.NSW	Border Rivers (NSW)
416.R	Border Rivers – regulated (NSW)
417.NSW	Moonie River (NSW)
418.R	Gwydir River – regulated
418.UR	Gwydir River – unregulated
419.R	Namoi River – regulated
419.UR	Namoi River – unregulated
420	Castlereagh River
421.R	Macquarie River – regulated
421.UR	Macquarie River – unregulated
422.NSW	Condamine – Culgoa Rivers (NSW)
423.NSW	Warrego River (NSW)
424.NSW	Paroo River (NSW)
425.R	Darling River – regulated
425.UR	Darling River – unregulated
426.NSW	Lower Murray River (NSW)
499	Barwon Darling Management Area

Victoria

401.A	Upper Murray River (Vic)
401.B	Mitta Mitta River
402	Kiewa River
403	Ovens River
404	Broken River
405	Goulburn River
406	Campaspe River
407	Loddon River
408	Avoca River
409.VIC	Mid-Murray River (Hume to SA Border) (Vic)
414.VIC	Mallee (Vic)
415	Wimmera – Avon Rivers

Queensland

416.A	Macintyre – Dumaresq Rivers
416.B	Macintyre Brook
417.QLD	Moonie River (Qld)
422.A	Balonne – Condamine
422.B	Upper Condamine River
422.C	Maranoa
422.D	St George
422.E	Bokhara River distributary area (Qld)
422.F	Wallum – Nebine – Mungallala (Qld)
423.QLD	Warrego River (Qld)
424.QLD	Paroo River (Qld)

South Australia

414.SA	Mallee (SA)
426.SAA	Lower Murray River (SA) Sub Catchment 1
426.SAB	Lower Murray River (SA) Sub Catchment 2

Australian Capital Territory

410.A	Murrumbidgee River A
410.B	Murrumbidgee River B
410.C	Murrumbidgee River C

5. South Australia Gulf Drainage Division

South Australia

501	Fleurieu Peninsula
502	Myponga River
503	Onkaparinga River
504	Torrens River
505.A	Light River
505.B	Gawler River
505.C	Gawler River Sub Catchment Little Para
506	Wakefield River
507.A	Broughton River
507.B	Yorke Peninsula
508	Mambray Coast
509	Willochra Creek
510	Lake Torrens
511	Spencer Gulf
512	Eyre Peninsula
513	Kangaroo Island

6. South-West Coast Drainage Division

Western Australia

601	Esperance Coast
602	Albany Coast
603	Denmark River
604	Kent River
605	Frankland River
606	Shannon River
607	Warren River
608	Donnelly River
609	Blackwood River
610	Busselton Coast
611	Preston River
612	Collie River
613	Harvey River
614	Murray River (WA)
615	Avon River
616	Swan Coast
617	Moore – Hill Rivers
618	Yarra Yarra Lakes
619	Ninghan

7. Indian Ocean Drainage Division

Western Australia

701	Greenough River
702	Murchison River
703	Wooramel River
704	Gascoyne River
705	Lyndon – Minilya Rivers
706	Ashburton River
707	Onslow Coast
708	Fortescue River
709	Port Hedland Coast
710	De Grey River

8. Timor Sea Drainage Division

Western Australia

801	Cape Leveque Coast
802	Fitzroy River (WA)
803	Lennard River
804	Isdell River
805	Prince Regent River
806	King Edward River
807	Drysdale River
808	Pentecost River
809.WA	Ord River (WA)
810.WA	Keep River (WA)

Northern Territory

809.NT	Ord River (NT)
810.NT	Keep River (NT)
811	Victoria River
812	Fitzmaurice River
813	Moyle River
814	Daly River
815.A	Darwin – Blackmore Rivers
815.B	Finniss – Elizabeth – Howard Rivers
816	Bathurst and Melville Islands
817	Adelaide River
818	Mary River (WA)
819	Wildman River
820	South Alligator River
821	East Alligator River
822	Goomadeer River
823	Liverpool River
824	Blyth River
825	Goyder River
826	Buckingham River

9. Gulf of Carpentaria Drainage Division

Queensland

910.QLD	Settlement Creek (Qld)
911	Mornington Island
912.QLD	Nicholson River (Qld)
913	Leichhardt River
914	Morning Inlet
915	Flinders River
916	Norman River
917	Gilbert River
918	Staaten River
919	Mitchell River (Qld)
920	Coleman River
921	Holroyd River
922	Archer River
923	Watson River
924	Embley River
925	Wenlock River
926	Ducie River
927	Jardine River
928.A	Horne Island
928.B	Thursday Island

Northern Territory

901	Koolatong River
902	Walker River
903	Roper River
904	Towns River
905	Limmen Bight River
906	Rosie River
907	McArthur River
908	Robinson River
909	Calvert River
910.NT	Settlement Creek (NT)
912.NT	Nicholson River (NT)
929	Groote Eylandt

Queensland

928.A	Horne Island

Hor Sumr Contents

10. Lake Eyre Drainage Division

New South Wales

003.NSW	Cooper Creek (NSW)
004.NSW	Lake Frome (NSW)

Queensland

001.QLD	Georgina River (Qld)
002.QLD	Diamantina River (Qld)
003.QLD	Cooper Creek (Qld)
004.QLD	Lake Frome (Qld)
007.QLD	Hay River (Qld)

South Australia

001.SA	Georgina River (SA)
002.SA	Diamantina River (SA)
003.SA	Cooper Creek (SA)
004.SA	Lake Frome (SA)
005.SA	Finke River (SA)
007.SA	Hay River (SA)

Northern Territory

006	Todd River
001.NT	Georgina River (NT)
005.NT	Finke River (NT)
007.NT	Hay River (NT)

11. Bulloo–Bancannia Drainage Division

New South Wales

011.NSW	Bulloo River (NSW)
012	Lake Bancannia

Queensland

011.QLD	Bulloo River (Qld)

12. Western Plateau Drainage Division

South Australia

022.SA	Nullarbor (SA)
023.SA	Warburton (SA)
026.SA	Mackay (SA)
021	Gairdner

Western Australia

022.WA	Nullarbor (WA)
023.WA	Warburton (WA)
026.WA	Mackay (WA)
024	Salt Lake
025	Sandy Desert

Northern Territory

023.NT	Warburton (NT)
026.NT	Mackay (NT)
027	Burt
028	Wiso
029	Barkly

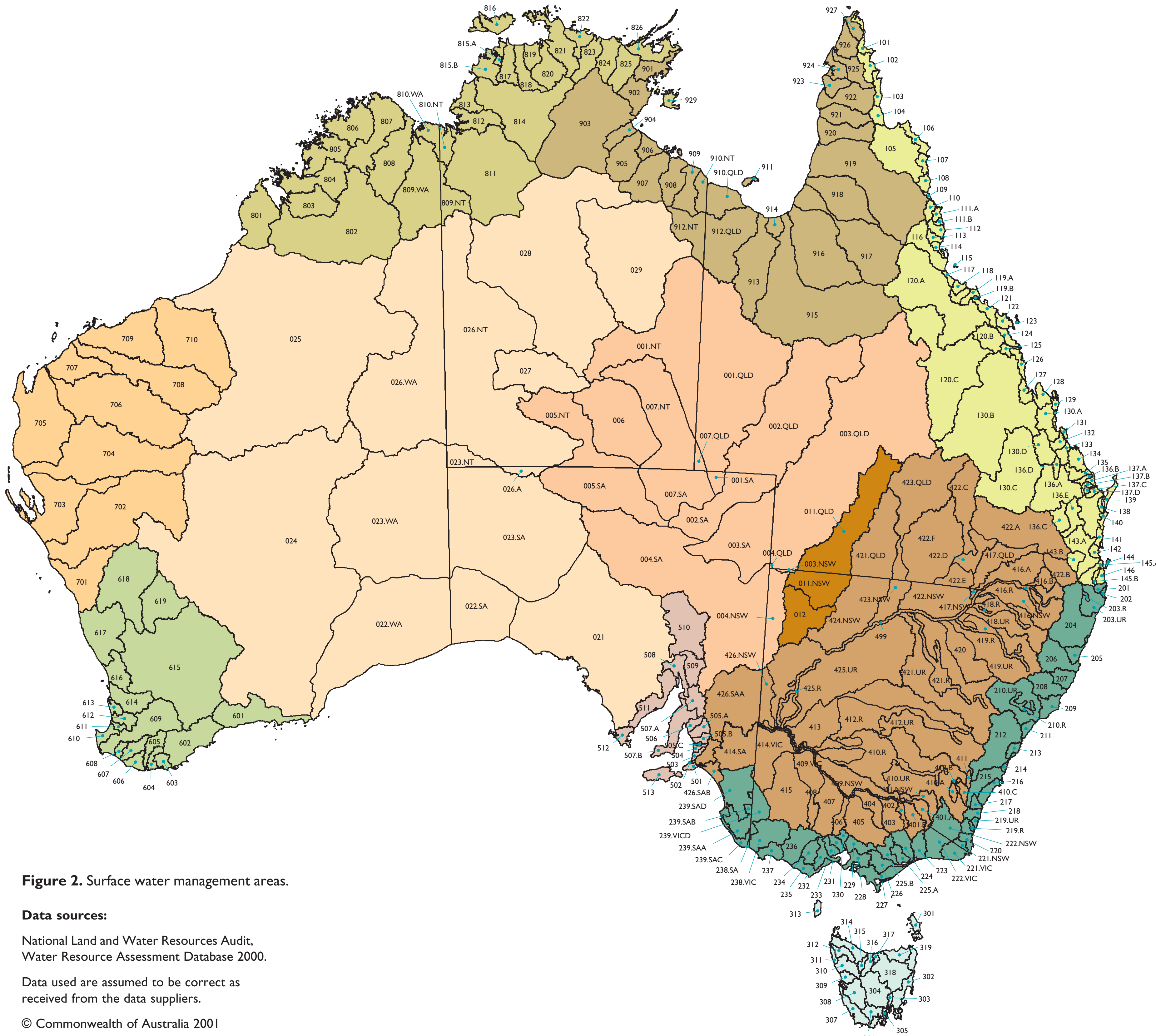


Figure 2. Surface water management areas.

Data sources:

National Land and Water Resources Audit, Water Resource Assessment Database 2000.

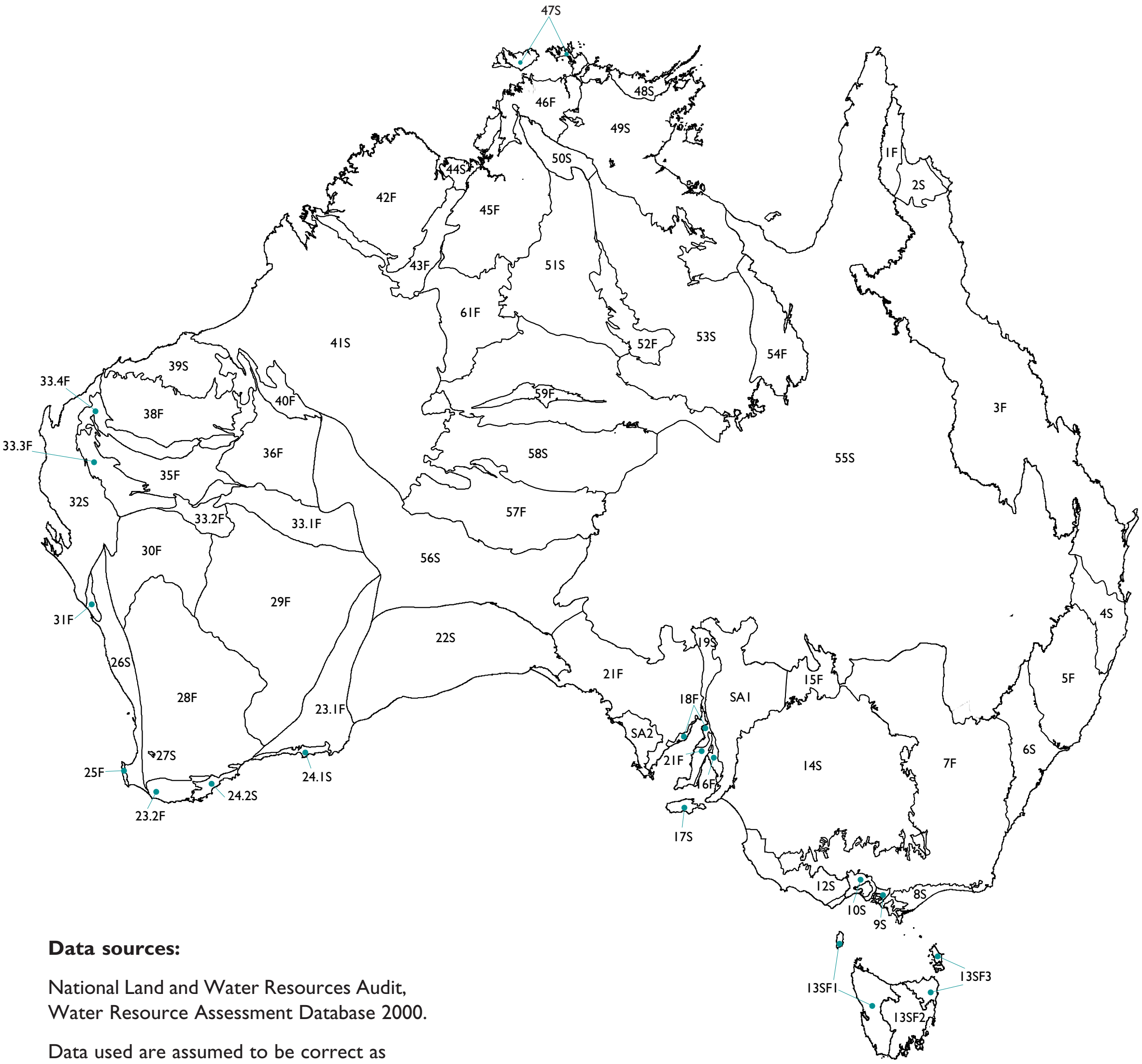
Data used are assumed to be correct as received from the data suppliers.

Groundwater provinces*

1F	Coen	24.1S	Bremer 1	45F	Ord – Victoria
2S	Laura	24.2S	Bremer 2	46F	Pine Creek
3F	Tasman	25F	Leeuwin	47S	Melville
4S	Clarence – Moreton	26S	Perth	48S	Arafura
5F	New England	27S	Collie	49S	McArthur
6S	Sydney	28F	Yilgarn – Southwest	50S	Daly River
7F	Lachlan	29F	Yilgarn – Gold Fields	51S	Wiso
8S	Gippsland	30F	Yilgarn – Murchison	52F	Tennant Creek
9S	Westernport	31F	Northampton	53S	Georgina
10S	Port Phillip	32S	Carnarvon	54F	Mt Isa – Cloncurry
11S	Otway Highlands	33.1F	Capricorn 1	55S	Great Artesian
12S	Otways	33.2F	Capricorn 2	56S	Officer
13SF1	Tasmania 1	33.3F	Capricorn 3	57F	Musgrave
13SF2	Tasmania 2	33.4F	Capricorn 4	58S	Amadeus
13SF3	Tasmania 3	34F	Marymia	59F	Arunta
14S	Murray	35F	Banemall	60S	Ngalia
15F	Olary	36F	Calyie – McFadden	61F	Tanami
16F	Mt Lofty – Flinders Ranges	37F	Sylvania	SA1	Adelaide Geosyncline
17S	St Vincent	38F	Hamersley	SA2	Eyre Penninsula
18F	Yorke Peninsula	39S	Pilbara		
19S	Pirie – Torrens	40F	Paterson		
21F	Gawler	41S	Canning		
22S	Eucla	42F	Kimberley		
23.1F	Albany – Fraser 1	43F	Halls Creek		
23.2F	Albany – Fraser 2	44S	Bonaparte		

* A groundwater province is a major area having a broad uniformity of hydrogeological and geological conditions, with reasonably uniform water-bearing characteristics, and identified as either predominantly sediment (S) or fractured rock (F).

Figure 3. Groundwater provinces.



Data sources:

National Land and Water Resources Audit, Water Resource Assessment Database 2000.

Data used are assumed to be correct as received from the data suppliers.

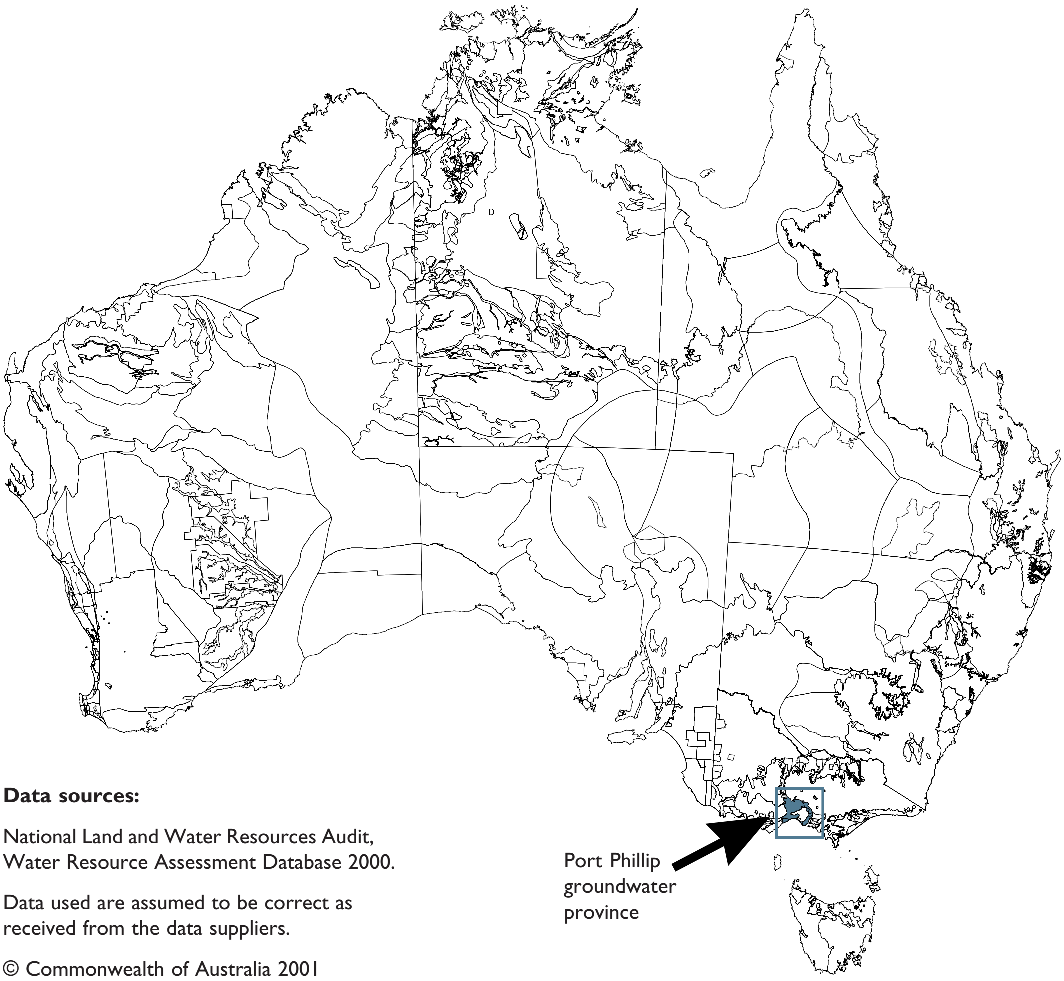
Groundwater management units

This map (Figure 4a) is provided to show the broad distribution of groundwater management units across Australia. In some cases groundwater management units overlie each other (e.g. in the Port Phillip Province, see Figure 4b).

Unincorporated areas

An unincorporated area is a groundwater resource defined by a groundwater province and excluding any designated groundwater management units. For the purposes of reporting the total groundwater resource, unincorporated areas have been included in the analyses that follow. For convenience unincorporated areas are reported as and under the heading of groundwater management units.

Figure 4a. Australia's groundwater management units.

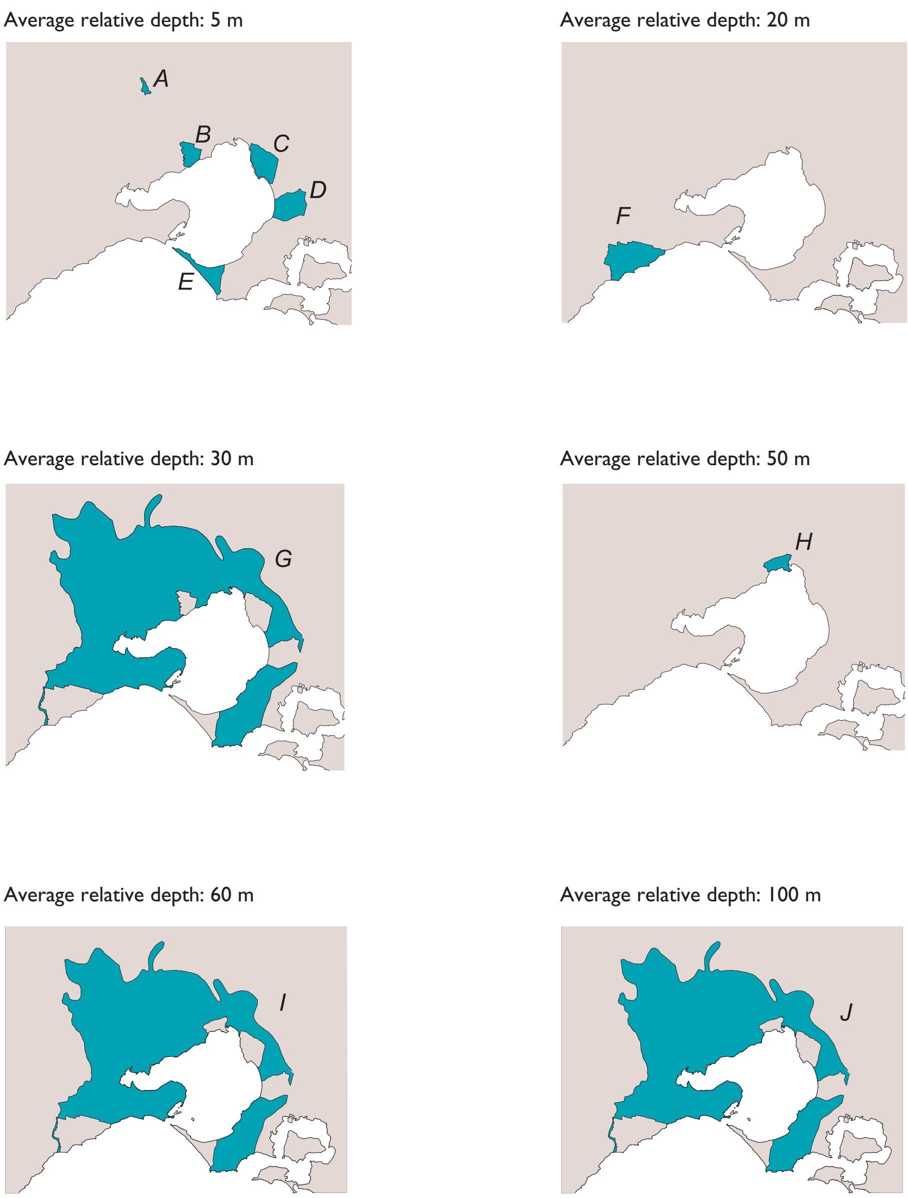


Data sources:

National Land and Water Resources Audit, Water Resource Assessment Database 2000.

Data used are assumed to be correct as received from the data suppliers.

Figure 4b. Groundwater management units in the Port Phillip Groundwater Province.



A Merrimu
B Deutgam
C Moorabbin
D Frankston
E Nepean
F Jan Juc
G Port Phillip – watertable aquifer
H Cut Paw Paw
I Port Phillip – middle Tertiary aquifer
J Port Phillip – lower Tertiary aquifer

Water availability

Australian Water Resources Assessment 2000 details our water resources, reports on the sustainability of surface water and groundwater resources. It compares nominated sustainability measures to the allocation, current use and degree of infrastructure development in 325 surface water management areas and 535 groundwater management units.

The determination of a measure for sustainable water use requires consideration of a complex set of biophysical interactions and social and economic demands. It involves a trade-off between maintenance of in situ ecological values and demands for water extraction. This is made more complex in that the allocation under licence may differ from the actual use. A system in which use patterns exceed the designated sustainable measure is deemed to be over-utilised. Where the water allocation pattern exceeds a designated sustainable measure, there is a potential for overuse.

A technical review of methods for establishing environmental water provisions was undertaken as part of the Audit's assessment (Appendix 3). Each State/Territory used methods to assess sustainability within the context of its water management programs (e.g. Water Allocation Management Planning [Queensland], the Bulk Entitlement Conversion Program [Victoria], Stressed River Assessment Reports [New South Wales], the Water Management Planning Program [Tasmania] and the Water Allocation Program [Western Australia]).

Key elements of the National Water Reform Framework

- Pricing based on principles of full cost recovery and removal (or transparency) of cross subsidies.
- Future investment in new irrigation schemes, or extensions to existing schemes, to be undertaken only after appraisal indicates it is economically viable and ecologically sustainable.
- Comprehensive systems of water allocations or entitlements; backed by separation of water property rights from land, and clear specification of entitlements in terms of ownership, volume, reliability, transferability and, if appropriate, quality.
- Formal determination of water allocations or entitlements, including allocations for the environment as a legitimate user of water.
- Trading, including cross-border sales, of water allocations and entitlements, within the social, physical, and ecological constraints of catchments.
- Providing an integrated catchment management approach to water resource management including water quality.
- The separation of resource management, standard setting and regulatory roles of government, from the role of providing water services.
- A greater degree of responsibility for local management of irrigation areas.
- Public education about water use and consultation in implementing the water reforms.
- Appropriate water related research and use of efficient technologies.

High Level Steering Group on Water, September 1999

Specific concepts of 'sustainable flow regimes' for surface water and 'sustainable yield' for groundwater were adopted for this assessment to:

- provide a comparable analysis across Australia;
- identify priority areas for further investigation or management action; and
- communicate Australia's progress towards sustainable water resource management.

Research on ecological requirements of rivers is progressing. Australian Water Resources Assessment 2000 represents the best available knowledge and its application by State and Territory water management agencies.

Categorisation

A four-class classification system was developed to provide a simple method to communicate the status of the use and allocation of Australia's water resources.

Category 1 systems have zero to low levels of resource use: direct management intervention and information requirement are low (e.g.[2] Victoria River, Northern Territory; Burnie, Tasmania).

Category 2 systems are moderately developed: management and resource information requirement is moderate (e.g.[2] Broughton River, South Australia; Ti Tree, Northern Territory).

Category 3 systems are close to, or at, their extraction limit and require a high level of management inputs. Resource information and monitoring are vital for these systems. Development depends on installation of appropriate water markets to move water to higher value use and to provide surplus for development or the environment through efficiency gains (e.g.[2] Pioneer River, Queensland; Woongarra, Queensland).

Category	Extraction/allocation[1] %	Development status
1	<30	Low development
2	30–70	Moderate development
3	70–100	Highly developed
4	>100	Overdeveloped

Category 4 systems are over-committed in water allocation and/or use: insufficient provision has been made for environmental and non-consumptive uses, management intervention and information requirements are substantial (e.g.[2] Wimmera–Avon Rivers, Victoria; Neuarpur GSPA, Victoria).

As the level of use nears or exceeds estimates of sustainable yield, higher levels of management are required. This will often require additional and more detailed information.

1 Water extraction (diversion for surface water or abstraction for groundwater) and/or allocation as a percentage of the sum of sustainable flow regime (surface water) and sustainable yield (groundwater).

2 Surface water example is given first, followed by a groundwater example.

Surface water

The working definition of sustainable flow regimes adopted by this assessment was:

> *The limit on potentially divertible water that will be allowed to be diverted from a resource after taking account of environmental values and making provision for environmental water needs.*

The concept of sustainable flow regimes needs to allow for the frequency of high, low and seasonal flow requirements of in-stream, wetland and floodplain environmental use and reliability of supply for extractive users. Methods of estimation across the States and Territories vary (Appendix 3).

Groundwater

The working definition of sustainable yield adopted for this assessment in 1998 for groundwater systems was:

> *The level of extraction measured over a specified planning timeframe that should not be exceeded to protect the higher value social, environmental and economic uses associated with the aquifer.*

As part of and to underpin this definition, it was agreed by the State and Territory agencies, that for Water Resources Assessment 2000, operationally this definition would be interpreted as groundwater use being sustainable where groundwater level and pressure was maintained. Methods of estimation across the States and Territories vary (Appendix 3).

Update on progress

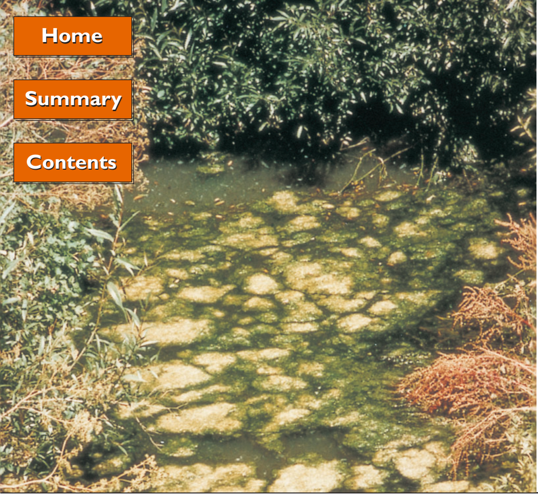
In May 2000 as part of the continued development of sustainability concepts, the National Groundwater Committee (a working group of the Sustainable Land and Water Resource Management Committee) agreed on the following definition of 'sustainable yield' and has submitted it to the High Level Steering Group on Water for endorsement:

> *The groundwater extraction regime, measured over a specified planning timeframe, that allows acceptable levels of stress and protects the higher value uses that have a dependency on the water.*

The States have used a broad range of approaches to implement sustainable yield. The principal method considers a percentage of the assessed rainfall—commonly between 1% and 5%—as being the recharge. Sustainable yield is then defined as all or the majority of the recharge. Other hydrogeological criteria and approaches have also been adopted to suit specific circumstances.

It was generally agreed by the State and Territory agencies, that groundwater level and pressure should be maintained at predetermined levels, while acknowledging that 'storage depletion' may occur.

Water requirements of groundwater-dependent environmental factors are significant in assessing sustainable yield. The extent to which environmental water provision has been taken into account for sustainable yield varies considerably between the States and Territories. River baseflow and wetlands requirements have often been considered to a rudimentary extent; vegetation and most other groundwater-dependent environmental factors have not been considered. As knowledge and appreciation of groundwater-dependent environmental factors increases, methods for calculating sustainable yield will be refined and values may decrease from present estimates.



Eutrophication: a water quality issue

Water quality

Australia Water Resources Assessment 2000 provides the first overview of Australia's declining surface water quality with salinity, nutrients and turbidity issues revealed across most of the intensively used basins. Assessments of blue–green algae blooms, acidity/alkalinity and contamination by faecal coliforms have also been compiled where data are available (see the Australian Natural Resources Atlas).

Data coverage available for each variable is broadly related to both the perception of water quality data needs or problem areas and the ease and expense involved in measuring the particular variable. Variables with the greatest coverage are salinity, followed by turbidity, total phosphorus, pH and total nitrogen. Faecal coliform data were only available for a small number of sites within Queensland and the Australian Capital Territory. Data from local government and corporatised service providers—which often have prime responsibility for the monitoring of surface waters from a human health perspective—were not accessed.

The assessment has been based on comparing collated data with State and Territory guidelines for 'good' water quality. These guidelines take account of the natural variation in Australia's surface water characteristics, the intensity of water quality impacting land uses, and the management objectives for the particular water body. Basin area characterisations were achieved by using a catchment area weighting method in which the results of a monitoring station were weighted by the area of river basin it sampled (Appendices 3 & 5). This method was supported and adopted by State and Territory agencies when compiling the assessment and can be rationalised in terms of the way water quality reflects land use activities in a basin. Nevertheless, the potential for generation of error was recognised, particularly when the monitoring coverage across a basin is limited and the opportunity for bias in the characterisation of basin water quality increases. This may lead to underestimation of the extent of declining water quality issue where monitoring stations are not placed in impacted areas, or alternatively overestimation of declining water quality where in the absence of upstream monitoring stations, results obtained by impacted lowland sites are used to characterise the upper basin.

In this Assessment monitoring sites were classified as 'good', 'fair' or 'poor' for each variable based on whether guidelines were met. Generally a 'good' classification was achieved where water quality was within guidelines for a majority of time while a 'poor' classification resulted where water quality did not meet the guidelines for a greater period of time. A range of statistical measures including the median, ninetieth percentile, and percent time exceedance were used by States and Territories for this determination. These were dependent on the variable and whether the analysis was based on assessing acute (short-term extreme event) or chronic (long-term sustained event) water quality impacts. Full discussion of the methods used for water quality exceedance and trend assessment are presented in the *A review of Australia's surface water quality* (ASoE & Audit, in prep.)

To compile the Australia-wide overviews of exceedances of 'good' water quality guidelines within basins a number of rationalised thresholds were used:

- 'major' issues occurred where guideline exceedances were calculated to occupy greater than a third (33%) of the basin area;

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- 'significant' issues occurred where guideline exceedances were calculated to occupy greater than 5% but less than 33% of the basin area;
- 'undetermined' issues occurred where monitoring coverage was less than 50% of the basin area, and observed guideline exceedances represented less than 5% of the basin area.
- 'not significant' issues occurred where monitoring coverage was greater than 50% of the basin area and observed guideline exceedances represented less than 5% of the basin area.

The water quality assessment is constrained by available monitoring data. Data for each variable ranged from between 43 and 75 basins. No assessments were possible for Tasmania or the Northern Territory, or for Australia's less intensive land use areas including the Indian Ocean, Timor Sea, Gulf of Carpentaria and Lake Eyre drainage divisions because the water quality datasets did not meet the minimum requirements in terms of frequency of sampling or duration of monitoring record.

Data are limited to the more developed areas of Australia. The areas of greatest data availability include most of the North-East Coast, South-East Coast, Murray–Darling and South-West Coast Drainage Divisions. The South Australian Gulf Drainage Division has only limited monitoring coverage. In terms of State coverage, Victoria is best served followed by New South Wales, Queensland and Western Australia.

To facilitate more detailed assessment beyond the basin aggregations presented in this report, site data are reported in the Australian Natural Resources Atlas. This builds on initiatives such as the Victorian Water Resources Data Warehouse and will be invaluable to regional groups seeking to understand water quality issues and priorities within their basin.

Table 2. River basin water quality data analysis coverage for different water quality variables. Percent figures indicate proportion of Australia's 246 basins.

Water quality variable	River basins with sufficient data for site exceedance assessment[1]		River basins with sufficient data for site trend assessment[2]	
Total phosphorus	101	41%	64	26%
Total nitrogen	75	30%	41	17%
Electrical conductivity	112	46%	99	40%
Turbidity	98	40%	74	30%
pH	73	30%	61	25%
Faecal coliforms		<1%		<1%

Criteria for inclusion of data in Australian Water Resources Assessment 2000:

1 At least three years of monthly data collected since 1995.

2 7–10 years of monthly data collected since 1990. Flow measurements must have also been taken.

Water quality trends

Water quality trend data were limited by the lack of monitoring sites with adequate long-term records. There are generally sufficient salinity data to assess trends in most of the more intensively developed catchments and a relatively good coverage of turbidity data for trend analyses in the intensive land use areas. Victoria is the only State that monitors both nitrogen and phosphorus with sufficient frequency to provide data across the State on which good trend analysis can be undertaken. Trend information that is available is detailed in the Australian Natural Resources Atlas, again as a basis for regional resource management.

Stringent data quality and length of record requirements needed to be met to enable defensible exceedance and trend analyses to be conducted (ASoE & Audit, in prep.). These requirements further reduced the amount of water quality data available for this assessment. A tabular summary of river basin coverage and data meeting criteria for inclusion in this assessment for each water quality variable is presented in Table 2.

WATER QUALITY VARIABLES EXAMINED AS PART OF THE AUDIT SURFACE WATER QUALITY ASSESSMENT

Water quality variables that were examined as part of the Audit surface water quality assessment include:

Salinity describes the salt concentration in water. Usually measured as electrical conductivity of water in microsiemens per centimetre (µS/cm—sometimes referred to as EC units). Electrical conductivity is an appropriate indicator of salinity, as it is proportional to the concentration of total dissolved salts and is easily measured in the field or by later laboratory analysis. Salinity is also sometimes measured directly (as is the case in Western Australia) as total dissolved solids.

Turbidity is a measure of the clarity, 'dirtiness' or light scattering/absorbing capacity of water, which is roughly proportional to the type and concentration of suspended matter. It is therefore commonly used as an indicator of the amount of suspended solids in the water column. Turbidity is usually measured in Nephelometric Turbidity Units (NTU), which provide a measure of the capacity of light to penetrate through water. Total suspended solids measured in milligrams per litre (mg/L) is also used as a less accurate measure of turbidity in some instances and by some States although it is recognised that non-solid or dissolved substances within water can also affect turbidity.

Nutrients. There are a number of nutrients that affect the quality of surface waters. These include nitrogen, phosphorus and organic carbon. These nutrients can occur in a range of chemical forms. Total nitrogen and total phosphorus were assessed as part of the Audit.

Total nitrogen is a measure that sums the concentration of the major forms of nitrogen including ammonia, organic nitrogen, nitrate and nitrite. Total nitrogen is reported in milligrams per litre (mg/L) and requires laboratory analysis of samples collected in the field for accurate measurement.

Total phosphorus is a measure that sums the concentration of all forms of phosphorus in the water column including dissolved forms, insoluble particulate forms and phosphorus already incorporated in phytoplankton. Total phosphorus is measured in milligrams per litre (mg/L) and requires laboratory analysis of samples collected in the field for accurate measurement.

pH is a measure of the concentration of free hydrogen ions in solution. It is expressed on a logarithmic scale (1–14). Values at the low (1–7) end of the pH scale represent extreme to low acidity, while values at the high (7–14) end of the pH scale are a measure of low to extreme alkalinity; 7 in the middle of the scale indicates a neutral solution.

Faecal coliforms are bacteria present in human and animal waste. Measures of faecal coliform concentration are obtained by cell counts using epifluoresence (measures the brightness of ultra violet illuminated bacteria in water samples) or by the use of standard sized sampling plates. Counts provide an indication of the contamination of water by sewage or animal wastes and the suitability of water for drinking.

Other surface water quality issues include blue–green algae blooms, toxic chemical and heavy metal pollution, organic carbon loading, oxygen depletion, thermal pollution and biological pathogens. Information on these issues is limited and localised and was not able to be assessed. In the case of blue–green algae it was assessed but due to the paucity of data, has not been reported (see *A review of Australia's surface water quality* [ASoE & Audit, in prep.]).

WATER AVAILABILITY

Scarce, variable, harnessed

Characterisation of water resources

A key part of Australian Water Resources Assessment 2000 was the collation of data on the characteristics of Australia's surface and groundwater resources.

Australia has excellent information on its surface water availability as a result of a long period of strategic investment, fostered and encouraged through previous Commonwealth initiatives such as the Australian Water Resources Council. These data were collated to make them accessible as input to analysis of natural resource management issues such as river, wetland or estuary management, catchment hydrology or the catchment scale assessment of land use change options. These land use change options and an assessment of their impacts on our natural resources in total will be needed for salinity management as Australia moves towards implementing targets under the National Action Plan.

To facilitate various applications, data were collated under a rigorous database structure that is now part of the Audit's Data Library. Access to the data library will be managed by the Bureau of Rural Sciences and in accordance with any licence arrangements that a particular State may wish to impose on specific data.

These data were collated to provide summary information derived from the databases as input to activities such as regional planning and to improve community understanding of the nature of Australia's water resources. Information on Australia's surface and groundwater resources is available through the Audit's Australian Natural Resources Atlas in a hierarchy from Australia-wide to drainage divisions to basins to individual stream gauging stations or bore monitoring sites. By providing readily available access to information on Australia's natural resources, the Atlas will be a key tool for regional groups as they develop and then monitor progress in their regional natural resources strategies.

Surface water characterisation

Attributes collated for quantitative resource characterisation for surface water management areas were:

Water availability

- Divertible yield: average annual volume (ML) that could be diverted using both existing and potential infrastructure and under an ultimate level of infrastructure development scenario—making no allowance for environmental water requirements.
- Developed yield: average annual volume (ML) that can be diverted for use by existing infrastructure. Developed yield represents the portion of the divertible yield that is potentially available for use.
- Developed use: average annual volume actually diverted for use.

Hydrogeological characteristics

- Mean annual flow: average annual volume of water streamflow passing a specified point on a stream
- Mean annual inflow: average annual volume of water flowing into a surface water management area
- Mean annual outflow: average annual volume of water flowing out of a surface water management area
- Mean annual run-off: streamflow generated as a result of direct precipitation on the area of interest

- Hydrograph: actual and natural (for mostly regulated systems) monthly hydrographs. Daily flow estimations of streamflow for a run of 100 years are also available for 350 sites based on a rainfall–run-off model that uses the Bureau of Meteorology 100-year rainfall record.
- Hydrometric statistics: annual* and monthly statistics for actual and natural flow regimes; mean flow; normalised flow; standard deviation; normalised standard deviation; minimum flow; maximum flow; coefficient of variation and auto correlation

Use and other features

- Major infrastructure: location and volumes of dams and weirs
- Major diversion: location and volume
- Water traded: volume and number of transactions of water traded within or between surface water management areas
- Water imported: volume of water imported into a surface water management area

Groundwater characterisation

Attributes collated for groundwater management units were:

Water availability

- Developed yield: average annual volume that can be abstracted for use by existing infrastructure
- Abstraction: average annual volume extracted for use
- Major abstractions: location and volume

Note: The total storage volume of groundwater aquifers was not determined as it was not considered to be a particularly useful measure from a water management or use perspective.

Aquifer characteristics

- Depth: average depth to aquifer
- Thickness: saturation thickness
- Salinity: salt concentration as measured by electrical conductivity in microSeimens per centimetre (μS/cm)
- Hydrographs: monthly hydrographs

Continued updating of these datasets is essential so that the information is current and available to support decision making. Updating could be undertaken through review and, where necessary, improvement of data management arrangements in place within States and Territories. Summary reporting at regular intervals as part of ongoing water resource assessments is also essential and would provide a framework for strategic management of Australia's water resources.

* Annual statistics are based on years with a full 12 month record and consequently may introduce bias/error into the statistics.

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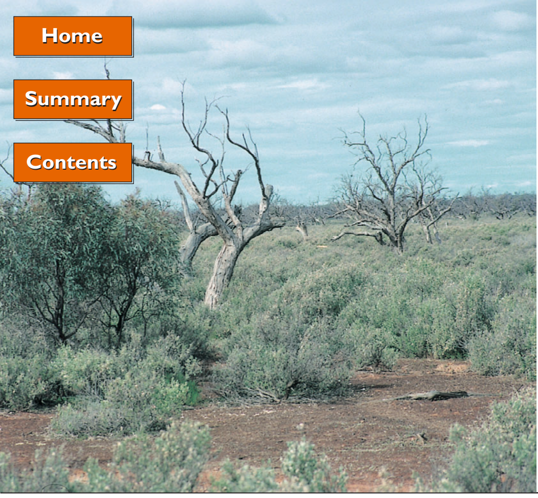
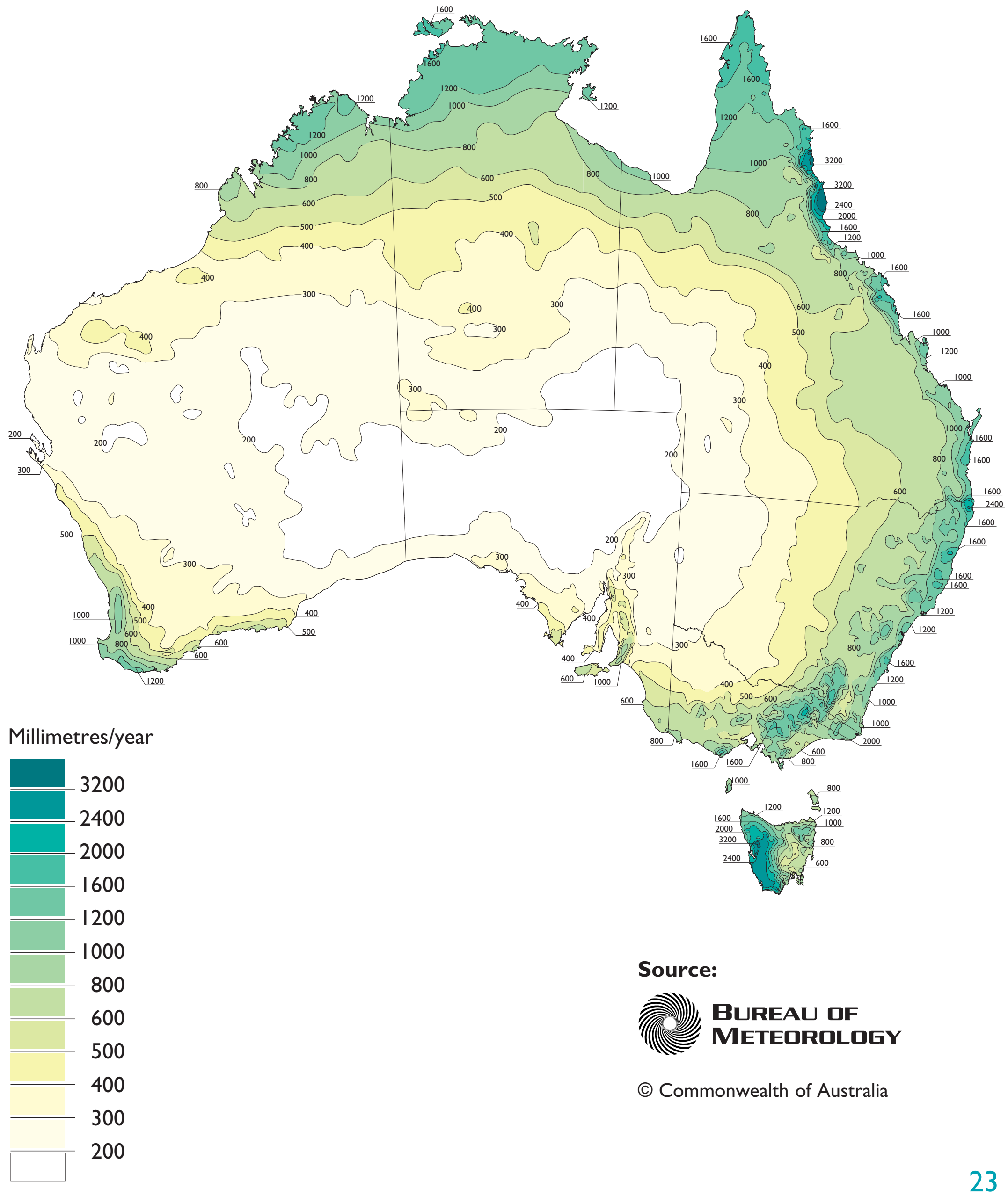


The bulk of Australia is arid with low amounts of available water

Surface water availability

Australia is a dry continent. Rainfall is distributed unevenly—both geographically and seasonally.

Figure 5. Average annual rainfall based on 30-year climatology (1961–90).



Source:

BUREAU OF METEOROLOGY

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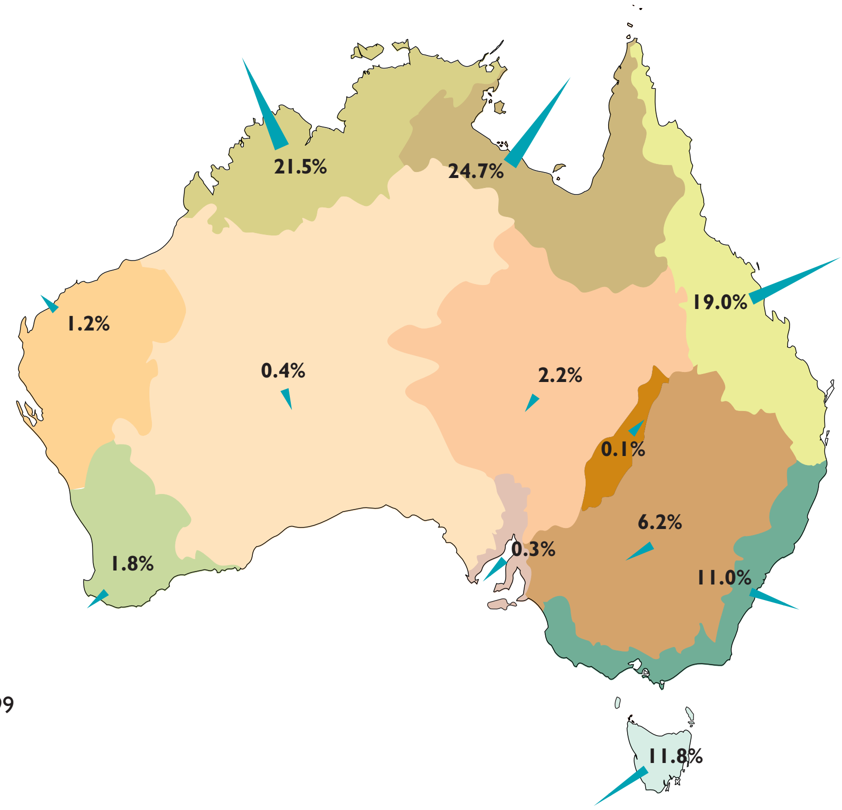
On average, only 12% of rainfall runs off to collect in rivers: in five of Australia's 12 drainage divisions, run-off is less than 2%; in the two drainage divisions of tropical monsoonal divisions of Timor Sea and Gulf of Carpentaria, run-off is greater than 20%. The remaining 88% of rainfall is accounted for by evaporation, water used by vegetation; and water held in storages including natural lakes, wetlands and groundwater aquifers.

Figure 6. Percent run-off from each drainage division. Arrows indicate relative amount of run-off for each drainage division.



Source:

AATSE 1999

Table 3. Run-off, outflows and diversion from each drainage division.

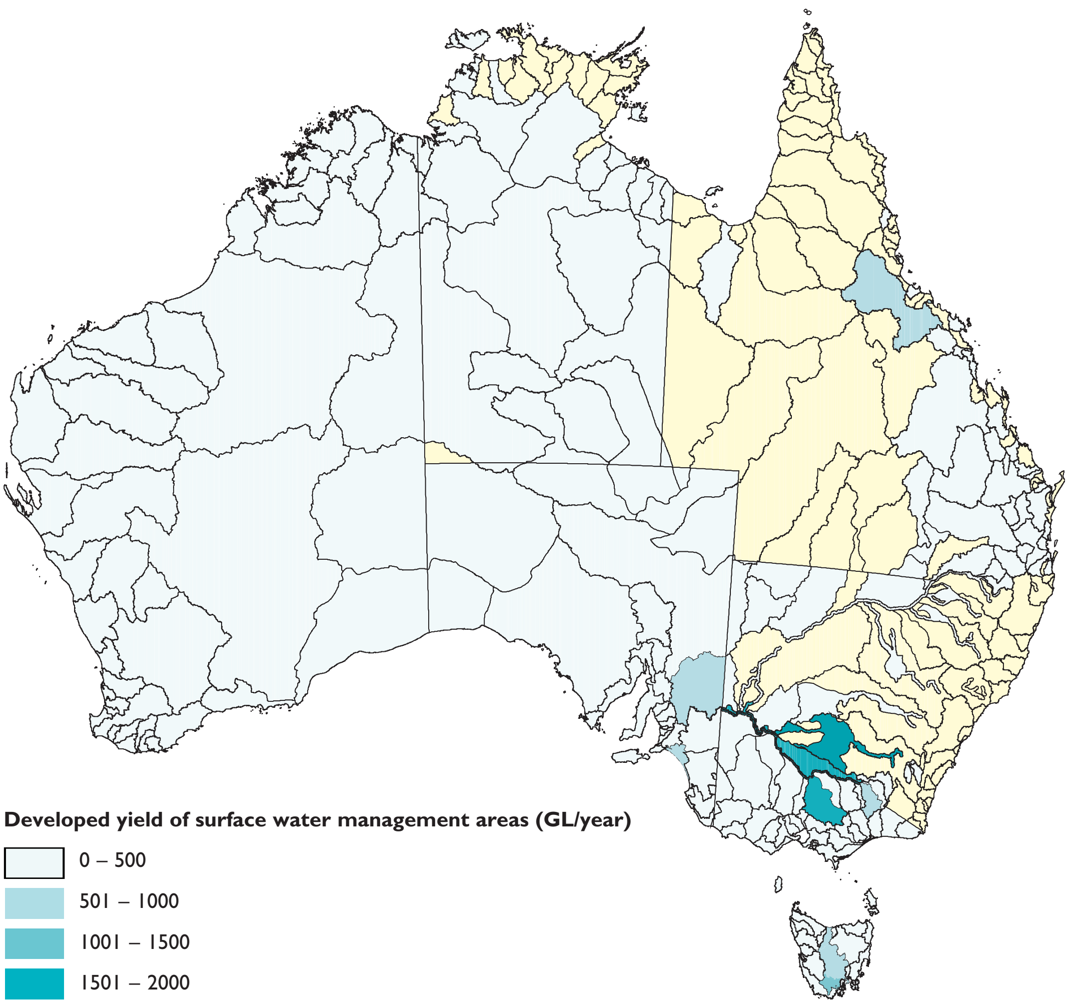
Drainage division	**Mean annual run-off** (GL)	**Percent mean annual run-off** (%)	**Mean annual outflow** (GL)	**Volume diverted** (GL)
North-East Coast	73 411	19.0	69 580	3 182
South-East Coast[1]	42 390	10.9	40 366	1 825
Tasmania[2]	45 582	11.8	45 336	451
Murray–Darling[1]	23 850	6.2	5 750	12 051
South Australian Gulf [3]	952	0.2	787	144
South-West Coast	6 785	1.8	5 925	373
Indian Ocean	4 609	1.2	3 481	12
Timor Sea	83 320	21.5	81 461	48
Gulf of Carpentaria	95 615	24.7	96 066	52
Lake Eyre	8 638	2.2	n/a	7
Bulloo–Bancannia	546	0.1	-	<1
Western Plateau	1 486	0.4	n/a	1
Total	**387 184**	**100**		**18 147**

1 South-East Coast and Murray Darling Division. The volume diverted represents the sum of available data (New South Wales has not reported water use for unregulated surface water management areas).

2 Tasmanian Division. Volume diverted does not include the HYDRO scheme diversions.

3 South Australian Gulf Division. Mean annual outflow includes the flow from surface water management areas Willochra Creek and Lake Torrens, which do not flow to the sea but flow into the terminal lake—Lake Torrens.

Figure 7. Developed yield of surface water management areas (2000).



Developed yield of surface water management areas (GL/year)

- 0 – 500
- 501 – 1000
- 1001 – 1500
- 1501 – 2000
- 2001 – 2500
- no data

Data sources:

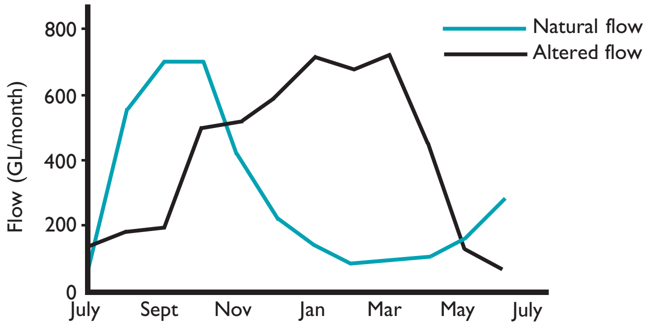
National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

Water div ersion has significantly altered flow patterns

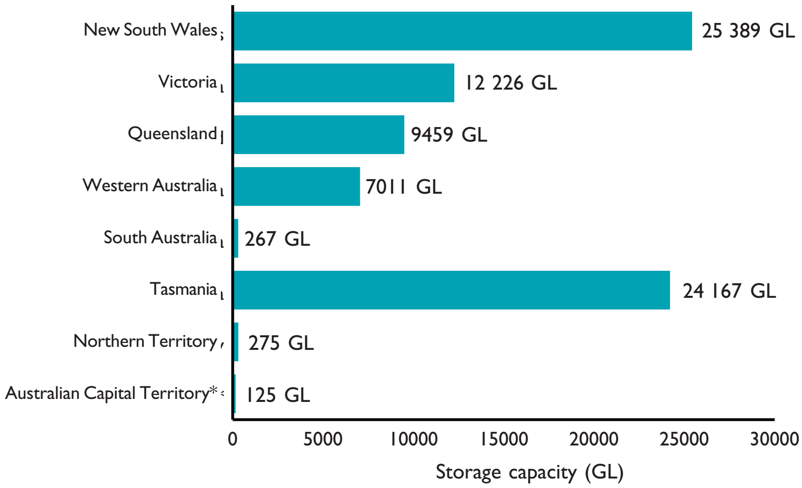
River flow is highly variable and driven largely by an irregular climate. Diversion of water into irrigation has significantly altered, and sometimes (e.g. mid-lower Murray–Darling Basin) led to the reversal of the annual river flow patterns (Figure 8).

Figure 8. Median monthly river flow at Albury (*An Audit of Water Use in the Murray–Darling Basin*, June 1995).



Australia has 447 large dams with a combined capacity of 79 000 GL of water (equivalent to 158 times the volume of Sydney Harbour) developed mainly for urban, irrigation and hydroelectric power users. Australia's several million farm dams account for an estimated 9% of the total water stored.

Figure 9. Storage capacity (GL) in large dams to 1990 (IEA 1999).



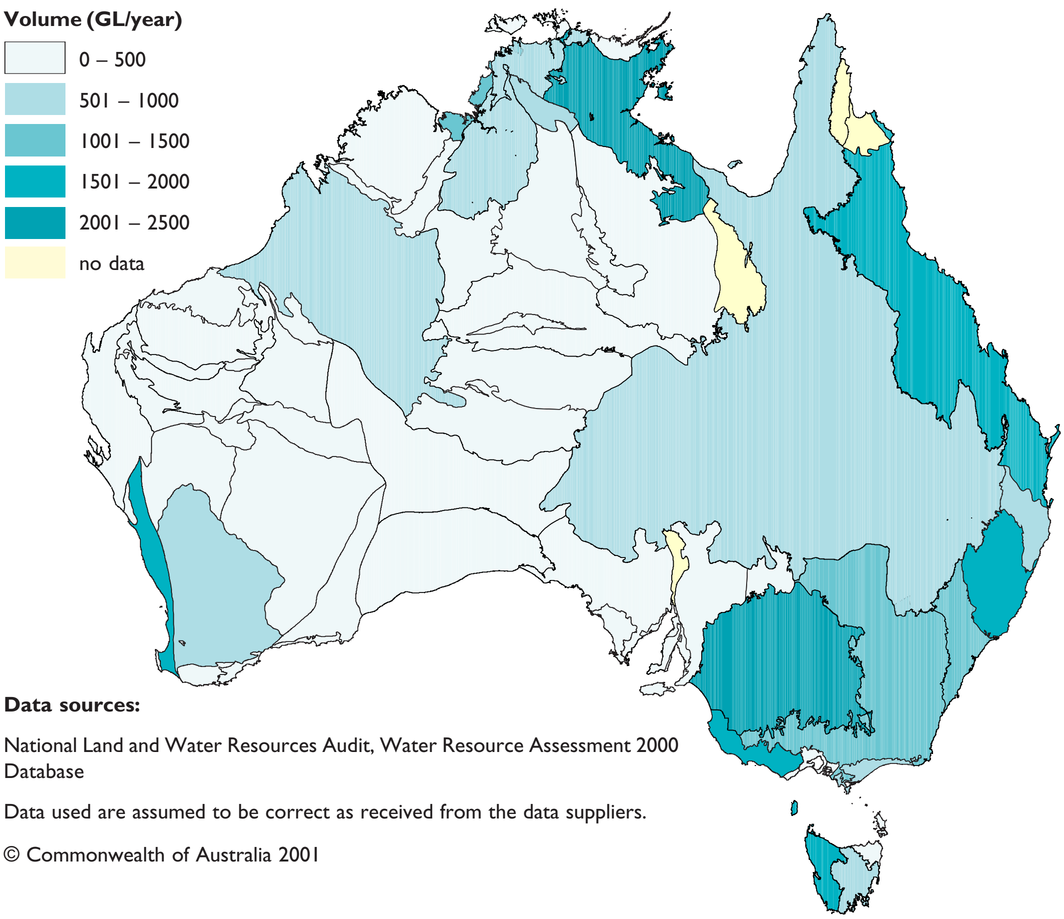
* Does not include Googong Dam (125 GL) which is an Australian Capital Territory-owned dam located in New South Wales.

Groundwater availability

Australia has 25 780 GL of groundwater that can be extracted sustainably each year and is suitable for potable*, stock and domestic use, and irrigated agriculture. Ten percent (2489 GL) is used. Groundwater's importance as a proportion of total use varies (e.g. in Western Australia groundwater use is twice surface water use; in New South Wales and Victoria, use is predominately from surface water).

Australia has one of the world's larger aquifer systems: the Great Artesian Basin is an estimated 1.7 million km^2 and stores 8 700 000 GL. Each year the Great Artesian Basin supplies 570 GL of water for a variety of uses—mainly grazing and mining.

Figure 10. Sustainable yield of groundwater provinces.



Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

* Potable water is measured at <1500 μS/cm (ANZECC 1992).

Achievements

- Overall, the characteristics of Australia's surface waters are well defined in all States and Territories.
- Groundwater resources are well characterised in some States (e.g. Western Australia). The definition of groundwater management units for Australia is a major advance undertaken as part of this assessment and provides a framework for improved groundwater management.

Blue–green algae proliferate where nutrient levels are high

WATER QUALITY

Water quality improved through coordinated catchment management

Surface water quality

Water quality affects industries as diverse as tourism, fishing and agriculture. Poor water quality heightens water treatment costs for domestic and commercial use, compromises the integrity of aquatic ecosystems and adversely impacts upon biodiversity. The National Eutrophication Management Program reports that freshwater algal blooms alone are costing the Australian community between $180 m and $240 m each year (LWRRDC 2000).

Water quality issues were present in most assessed basins. Turbidity and nutrients were identified as the most widespread water quality issues, followed by salinity and acidity/alkalinity. Better information on the nature and extent of existing water quality problems is fundamental to improving water quality management.

This part of Australian Water Resources Assessment 2000 was undertaken in partnership with the Australian State of the Environment Reporting section of Environment Australia and State and Territory agencies.

Measurement of surface water quality

Monitoring of surface water quality is undertaken to address a range of requirements including:

- protection of public health;
- protection of aquatic ecosystems;
- assessment of waterway condition;
- compliance with discharge licences;
- State of the Environment reporting;
- furthering scientific understanding of catchment processes; and
- identifying relationships between water quality and land management practices.

It has been estimated that Australia spends $142 – $168 m each year on water quality monitoring (ATECH, in press). This monitoring is undertaken by a range of groups and organisations including:

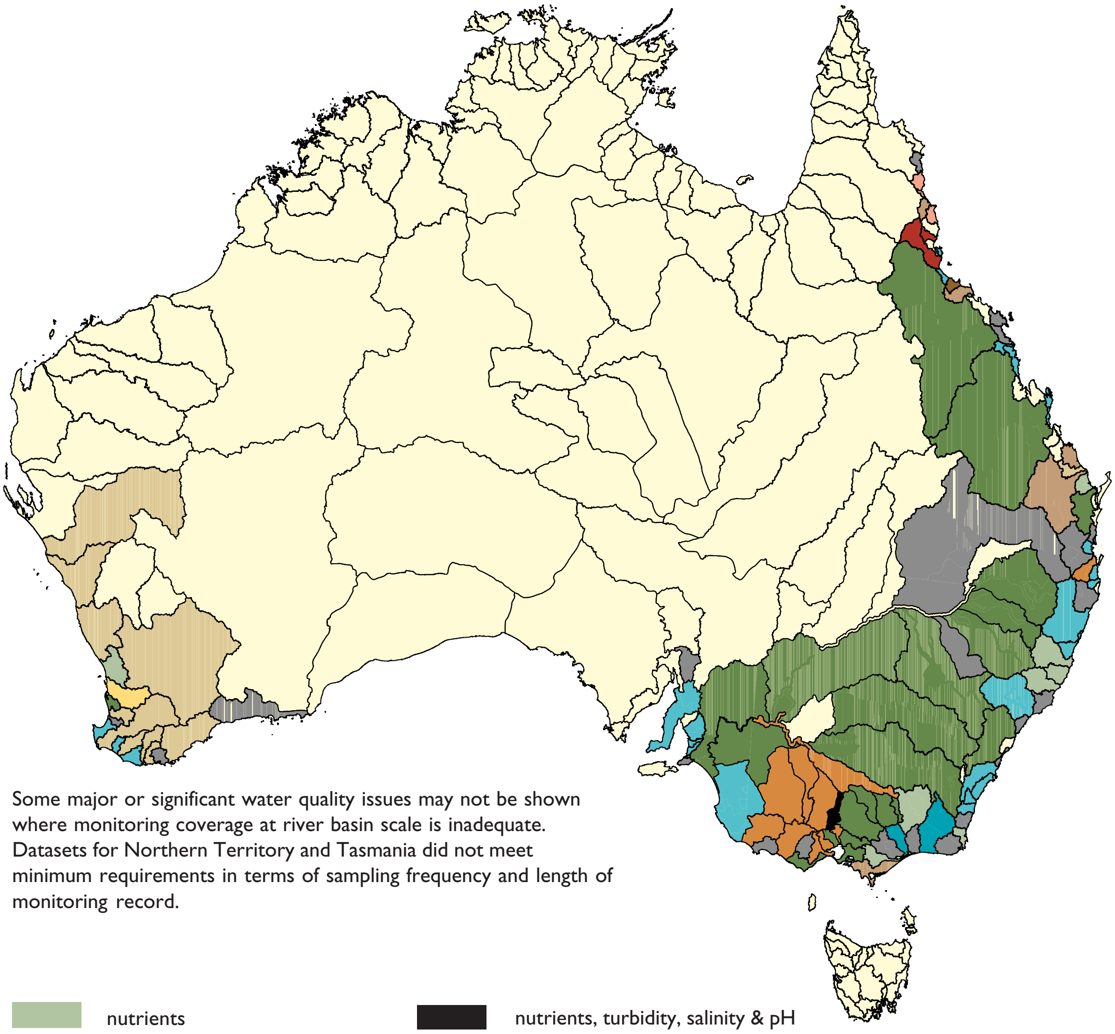
- Commonwealth/regional agencies (e.g. Murray–Darling Basin Commission, Great Barrier Reef Marine Park Authority);
- local and State government agencies involved in environmental monitoring and the regulation of pollution;
- government agencies or government-owned corporations involved in providing services to the community (e.g. water, sewage);
- private companies or organisations whose activities may cause water pollution, often as part of their discharge licensing requirements (e.g. mines, industrial plant operators);
- research groups including universities (e.g. CSIRO); and
- community groups (e.g. WaterWatch).

For the assessment of surface water quality guideline exceedances and trends, data have been provided by all the major State and Territory agency water quality monitoring programs. Data were not able to be obtained from other sources because:

- access to the data is limited by ownership issues;
- access is too costly because of poor database management;
- data are only relevant to a specific area of research interest or licence;
- data collection has involved non-standard procedures; or
- data are of poor quality.

Interpretation of water quality trend data nationally is constrained by the density of data coverage and their availability. Findings are skewed toward States with the most comprehensive monitoring coverage.

Figure 11. Water quality issues. Major water quality issues affecting more than 33% of the river basin.



Some major or significant water quality issues may not be shown where monitoring coverage at river basin scale is inadequate. Datasets for Northern Territory and Tasmania did not meet minimum requirements in terms of sampling frequency and length of monitoring record.

- nutrients
- turbidity
- salinity
- pH
- nutrients & salinity
- nutrients & turbidity
- turbidity & salinity
- turbidity & pH
- nutrients, turbidity & salinity
- nutrients, turbidity & pH
- nutrients, turbidity, salinity & pH
- significant issues (affect less than 33% of the basin)
- undetermined issues for all assessed variables
- good water quality
- no monitoring coverage/data not available

Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

Nutrients

Nutrients are a major water quality issue in 43 (61%) of the 70 assessed basins

Australia has a wide range of soil and vegetation types and climatic regimes affecting the natural nutrient status of surface water. State and Territory water quality guidelines reflect this natural variation, the pattern of land use in the catchment and the values of the water resources required to be protected.

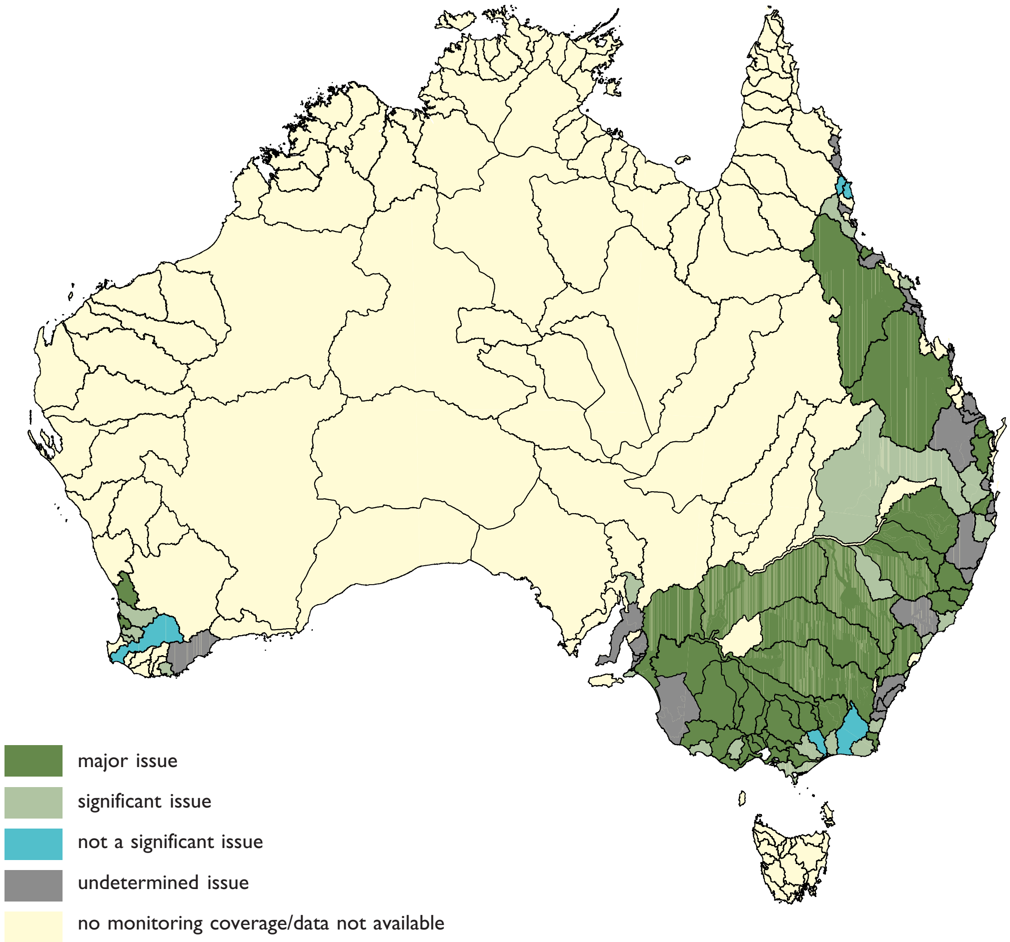
The national summary of exceedance of surface water nutrient guidelines indicates that widespread exceedances occur across Australia. They affect the majority of the more intensively developed basins in the North-East Coast, Murray–Darling, South-East Coast and South-West Coast Drainage Divisions. Basins assessed to have nutrient levels within guidelines are generally the relatively well-vegetated and less developed ones within areas such as north Queensland, north-eastern Victoria and south-western Western Australia.

The availability of data and intensity of monitoring coverage within individual river basins potentially underestimates the extent of nutrient exceedances as a *major* issue. Monitoring coverage for total nitrogen levels is more limited than that available for total phosphorus levels. Recognising the paucity of data to adequately characterise the nutrient exceedance and trend for Australia, the Audit has commissioned a series of projects that will provide information on the nutrient status of Australia's catchments, rivers and estuaries. These projects include:

- development of a full nutrient budget for Australia's intensively developed catchments;
- collaborative work with the Australian fertiliser industry to determine actual use and application rates for fertiliser on farm;
- further data collection and analysis for Australian estuaries; and
- assessment of nutrient impact on Australia's rivers and estuaries.

These projects will report in 2001 and build on the context provided by this assessment of water quality monitoring data.

Figure 12. Surface water quality 2000. Exceedance of nutrient guidelines.
Nutrient exceedances are based on total nitrogen and/or total phosphorus values.



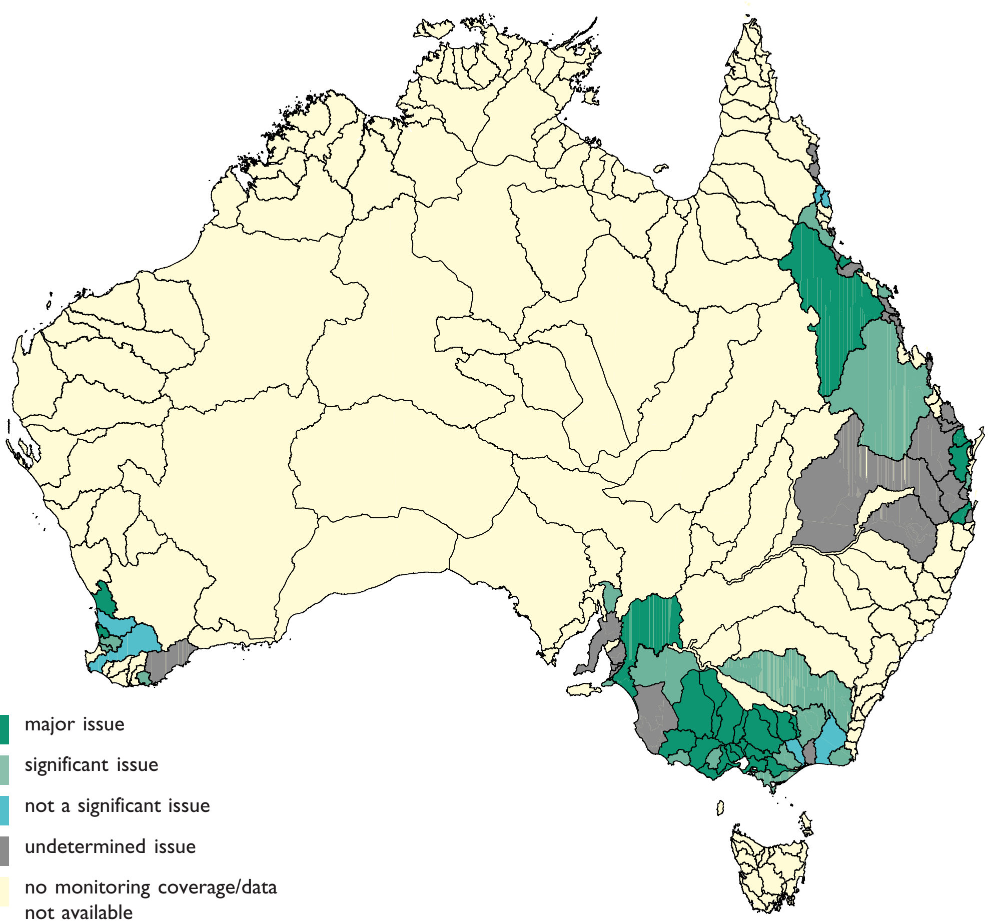
Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

Some major or significant water quality issues may not be shown where monitoring coverage at river basin scale is inadequate. Datasets for Northern Territory and Tasmania did not meet minimum requirements in terms of sampling frequency and length of monitoring record.

Figure 13. Surface water quality 2000. Exceedance of total nitrogen guidelines.



major issue
significant issue
not a significant issue
undetermined issue
no monitoring coverage/data not available

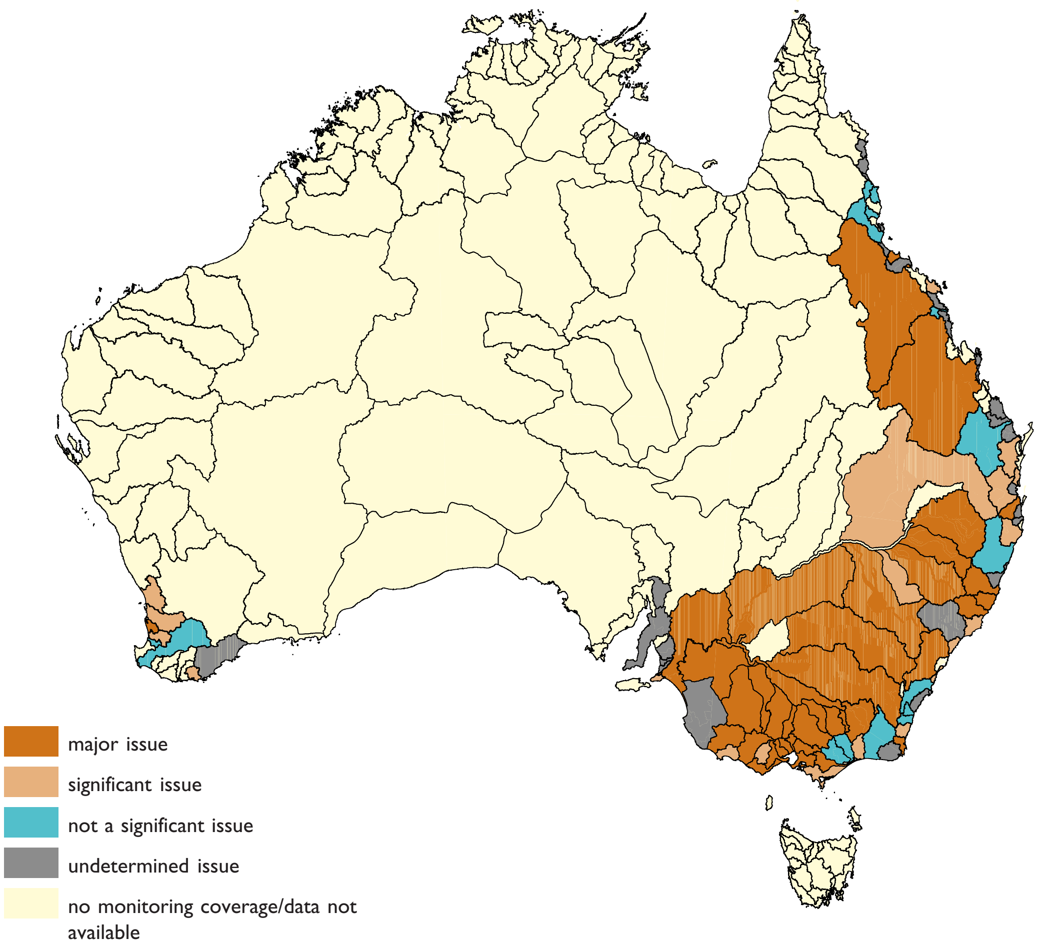
Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

Some major or significant water quality issues may not be shown where monitoring coverage at river basin scale is inadequate. Datasets for Northern Territory and Tasmania did not meet minimum requirements in terms of sampling frequency and length of monitoring record.

Figure 14. Surface water quality 2000. Exceedance of total phosphorus guidelines.



Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

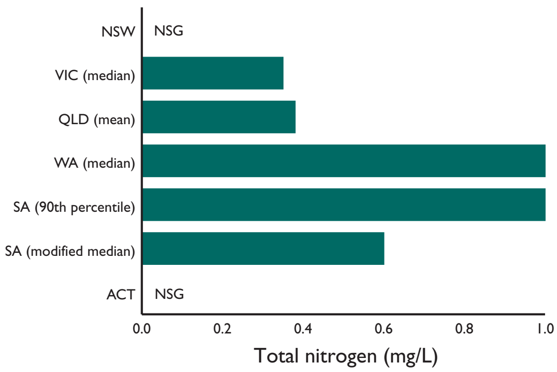
Data used are assumed to be correct as received from the data suppliers.

Some major or significant water quality issues may not be shown where monitoring coverage at river basin scale is inadequate. Datasets for Northern Territory and Tasmania did not meet minimum requirements in terms of sampling frequency and length of monitoring record.

Nutrient trend analyses were constrained by the availability of data. The available trend data suggests that:

- six of the basins with exceedances in the Murray–Darling Drainage Division had decreasing nutrient concentration trends, while two basins had increasing nutrient concentration trends;
- six affected basins within the southern Victorian section of the South-East Coast Drainage Division showed increasing nutrient concentration trends, and three basins showed decreasing nutrient concentration trends; and
- one basin in the North-East Coast Drainage Division (Tweed) also showed a clear increasing nutrient concentration trend.

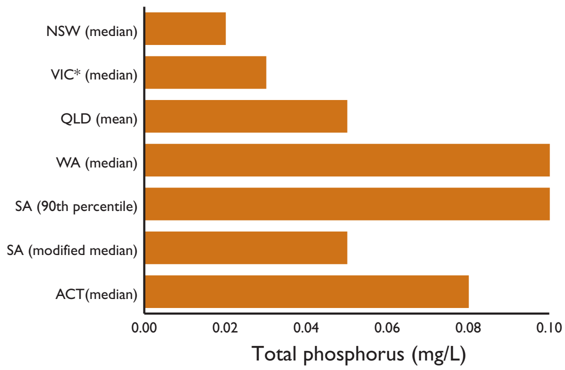
Figure 15. 'Good' quality surface water total nitrogen guidelines.



NSG No State/Territory guideline established. ANZECC (1992) guideline was used as the basis for the exceedance assessment. Refer to Table A6 in Appendix 5 for actual values.

Relative size of basin area, significance of measured values and influence of climatic variation complicate summation of trends. Trend data are best assessed by reference to basin scale reporting through the Australian Natural Resources Atlas.

Figure 16. 'Good' quality surface water total phosphorus guidelines.



* ANZECC (1992) guideline was used as the basis for the exceedance assessment.

Salinity: a major water quality issue across Australia

Salinity

Salinity is a major water quality issue in 24 (32%) of 74 assessed basins—particularly in the temperate South-West Coast, South-East Coast and southern Murray–Darling drainage divisions

Australia's climate and ancient weathered landscape result in naturally high stores of salt within a range of soil types. Consequently, there are relatively high 'natural' salinity levels in Australian surface waters. This is compounded by the increasing extent of groundwater rise from dryland and irrigation salinity processes as detailed in the Audit's report on dryland salinity. The State and Territory guidelines reflect these issues.

Salinity in surface water refers to salt concentration and should not be confused with salt load. Stream flow rates may dilute salt concentration so basins can export high salt loads while not exceeding surface water salinity guidelines. This is the case of some basins such as the Murrumbidgee, which exhibit good surface water salinity but export significant salt loads downstream (MDBMC 1999).

The analysis of exceedance of salinity guidelines indicates that salinity is an issue in much of temperate southern Australia and affects basins in the majority of the South-West Coast, the southern South-East Coast and southern Murray–Darling Drainage Divisions. Four basins in western New South Wales within the Murray–Darling Drainage Division, one east coast basin in the South Coast Drainage Division (Hawkesbury) and three basins in the South Australian Gulf also recorded major and significant salinity exceedances. Two tropical and several subtropical Queensland basins in the North–East Coast Drainage Division are also assessed to have basin scale salinity exceedances although the skewing of results by tidally influenced monitoring stations was likely for three of these basins.

Basins with no existing 'major' or 'significant' exceedance of salinity guidelines (see Figure 18 for State guideline thresholds) include:

- the majority of coastal basins within the North-East Coast and South-East Coast Drainage Division;
- many of the upper and lower basins within the Murray–Darling Drainage Division; and
- four near coastal basins within the South-West Coast Drainage Division.

The availability of data and the intensity of monitoring coverage limit comprehensiveness of this assessment. Salinity exceedances could also be expected to occur in some basins were there is insufficient monitoring coverage in the South Australian Gulf, the southern South-East Coast and the Murray–Darling Drainage Divisions as all these areas have significant occurrences of soil salinisation.

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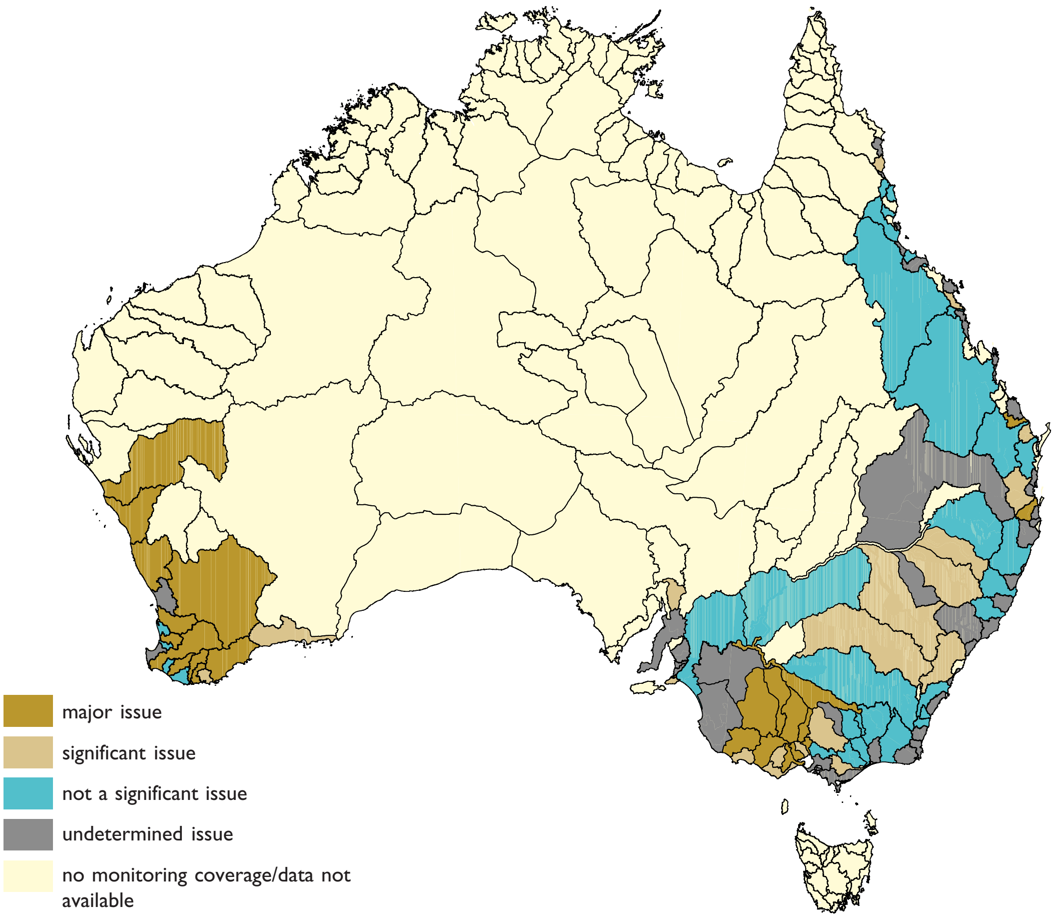
Figure 17. Surface water quality 2000. Exceedance of salinity guidelines.



Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

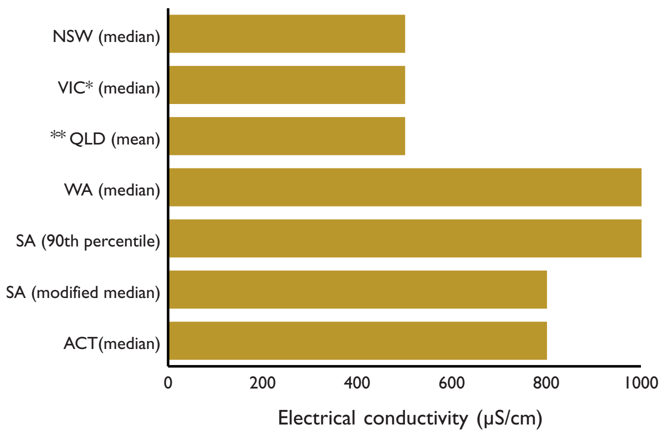
Some major or significant water quality issues may not be shown where monitoring coverage at river basin scale is inadequate. Datasets for Northern Territory and Tasmania did not meet minimum requirements in terms of sampling frequency and length of monitoring record.

Trend analyses were constrained by available data. Where available, data indicated both increasing and decreasing trends.

- Two affected basins in the South-East Drainage Division showed increasing trends while another two affected basins showed decreasing trends.
- In the North-East Coast Drainage Division, two basins where salinity is not yet recognised as a basin-scale exceedance issue—the Manning and the Burdekin—had increasing basin trends.
- Within the Murray–Darling Drainage Division at least four affected basins had decreasing trends while three affected basins had increasing trends. A basin not yet recording salinity exceedances (Lower Murray) and another with limited monitoring coverage (Mallee) also showed decreasing trends.

The *Murray–Darling Basin's Salinity Audit* (MDBMC 1999) predicts increased salinity for almost all river basins within the Murray–Darling Drainage Division through to 2020, 2050 and 2100. It is important to recognise that the trends identified in Australian Water Resource Assessment 2000 are based on observed river salinity values over the preceeding 8–10 year period. While such trend assessments are important for tracking changes in river salinity they have a limited capacity to predict future salinity values due to the non-linear nature of salinity trends which are driven by climate, water diversion patterns and complex interactions with groundwater levels and salt stores. In comparison the predictive method used in the Murray–Darling Basin Ministerial Council study (1999) incorporates modelling of groundwater rise and salt load mobilisation processes, and highlights the complexity of developing a predictive capacity for surface water quality.

Figure 18. 'Good' quality surface water salinity guidelines.



* Specific guidelines apply for some Victorian basins under State environment protection policies.

** Measured as total dissolved solids (mg/L).

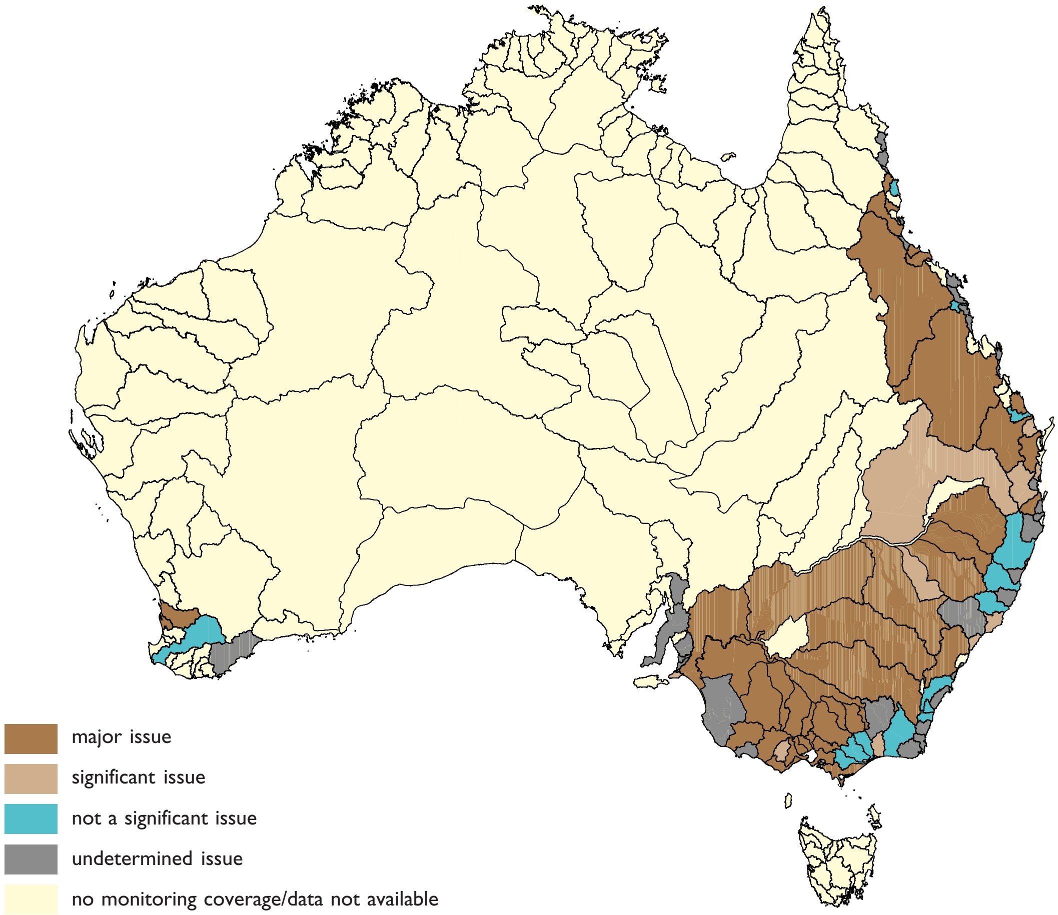
Turbidity

Turbidity is a major water quality issue in 41 (61%) of the 67 assessed basins.

Australia's variable rainfall and stream flow, and highly erodible soils and streambanks combine to create naturally high turbidity levels in surface waters. To varying degrees State and Territory exceedance guidelines reflect this natural variation, the land use pattern of the basins and the values for which the basins are being managed.

High turbidity levels are a widespread water quality issue in Australia. The affected areas included most inland and lower rainfall basins of the North-East Drainage Division, the majority of the Murray–Darling Drainage Division and the more intensively developed basins of the southern South-East Coast Drainage Division. For some basins, turbidity exceedances may reflect the use of guideline values which do not adequately recognise the naturally turbid conditions of their surface waters. Basins for which exceedance analyses indicated turbidity was not an issue included relatively well forested, less developed and higher rainfall coastal basins within the North-East Coast, South-East Coast and South-West Coast Drainage Divisions. The availability of data and the intensity of monitoring coverage within individual river basins limits this assessment. A lack of monitoring coverage in the Indian Ocean, Timor Sea, Gulf of Carpentaria and Lake Eyre Drainage Divisions limit the ability to assess potential turbidity issues that may be associated with extensive land uses.

Figure 19. Surface water quality 2000. Exceedance of turbidity guidelines.



Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

Some major or significant water quality issues may not be shown where monitoring coverage at river basin scale is inadequate. Datasets for Northern Territory and Tasmania did not meet minimum requirements in terms of sampling frequency and length of monitoring record.

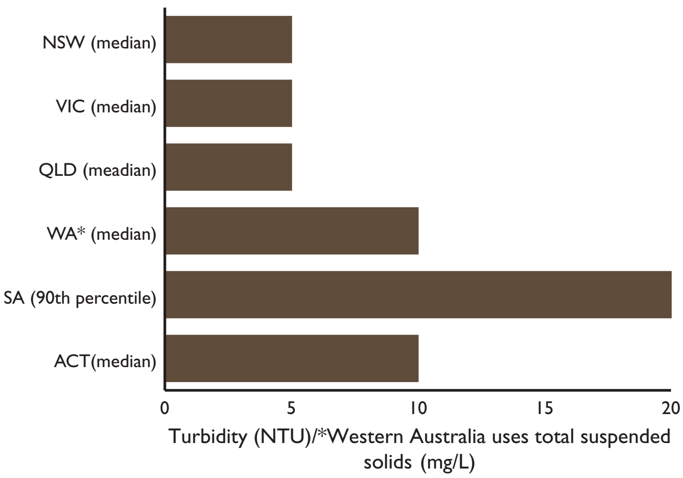
Recognising the limitations of the monitored data to accurately present the extent of turbidity and soil erosion across the Australian landscape, the Audit has commissioned a series of projects to better define these issues. This includes an assessment of water-borne soil erosion and sediment loads down rivers and estuaries, mapping of sediment types in estuaries, and an assessment of turbidity and sediments as key attributes for both river and estuary health. These projects will report in 2001.

Existing widespread exceedances and predominantly increasing trends suggest that turbidity is a worsening water quality issue for Australia. While constrained by data availability, the majority of trend analyses found increasing turbidity trends.

- In the Murray–Darling Drainage Division at least five affected basins had increasing trends while three affected basins had decreasing basin trends.
- In the South-East Coast Drainage Division at least two affected basins had increasing trends and one affected basin had decreasing trends.

Four basins with no recognised turbidity problems in the southern New South Wales section of the South-East Coast Drainage Division also showed increasing turbidity trends.

Figure 20. 'Good' quality surface water turbidity guidelines.



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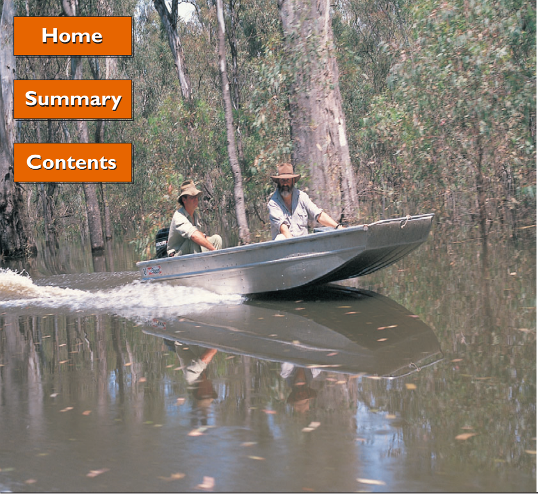

Water under these forests can be naturally acid

pH

pH is a major water quality issue in 7 (16%) of 43 assessed basins

The natural pH of Australian surface waters is highly variable and is driven by a range of factors including underlying geology, organic loading, flow characteristics and climate. State- and Territory-based water quality guidelines designate ranges for pH values and reflect some of this variability. Ranges are relatively consistent across the country. The monitoring coverage compiled for this variable was primarily limited to Queensland and Victoria. Problems are well documented but not necessarily well monitored in other basins (e.g. acid-drainage water quality problems have been detailed for a number of coastal New South Wales catchments [NSW EPA 1997]).

The areas with major pH exceedances included tropical Queensland coastal basins within the North-East Coast Drainage Division and the Campaspe basin within the southern Murray–Darling Drainage Division. Several other basins within the southern Murray–Darling Drainage Division and one each within the South-East Coast, South-West Coast and North-East Coast Drainage Divisions also exhibited significant exceedances of pH guideline.

Exceedances included both acidic and alkaline values, sometimes recorded from within the same basin. Many of the observed pH exceedances are located in coastal basins and may indicate natural floodplain conditions or the disturbance of in situ acid-sulfate soils. The exceedance characterisation of some coastal catchments may be biased by the catchment area weighting of lower basin floodplain/coastal monitoring sites.

Data to support trend analyses were limited to Victoria, Queensland and South Australia. In the Victorian section of the Murray–Darling Drainage Division, analyses identified increasing pH trends (increasing alkalinity) in one basin and decreasing pH trends (increasing acidity) in six basins, only one of which is recognised to have an existing pH exceedance water quality issue. In the South-East Coast Drainage Division, decreasing pH trends were identified in four basins and extensive increasing trends in three basins, all of which do not yet have recognised pH exceedance water quality issues. Two Queensland basins in the North-East Coast Drainage Division also exhibited pH trends—the Brisbane, more acid and the Fitzroy more alkaline. The predominance of decreasing pH (increasing acidity) trends within inland Victoria highlights a need for further investigation. Increasing acidity trends in non-coastal areas could be associated with land degradation processes (e.g. soil acidification) and may be indicative of an emerging surface water quality issue (Harris 2000).

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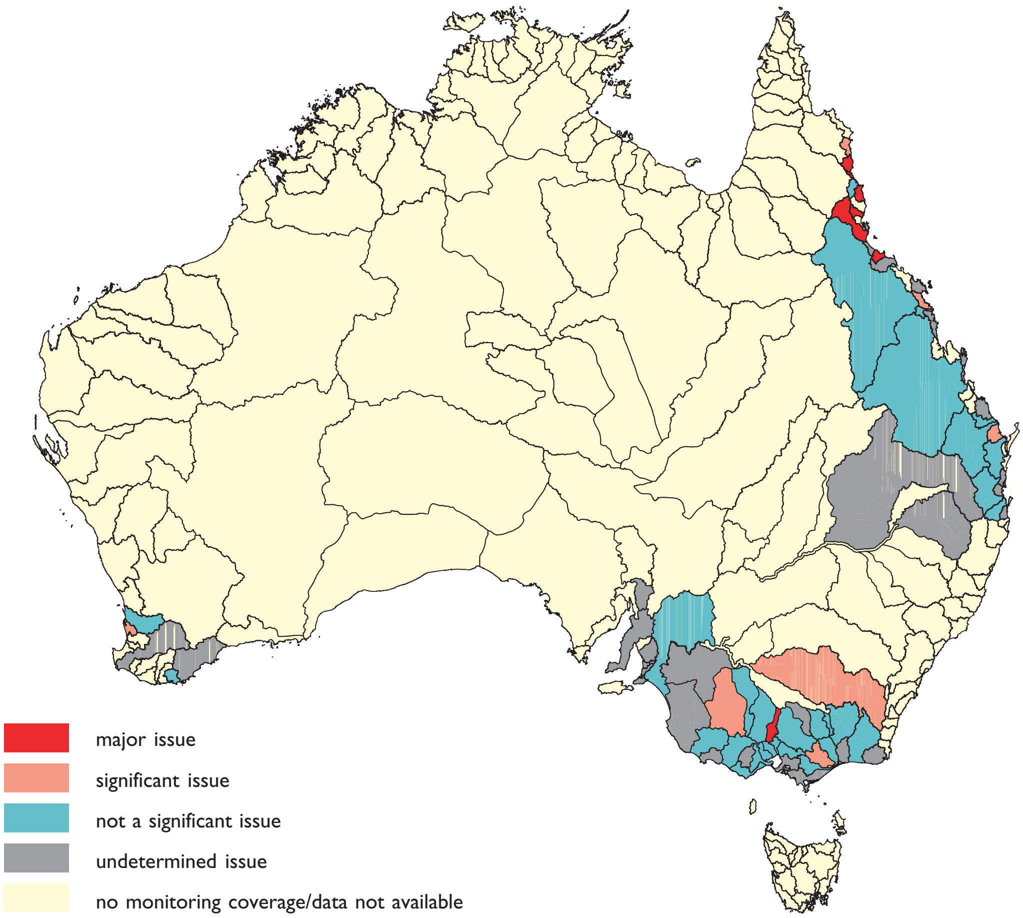
Figure 21. Surface water quality 2000. Exceedance of pH guidelines.



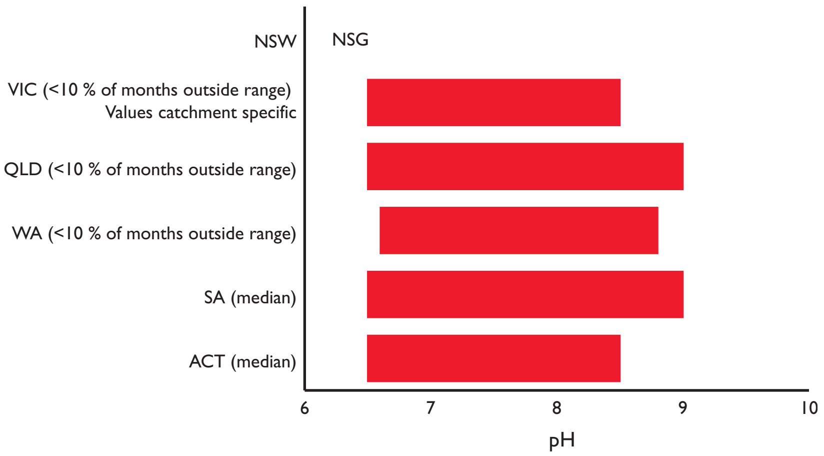
Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

Some major or significant water quality issues may not be shown where monitoring coverage at river basin scale is inadequate. Datasets for Northern Territory and Tasmania did not meet minimum requirements in terms of sampling frequency and length of monitoring record.

Figure 22. 'Good' quality surface water pH guidelines .



NSG No State/Territory guideline established. ANZECC (1992) guideline was used as the basis for the exceedance assessment. Refer to Table A6 in Appendix 5 for actual values.

Assessment of State surface water quality

The key water quality problems for Australia are summarised below. State by State detail follows.

Exceedances: Australia

Table 4. Exceedance of water quality guidelines for Australia (number of river basins).

	Major exceedances	Significant exceedances	Number of basins assessed
Nutrient: total nitrogen	19	19	50
Nutrient: total phosphorus	40	20	75
Salinity: electrical conductivity	24	18	74
Turbidity	41	10	67
pH	7	6	43

Table 5. Availability of trend data.

	Total phosphorus	Total nitrogen	Salinity	Turbidity	pH
New South Wales	Y	N	Y	Y	N
Victoria	Y	Y	Y	Y	Y
Queensland	N	N	Y	Y	Y
South Australia	Y	Y	Y	Y	Y
Western Australia	Y (limited)	Y (limited)	Y	N	N
Australian Capital Territory	Y	Y	Y	Y	Y

Exceedances: New South Wales

Table 6. Exceedance of water quality guidelines for New South Wales (number of river basins, total = 34).

	Major exceedances	Significant exceedances	Number of basins assessed
Nutrient: total nitrogen*	1	2	3
Nutrient: total phosphorus	16	7	27
Salinity: electrical conductivity	2	5	16
Turbidity	11	4	21
pH	0	2	2

Nutrient exceedances in New South Wales were assessed in terms of total phosphorus. They occurred in both inland and coastal regions. In the Murray–Darling Basin, nutrient exceedances often occurred with and would appear to be related to turbidity exceedances. Increasing trends in phosphorus were identified for a number of basins both coastal (Tweed, Macquarie–Tuggerah Lakes) and inland (Macquarie–Bogan). Decreasing phosphorus trends were observed for three inland basins (Murray–Riverina, Upper Murray, Namoi) and one coastal basin (Clarence).

Salinity exceedances were not widely recorded within New South Wales. Chronic exceedances were recorded within the Murray–Riverina basin and to a lesser extent within other Murray–Darling basins. Observed salinity trends are predominantly remaining steady or decreasing. Several of the Murray–Darling basins (Lachlan, Murray–Riverina, Namoi) showed decreasing salinity trends. Basins with increasing trends included the Manning Basin and the Horton River within the Gwydir Basin.

Turbidity exceedances are widespread throughout inland New South Wales. They include most basins within the Murray–Darling Drainage Division but are less prominent in coastal New South Wales with exceedances only being recorded in three basins (Hawkesbury, Macquarie–Tuggerah Lakes, Hunter). However inland rivers typically have finer sediments and often higher natural turbidity than coastal rivers. Increasing turbidity trends were observed for basins with existing turbidity exceedance issues (Macquarie–Bogan) and a number of southern coastal basins lacking existing turbidity problems (Clyde, Bega, Towamba). Two inland basins (Namoi, Gwydir) also showed decreasing turbidity trends. New South Wales trend analyses were based on a seven year record.

Very limited surface water acidity/alkalinity data were able to be compiled for New South Wales.

* ANZECC (1992) guideline was used for the exceedance assessment.

Exceedances: Victoria

Table 7. Exceedance of water quality guidelines for Victoria (number of river basins, total = 29).

	Major exceedances	Significant exceedances	Number of basins assessed
Nutrient: total nitrogen	17	6	25
Nutrient: total phosphorus	18	4	25
Salinity: electrical conductivity	8	6	21
Turbidity	17	2	23
pH	1	1	19

Water quality monitoring in Victoria is more intensive and has a greater coverage than in any other State. Water quality is generally 'fair' across the State with a majority of basins continually exceeding guideline values for turbidity, total nitrogen and phosphorus concentrations. Only two less developed basins in the east of the State (Snowy, Mitchell) did not record exceedances for both nitrogen and total phosphorus. Victorian nutrient exceedance guidelines are under review and may be relaxed for nitrogen levels to better reflect the variability of the surface waters. Nutrient trend analyses were limited by the length of available datasets but where available, tended to indicate decreasing total nitrogen trends for northern and eastern basins and increasing trends for a number of south coast basins (e.g. Hopkins, Tambo, South Gippsland). A mixture of up and downward trends was observed for total phosphorus. South coast basins (e.g. Portland coast, Hopkins, Otway, South Gippsland) showed upward trends while the Latrobe and the Maribyrnong showed downward trends.

A significant portion of the Victorian basins obtained poor exceedance results for salinity, including most western basins in the Murray–Darling and South-East Coast Drainage Divisions. Four of these basins also showed increasing salinity trends while basins in the central north and south (Maribyrnong, Barwon, Campaspe, Latrobe) showed decreasing trends in salinity.

Turbidity exceedances were widespread across Victoria with only eastern basins (Latrobe, Thomson, Mitchell, Snowy) showing good results. Turbidity trends indicated an increasing pattern in several basins within the Murray–Darling Drainage Division in the north and within the Maribyrnong and South Gippsland basins in the south of the State. Decreasing trends were observed in the Latrobe and Wimmera–Avon basins.

Only a few basins exhibited acidity/alkalinity guideline exceedances (e.g. Campaspe, Wimmera–Avon, Thomson). However strong state-wide trends for increasing acidity were recorded for most eastern basins while several central southern basins recorded increasing trends for alkalinity.

Exceedances: Queensland

Table 8. Exceedance of water quality guidelines for Queensland (number of river basins, total = 69).

	Major exceedances	Significant exceedances	Number of basins assessed
Nutrient: total nitrogen	5	4	11
Nutrient: total phosphorus	4	5	15
Salinity: electrical conductivity	2	4	16
Turbidity	11	4	18
pH	6	3	18

Turbidity and nutrients are the dominant water quality issues within Queensland. Most North-East Coast Drainage Division basins, particularly larger inland extending basins, recorded turbidity exceedances. Several smaller, relatively well vegetated coastal basins (e.g. Russell–Mulgrave, Johnstone, Pioneer) did not have turbidity exceedances. The distribution of nutrient exceedances, particularly total phosphorus, parallels turbidity. Basins without phosphorus exceedances included the Herbert, Tully, Pioneer and Burnett. Data for total nitrogen were less extensive but showed that some basins without exceedances for total phosphorus did have total nitrogen exceedances (e.g. Herbert). Insufficient data were available to assess nutrient concentration trends.

Queensland does not suffer the major salinity problems experienced in other States. However, trend results have identified that some basins are undergoing changes to the salinity regime, with the Burdekin and Condomine–Balonne both recording increasing salinity trends. The inclusion of lower basin tidally influenced sampling sites in the exceedance analyses is thought responsible for all basins that recorded salinity exceedances including the Daintree, O'Connell, Kolan, Burrum, Brisbane and Logan–Albert basins.

Acidity/alkalinity exceedances were recorded for a number of coastal Queensland basins. In several instances these included relatively undisturbed basins (Endeavour, Daintree), and may reflect the naturally acidic conditions of lowland floodplain surface waters. Other basins recording exceedances (Russell–Mulgrave, Tully, Herbert, Ross, O'Connell, Burrum) have relatively intensive floodplain development and modification. Acidity could be associated with disturbance of acid-sulfate soils.

With the exception of two sites in Oxley Creek in the Brisbane Basin, faecal coliforms are not routinely monitored in Queensland waterways.

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Exceedances: Western Australia

Table 9. Exceedance of water quality guidelines for Western Australia (number of river basins, total = 44).

	Major exceedances	Significant exceedances	Number of basins assessed
Nutrient: total nitrogen	2	3	7
Nutrient: total phosphorus	1	4	7
Salinity: electrical conductivity	11	2	17
Turbidity*	2	0	3
pH	0	1	3

* Measured as total suspended solids (mg/L).

Available nutrient data indicated that exceedances—both total phosphorus and total nitrogen—were significant water quality issues in most monitored basins. Only the Blackwood basin did not exceed guidelines for both total nitrogen and total phosphorus. The Preston basin reported exceedances for total nitrogen but not phosphorus, while the Murray basin did not exceed guidelines for total nitrogen but did for total phosphorus—possibly associated with its high turbidity status (phosphorus can be bound to suspended sediment). Trend data indicated increasing nutrient trends for the Denmark (total nitrogen), and for Murray and Harvey (total nitrogen and total phosphorus) basins. Small areas of decreasing trends were also observed for the Murray, Albany (total phosphorus) and Swan Coastal basins (total nitrogen and total phosphorus).

Salinity was identified as the most widespread surface water quality issue in Western Australia. This may partially reflect the limited data collected on other water quality variables. Except for some smaller coastal basins in the South-West Drainage Division (Harvey, Preston, Donnelly, Shannon) almost all basins—both inland and coastal—were affected by salinity. Trend data identified a relatively large number of basins with increasing salinity trends (Kent, Frankland, Warren, Busselton, Murray, Esperance, Shannon). Some parts of the Shannon basin recorded decreasing trends. The Preston also recorded decreasing salinity trends.

Turbidity data were available for analysis from only four basins. They indicated that the Murray and Harvey Basins had significant exceedances while the Blackwood basin did not.

pH data were also limited. Only one basin (Harvey) had recorded exceedances.

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Exceedances: South Australia

Table 10. Exceedance of water quality guidelines for South Australia (number of river basins, total = 21).

	Major exceedances	Significant exceedances	Number of basins assessed
Nutrient: total nitrogen	2	3	5
Nutrient: total phosphorus	3	1	4
Salinity: electrical conductivity	1	2	4
Turbidity	2	1	3
pH	0	0	1

Only a limited number of South Australian river basins have sufficient monitoring coverage to support basin water quality exceedance and trend assessments. Therefore some reference is made to monitoring station results.

The best basin monitoring coverage available was for nutrients and recorded total nitrogen and/or total phosphorus exceedances for the Lower Murray, Mallee, Myponga, Fleurieu Peninsula and Willochra Creek basins. Individual site nutrient exceedances were recorded from all monitored basins.

Significant and major salinity exceedances at a basin scale were recorded for the Myponga, Fleurieu Peninsula and Willochra Creek basins. However, salinity exceedances were recorded for monitoring stations from all basins indicating the widespread nature of salinity as a water quality issue in South Australia. Although tributaries of the Lower Murray Basin recorded large exceedances of salinity guidelines these tributaries occupy only a small area of the Lower Murray Basin. Trend analyses of observed salinity values for the Lower Murray Basin indicated a decreasing trend in salinity.

Basin turbidity exceedances were recorded for the Lower Murray, Mallee and Fleurieu Peninsula. Individual monitoring station exceedances were also recorded from the Broughton, Torrens and Millicent Coast basins. Trend data indicated increasing turbidity within the Mallee and Lower Murray basins.

Only the lower Murray had basin monitoring coverage for pH, which indicated no significant basin exceedances for this variable.

Exceedances: Australian Capital Territory

Table 11. Exceedance of water quality guidelines for the Australian Capital Territory (number of monitoring stations[1]).

	Major exceedances	Significant exceedances	Number of monitoring sites assessed
Nutrient: total nitrogen[2]	5	0	5
Nutrient: total phosphorus	0	5	5
Salinity: electrical conductivity	0	5	5
Turbidity	2	3	5
pH	0	5	5
Faecal coliforms	3	2	5

1 Results presented here are for individual monitoring stations because the Australian Capital Territory lies within one river basin (Murrumbidgee).

2 ANZECC (1992) guideline was used as the basis for the exceedance assessment.

Water quality within the Australian Capital Territory is generally within guideline values. Main exceptions are sites that have direct run-off from urban development, showing elevated total nitrogen, turbidity and faecal coliforms. Land use and development impacts are shown particularly in the Molonglo River sites. Total nitrogen values downstream of the Australian Capital Territory are high due to the discharge of treated waste water effluent high in nitrate.

Trend analyses for all attributes indicated an increasing trend in faecal coliforms in the Murrumbidgee River downstream of the Australian Capital Territory.

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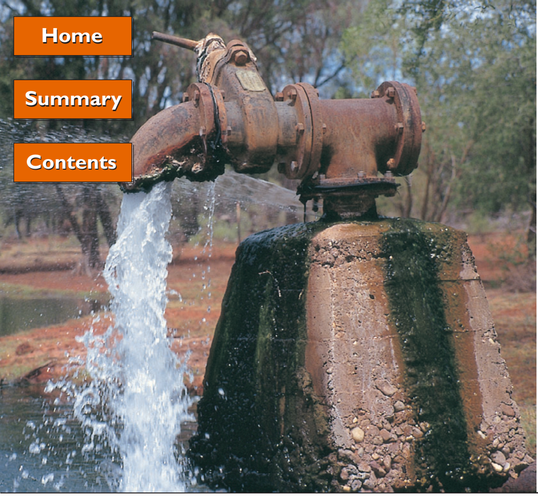


Groundwater quality: not easily accessible

Groundwater quality

Water quality data for groundwater are limited. A review of the salinity status of groundwater revealed that approximately 21 000 GL (72%) of Australia's readily accessible groundwater supply is suitable for drinking water*.

Figure 23. Proportion of groundwater sustainable yield (GL/year) by salinity status.

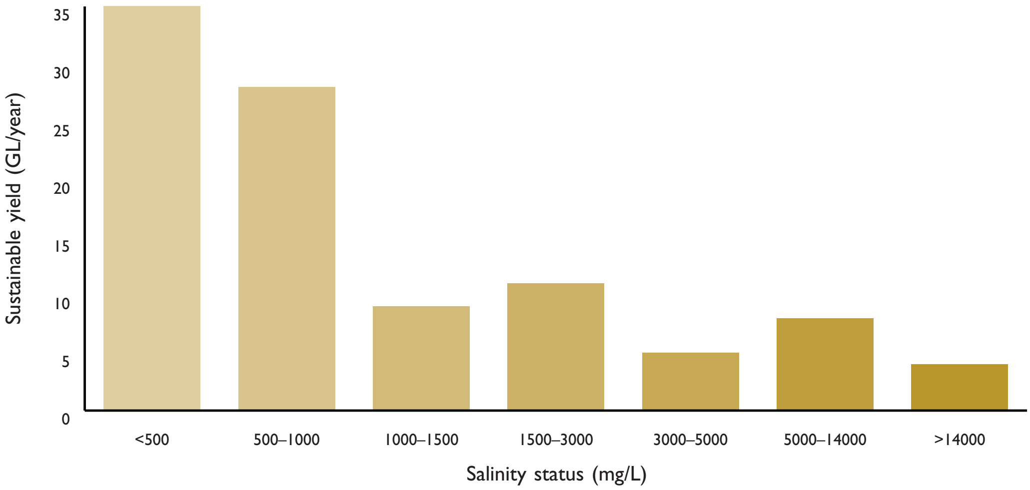


Table 12. Groundwater sustainable yield (GL) by salinity status (mg/L).

	<500	500–1000	1000–1500	1500–3000	3000–5000	5000–14000	>14000	Total
NSW	554	4 237	129	790	480	-	-	6 189
VIC	302	422	244	367	207	1 377	797	3 717
QLD	1 422	1 030	113	160	35	23	-	2 784
WA	514	1 162	1 150	1 500	766	841	371	6 304
SA	-	290	709	102	21	25	-	1 146
TAS	1 585	767	-	178	-	-	-	2 531
NT	5 785	186	324	141	5	-	-	6 441
ACT	103	-	-	-	-	-	-	103
Total	**10 264**	**8 094**	**2 670**	**3 238**	**1 515**	**2 266**	**1 168**	**29 215**
Percent of groundwater resource	35	28	9	11	5	8	4	100

* Potable water is measured at <1500 µS/cm (ANZECC 1992) compared with 800 µS/cm (World Health Organization). 1µS/cm is approximately 0.65mg/L.

Achievements in water quality management

Australia has:

- implemented a National Water Quality Management Strategy (ANZECC/ARMCANZ 1994);
- prepared National Water Quality Guidelines (ANZECC, in press);
- prepared National Guidelines for Water Quality Monitoring and Reporting (ANZECC, in press);
- initiated a National Action Plan for Salinity and Water Quality (Commonwealth Government 2000) providing a basis for coordinating water quality management activities in some key catchments;
- conducted an Australia-wide review of water monitoring to provide baseline information for improving monitoring activities (ATECH, in press); and
- reviewed water quality exceedances and trends (Australian Water Resources Assessment 2000).

WATER USE

An insight into opportunities for improved water resource management and development

Approximately 73% of the water used in Australia (~24 000 GL) is supplied by rivers, 21% by groundwater aquifers, and the remaining 9% by harvest of overland flows.

Surface water predominates in all States and Territories except Western Australia and the Northern Territory.

Figure 24. Proportion (%) of Australia's total mean annual water use by State/Territory (1996/97).

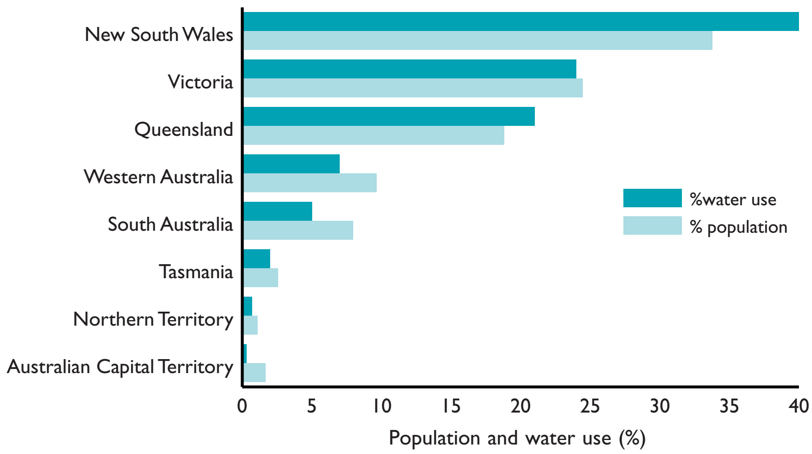


Table 13. Australia's mean annual water use (GL) by primary water source (1996/97).

	Total use surface water (GL)	Total use groundwater (GL)	Ratio of surface water to groundwater use
New South Wales	9 000	1 008	9.0
Victoria	5 166	622	8.3
Queensland	2 969	1 622	1.8
Western Australia	658	1 138	0.6
South Australia	746	419	1.8
Tasmania	451	20	22.6
Northern Territory	51	128	0.4
Australian Capital Territory	68	5	13.6
Total	**19 109**	**4 962**	**3.9**

Approximately 75% of Australia's water is used in irrigated agriculture. New South Wales (48%), Victoria (25%) and Queensland (16%) account for 90% of all irrigation across Australia. About 20% of total water use is for urban and industrial purposes, the remainder for other rural uses such as stock and domestic needs.

In a typical Australian household in 1996/97 each person used around 274 L/day. Gardening is responsible for up to half of this use; flushing toilets uses approximately a quarter. People in Asia, Africa and Latin America use 50–100 L/day; people in the USA use 400–500 L/day.

Table 14. Australia's mean annual water use (GL) by use category (1996/97).

	Irrigation	Urban/industrial	Rural	Total use[1]
New South Wales	8 643	1 060	305	10 008
Victoria	4 451	987	339	5 777
Queensland	2 978	1 052	561	4 591
Western Australia	710	1 027	59	1 796
South Australia	819	292	53	1 164
Tasmania	276	186	9	471
Northern Territory	53	87	39	179
Australian Capital Territory	5	63	4	72
Total	**17 935**	**4 754**	**1 369**	**24 058**[2]

1 Does not include in situ groundwater use.

2 Not all water use could be assigned to use categories.

On average, Australian water use increased by 65% between 1983/84 and 1996/97. This was mostly due to increases in irrigated agriculture. Urban centres have shown either low increases or net decreases in water consumption per person over the same period (AATSE 1999).

Urban water use per person in several State capitals declined over the 1990s mainly due to an increased awareness of the need to reduce water wastage and changes in water pricing. Much remains to be achieved, with changes to urban gardening practices and water efficiency in toilets being obvious opportunities for improvement. Industrial use is not large and is falling as industries become more water efficient, often coupled with increased emphasis on recycling or with efficiency gains in energy use as part of overall industry environmental responsibility (AATSE 1999).

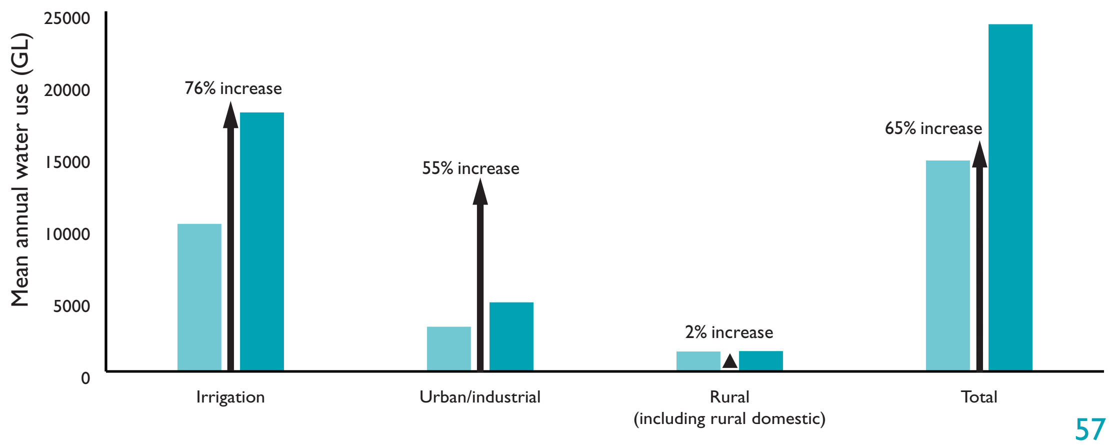
The change in 'rural' water use has been variable (Table 17). Decreases in some States indicated by this assessment supports the suggestion that

> *... rural domestic and stock water use has been declining in the pastoral zone and drier wheat–sheep areas. This is likely to have been due to rural population decline and destocking due to increased cropping in the agricultural areas and reduced carrying capacity of the natural pasture in semi-arid areas.*
>
> *Water and the Australian Economy* (AATSE 1999)

Table 15. Change in mean annual water use (GL) in Australia between 1983/84 and 1996/97 by water use category.

	1983/84	1996/97	Percent change in use
Irrigation	10 200	17 935	76
Urban/ Industrial	3 060	4 754	55
Rural (including rural domestic)	1 340	1 369	2
Total	**14 600**	**24 058**	**65**

Figure 25. Change in mean annual water use in Australia between 1983/84 and 1996/97.



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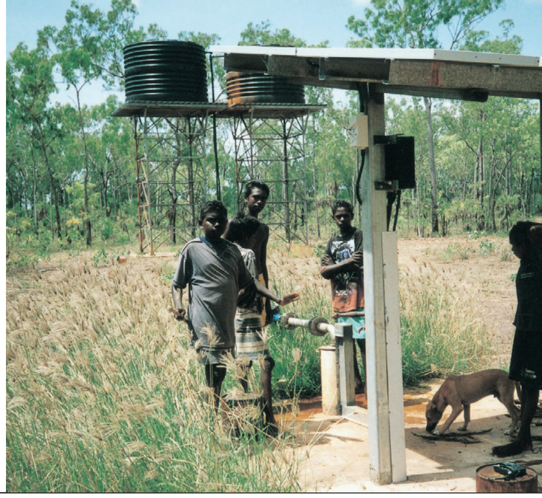

Table 16. Change in total mean annual water use (GL) between 1983/84 and 1996/97 by State/Territory.

	Total use 1983/84 (GL)	Total use 1996/97 (GL)	Percent increase in total water use
New South Wales	6 250	10 008	60
Victoria	3 920	5 788	48
Queensland	2 330	4 591	97
Western Australia	834	1 796	115
South Australia	1 040	1 165	12
Tasmania	174	471	171
Northern Territory	94	179	90
Australian Capital Territory	n/a	73	-
Total	**14 642**	**24 071**	**65**

Table 17. Comparison of Australia's total mean annual water use (GL) between 1983/84 and 1996/97 by water use category and State/Territory.

	Water use 1983/84 (GL)			Water use 1996/97 (GL)		
	Irrigation	Urban/industrial	Rural	Irrigation	Urban/industrial	Rural
New South Wales	4 910	953	391	8 643	1 060	305
Victoria	2 960	671	289	4 451	987	339
Queensland	1 200	628	503	2 978	1 052	561
Western Australia	338	447	49	710	1 027	59
South Australia	722	243	70	819	292	53
Tasmania	97	66	11	276	186	9
Northern Territory	11	55	28	53	87	39
Australian Capital Territory	n/a	n/a	n/a	5	63	4
Total	**10 238**	**3 063**	**1 341**	**17 935**	**4 754**	**1 369**

n/a Not available, included in New South Wales figures.

States and Territories have put water allocation systems in place. Entitlements ensure security and reliability of supply. Trading maximises the value of water that is provided and water can be moved to high value uses.

Catchments across Australia are at differing levels of water resource development and use. In parallel with the need to move towards full volumetric allocations is the need to track allocations by use type. As a minimum, for those water resource systems where total extractive use is approaching sustainable limits and water quality thresholds, metering and water quantity management need to be implemented.

Australia wide, the Audit's assessment of water use of approximately 24 000 GL per year generally agrees with the *Water Account for Australia* (ABS 2000) of 22 200 GL per year. The Audit's assessment differed from the Water Account for Australia in several ways. The Audit:

- was focused primarily on rural Australia and did not attempt to partition water use within urban centres;
- aimed to gain a geographic understanding of water use and how this related to water licensing, environmental water provisions and to specific surface water and groundwater sources;
- did not attempt to extrapolate or model water use; and
- aimed to compare water use in the later 1990s with *Water Review 85* (DPIE 1987).

Water use estimates for *Australian Water Resources Assessment 2000* have been derived by a number of different methods including the water use for water authorities (information provided with provider consent as part of the Australian Bureau of Statistics *Water Account for Australia*) and from other information gathered from the State and Territory water agencies. In some cases where water use information was not available, estimates were based on allocation (licences). In other cases an estimate of total water use was provided at State level only (e.g. New South Wales could not provide detailed water use data for unregulated surface water systems).

Adjustments have been made by State experts to take account of water diverted directly off stream and held in off-stream storages. A lack of water use monitoring in Australia, particularly in the rural and agriculture sectors, reduces our ability to assess the accuracy of these estimates.

Table 18. Water use categories used in Australian Water Resources Assessment 2000.

Summary (Level 1) water use categories	Detailed (Level 2) water use categories
Urban/industrial	Domestic
	Industrial
	Mining and minerals
	Power generation
	Commercial
	System losses
	Other
Irrigation	Pasture
	Cereal
	Other crops
	Vegetables
	Fruit
	Grapes
	System losses
	Sugar cane
	Other
Rural	Stock and domestic
	System losses
In situ	Environmental needs
	Other

To enable and facilitate water trading, changes in water allocation and definition of rights to water, use monitoring is important. Water use monitoring will also provide information for managers to track and to evaluate the effectiveness of allocation policies particularly in relation to highly and over-committed resources. Targeted monitoring of water use is an important component of water resource management as Australia seeks to maximise economic and ecological benefits from its water resources.

The detailed knowledge of the end use of the water is poorly recorded. Obtaining use data was one of the most challenging tasks of this assessment; 31% of surface water management areas and 30% of groundwater management units have no recorded use data. Only 52% of surface water and 56% of groundwater management units have water use data broken down to the detailed water use categories.

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Surface water use

- Surface water use across Australian States and Territories has increased to 20 300 GL with an overall 69% increase Australia-wide since 1983/84. The greater percentage increases were in Tasmania (173%) and Queensland (145%). By volume, New South Wales had the largest increase in water use by about 3000 GL.
- Surface water use represents 83% of the total water used.

Figure 26. Change in mean annual surface water use (GL) between 1983/84 and 1996/97.

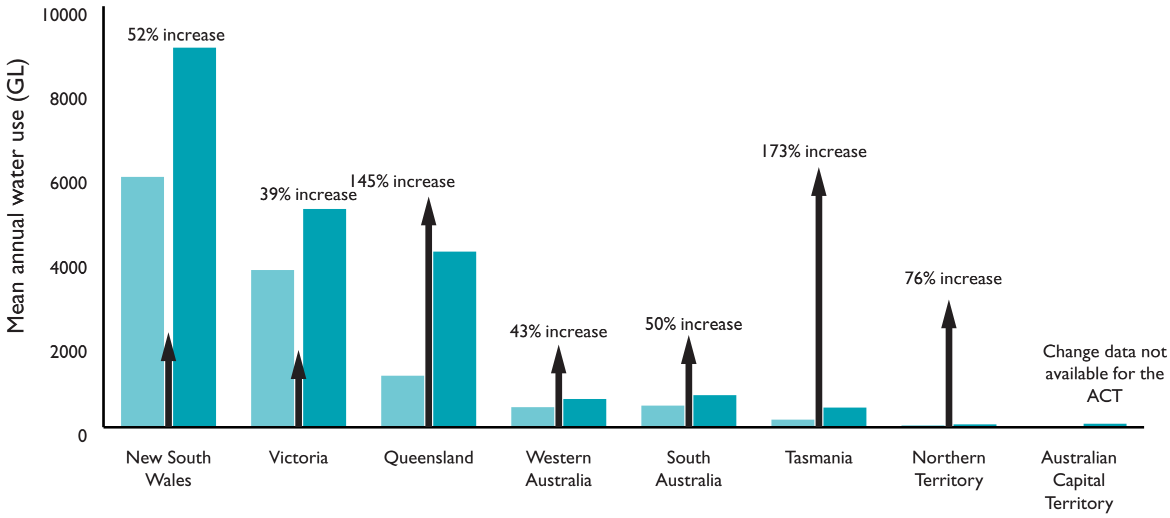
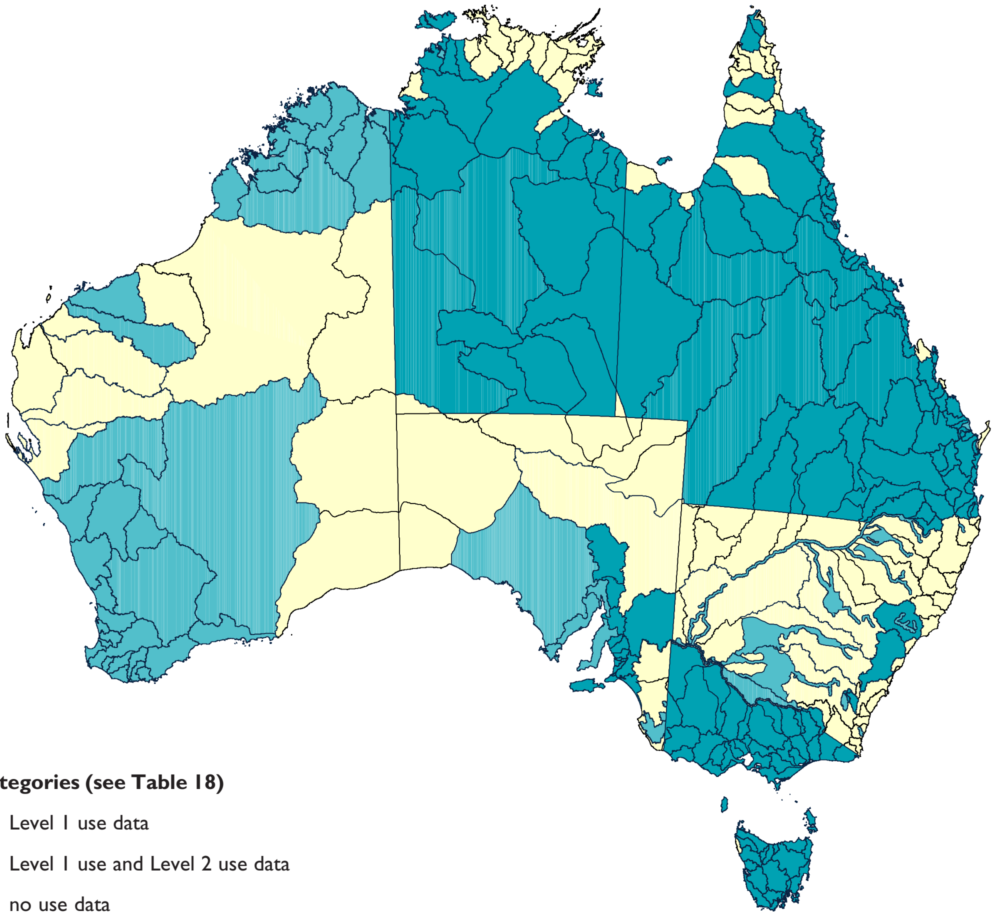


Table 19. Change in mean annual surface water use (GL) between 1983/84 and 1996/97.

	Total use 1983/84 surface water (GL)	Total use 1996/97 surface water (GL)	Percent increase in surface water use
New South Wales	5 932	9 000	52
Victoria	3 714	5 166	39
Queensland	1 209	2 969	145
Western Australia	461	658	43
South Australia	498	746	50
Tasmania	165	451	173
Northern Territory	29	51	76
Australian Capital Territory	n/a	68	-
Total	**12 008**	**19 109**	**59**

Figure 27. Availability of Level 1 and Level 2 surface water use data.



Use categories (see Table 18)

- Level 1 use data
- Level 1 use and Level 2 use data
- no use data

Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

Table 20. Availability of surface water use data (number of surface water management areas).

	Summary (Level 1) water use data	Detailed (Level 2) water use data	Total number of surface water management areas
New South Wales	12	0	54
Victoria	31	30	32
Queensland	81	80	99
Western Australia	34	0	44
South Australia	19	14	34
Tasmania	18	18	19
Northern Territory	27	25	40
Australian Capital Territory	3	2	3
Total	**225**	**169**	**325**

Table 21. Mean annual surface water use (GL) by summary (Level 1) use categories.

	Irrigation	Urban/industrial	Rural	Total
New South Wales	8 000	900	100	**9 000**
Victoria	4 021	860	285	**5 166**
Queensland	2 162	787	20	**2 969**
Western Australia	430	206	22	**658**
South Australia	465	269	12	**746**
Tasmania	266	179	5	**450**
Northern Territory	6	39	6	**51**
Australian Capital Territory	4	63	1	**68**
Total	**15 354**	**3 303**	**451**	**19 109**

Groundwater use

- Groundwater use across Australia's States and Territories has increased 88% from 2600 GL to 5000 GL since 1983/84. In percentage terms, in some States, the increase in groundwater use is much higher—being about 200% for New South Wales, Victoria and Western Australia. In volume terms, Western Australia increased groundwater use by almost 800 GL followed by New South Wales with a 690 GL increase.
- Groundwater use information is very limited in availability and reliability. A reliable estimate of groundwater use cannot be determined relative to the total groundwater allocated. Only 14% of groundwater management units have some or all water use metered. Some level of detail on water use is available for 286 or 56% of Australia's groundwater management units.
- Despite the lack of objective information, water resource managers generally contend that use far exceeds licenced allocation.

Figure 28. Change in mean annual groundwater use (GL) between 1983/84 and 1996/97.

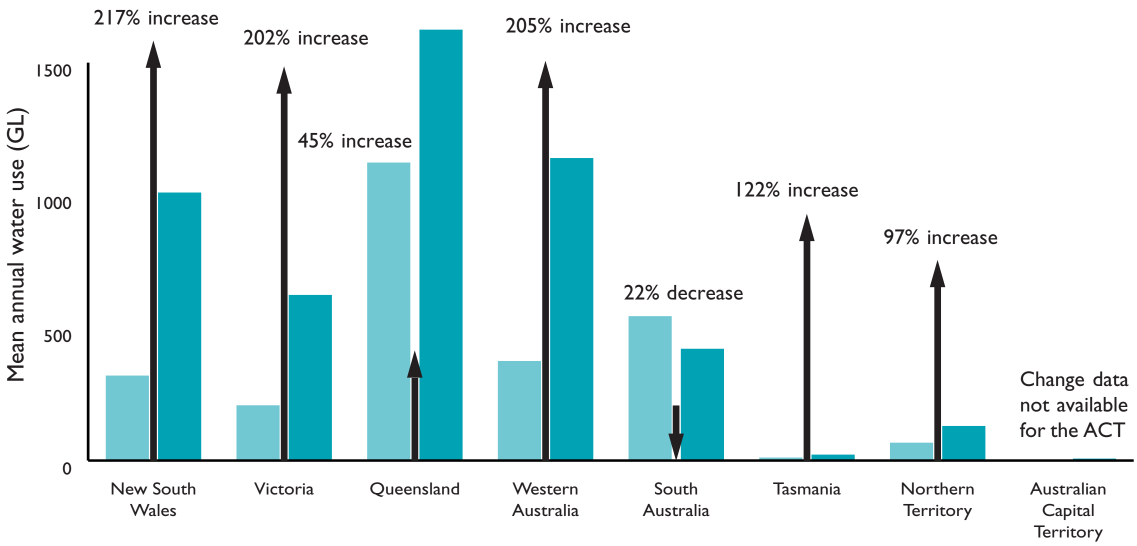


Table 22. Change in mean annual groundwater use (GL) between 1983/84 and 1996/97.

	Total use 1983/84 groundwater (GL)	Total use 1996/97 groundwater (GL)	Percent change in groundwater use 1983/84 – 1996/97
New South Wales	318	1 008	217
Victoria	206	622	202
Queensland	1 121	1 622	45
Western Australia	373	1 138	205
South Australia	542	419	-22
Tasmania	9	20	122
Northern Territory	65	128	97
Australian Capital Territory	n/a	5	-
Total	**2 634**	**4 962**	**88**

Table 23. Mean annual groundwater use (GL) by summary (Level 1) use categories.

	Irrigation	Urban/Industrial	Rural	In situ	Total
New South Wales	643	160	205	0	1 008
Victoria	431	127	54	10	622
Queensland	816	265	541	0	1622
Western Australia	280	821	37	0	1 138
South Australia	354	23	42	24*	419*
Tasmania	9	7	4	0	20
Northern Territory	47	48	33	0	128
Australian Capital Territory	2	0	3	0	5
Total	**2 582**	**1 451**	**919**	**34**	**4 962**

* South Australia in situ: not an extractive use and therefore not included in total water use figure.

Table 24. Availability of groundwater use data (number of groundwater management units).

	Summary (Level 1) water use data	Detailed (Level 2) water use data	Total
New South Wales	49	41	53
Victoria	70	65	79
Queensland	46	21	103
Western Australia	134	133	174
South Australia	9	7	53
Tasmania	17	16	17
Northern Territory	49	3	55
Australian Capital Territory	3	0	3
Total	**377**	**286**	**535**

Table 25. Metering of water use within groundwater management units[1].

	Not determined	No	Yes	Total
New South Wales	-	39	11	53
Victoria	8	66	5	79
Queensland	28	57	22	103
Western Australia	40	134[2]	-	174
South Australia	15	27	11	53
Tasmania	-	17	-	17
Northern Territory	2	26	27	55
Australian Capital Territory	-	3	-	3
Total	**93**	**369**	**76**	**535**

1 Metering of water use may be limited to specific use types (e.g. urban supply). Hence the use of metering within a groundwater management unit should not be inferred to apply to all water use.

2 Allocations >0.5ML/year require meters.

Return on water use

- The gross value from irrigated agriculture for 1996/97 was $7254 m.
- The highest financial return in agriculture per hectare of irrigation comes from vegetables, closely followed by fruit. Financial return on net water use is similarly highest for vegetables followed by fruit.

Table 26. Water use and gross value for irrigated agriculture (1996/97) (modified after ABS *Water Account for Australia* 2000).

	Gross value ($m)	**Net water use** (GL)	**Irrigated area** (ha)	**Value/ha** $/ha	**Value/GL** $m/GL
Livestock, pasture, grains and other agriculture	2 540	8 795	1 174 687	2 162	0.3
Vegetables	1 119	635	88 782	12 604	1.8
Sugar	517	1 236	173 224	2 985	0.4
Fruit	1 027	704	82 316	12 476	1.5
Grapes	613	649	70 248	8 726	0.9
Cotton	1 128	1 841	314 957	3 581	0.6
Rice	310	1 643	152 367	2 035	0.2
Total	**7 254**	**15 503**	**2 056 581**		

Achievements

Important achievements in Australian water use documentation include:

- The ABS Water Account Project is a compilation of data from a range of sources. It details water supply and use for each State and Territory. The Australian Bureau of Statistics released the results in May 2000.
- Australian Water Resources Assessment 2000 further defines water use by surface water management areas and groundwater management units. It links use to allocation and licensing arrangements.

ACHIEVING SUSTAINABLE MANAGEMENT

Setting and achieving sustainable water management for Australia's surface and groundwater resources

The social and economic benefit of Australia's water resource development has come at a cost to the environment. Water management policies are evolving rapidly and recognise the need to manage systems to also provide for environmental water.

Surface water management

Surface water management is entering a mature phase: economic efficiency, management of the entire resource, equity, and environmentally sustainable practices are key concepts being addressed by Australia's surface water managers.

Key environmental considerations for improved surface water management are:

Maintenance of environmental flows or water regimes to support in-stream, riparian and floodplain processes, and contribute to biodiversity (e.g. fish breeding, waterfowl habitat and food, triggers for prawn movement in estuaries).

Provision of flushing and dilution flows. This is particularly important in regulated systems, where the natural regime has been substantially altered and the downstream effects of land uses lead to potential water quality problems. Flushing and dilution flows can ensure water quality goals are met (e.g. salinity) and also reduce the release of nutrients—consequently reducing the risk of toxic algal blooms (e.g. blue–green algae blooms).

Conservation of key biodiversity values. Management actions to protect significant in-stream values and biota may need to occur before any decision is made to develop water resources.

Water resource development is approaching or has exceeded extraction limits in the southern States—especially Victoria, New South Wales and South Australia. Development opportunities in south-eastern Australia have shifted from the development of infrastructure to improving water use efficiency. This entails development of more efficient water delivery systems, improving infrastructure and methods of water use, gains through water use efficiency technologies and water trade. There is significant potential for efficiency gains in use within the agricultural sector, particularly through moving to more efficient methods of application such as trickle irrigation and minimising supply system losses to evaporation or seepage. On average only 77% (values range from 41% to 100%) of water diverted for use is delivered to the customer.

Assessment of progress in sustainable surface water management

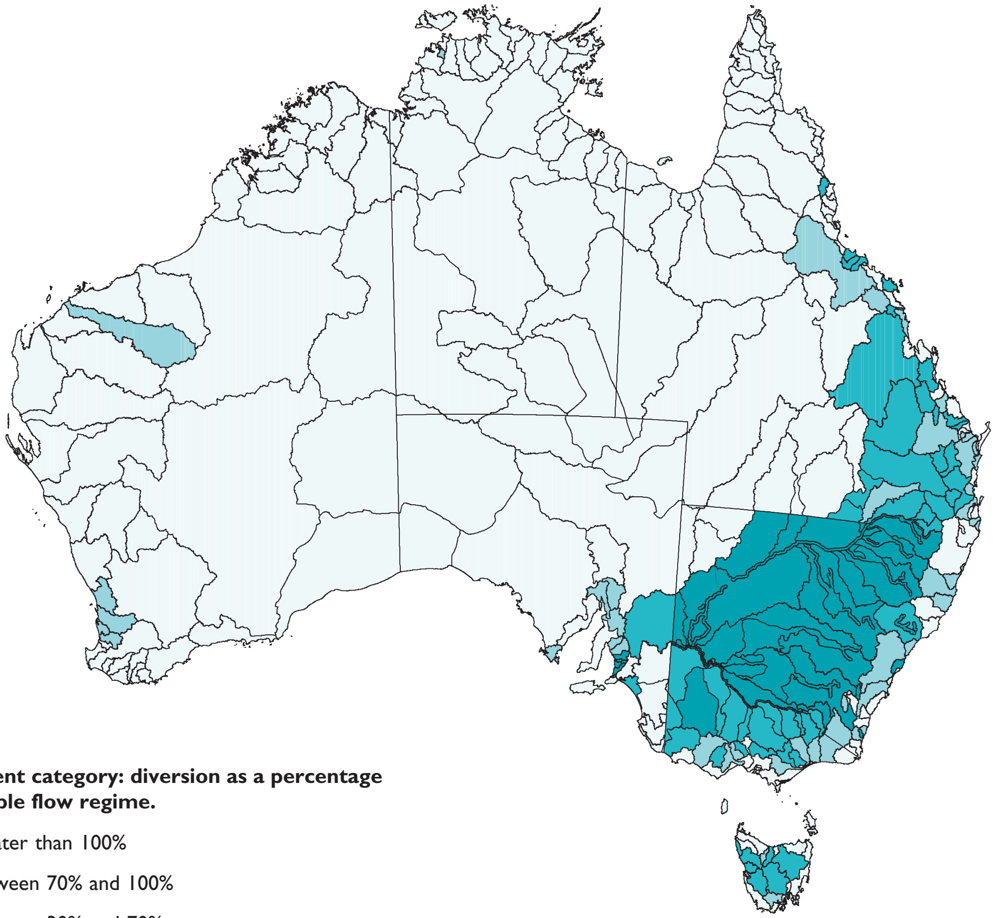
All States and Territories have established definitions and differing methods to determine sustainable flow regimes for surface water (Appendix 3). Methods recognise the variability of water resources and ecosystems across Australia but are limited in their application by an inadequate knowledge of ecological requirements.

Assessment of progress based on State methods as part of this Audit revealed:

- Thirty-four (10.5%) of Australia's 325 surface water basins are recognised as over-utilised (Appendix 1).
- Forty-three (13.2%) of Australia's 325 basins have been reported to have formal allocations for the environment. The benefits of these allocations to the environment will be assessed over time by monitoring improvements in the ecological health of these systems.

This assessment is based on the methods detailed in Appendix 3.

Figure 29. Surface water management areas. Level of surface water resource commitment (2000).



Development category: diversion as a percentage of sustainable flow regime.

- greater than 100%
- between 70% and 100%
- between 30% and 70%
- less than 30%

Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

Table 27. Surface water management areas in each nominated diversion development category.

	Number of surface water management areas	Percent of total number of surface water management areas
Low development: less than 30% of nominated sustainable flow regime	195	60
Moderate development: between 30% and 70% of nominated sustainable flow regime	46	14
Highly developed: between 70% and 100% of nominated sustainable flow regime	50	15
Overdeveloped: more than 100% of nominated sustainable flow regime	34	11

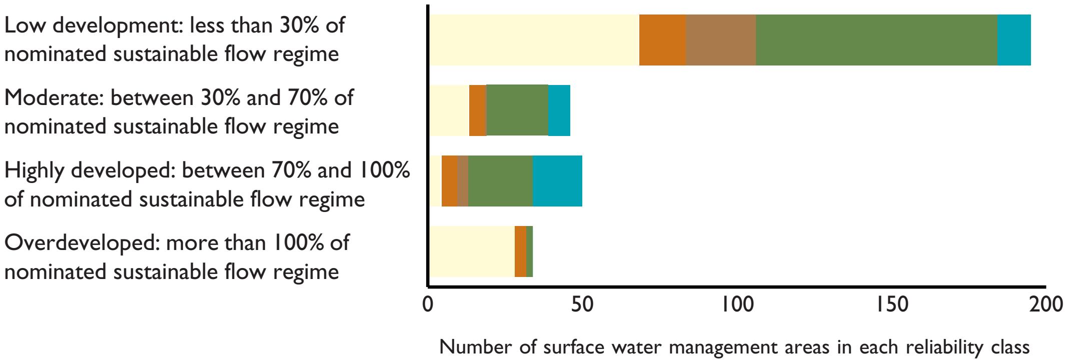
Table 28. Environmental flow allocations for surface water management areas as at June 2000.

	Undetermined	No formal allocation	Less than 33%[1] with formal allocation	Less than 67%[1] with formal allocation	Total
New South Wales	-	45	-	9	54
Victoria	2[2]	-	30	-	32
Queensland	-	99	-	-	99
Western Australia	-	42	-	2	44
South Australia	-	34	-	-	34
Tasmania	19	-	-	-	19
Northern Territory	-	40	-	-	40
Australian Capital Territory	1	-	-	2	3
Total	**22**	**260**	**30**	**13**	**325**

1 Percent of sub-catchments within the surface management area.

2 Surface water use is negligible—environmental flow allocations are therefore not applicable.

Figure 30. Surface water management areas in each diversion development category by reliability class (see Appendix 1).



Reliability class

Class A	Based mainly on reliable recorded and surveyed data and detailed storage analysis.
Class B	Based on approximate hydrologic analysis and limited surveys.
Class C	Based largely on reconnaissance data. Little measured data.
Class D	Derived without investigation data.
not recorded	

Efficiencies in groundwater use can be gained by capping bores and limiting evaporation

Groundwater management

Generally groundwater resources are not as well defined and their management is not as advanced or sophisticated as surface water resources. Implementation levels of best practice groundwater resource management vary. In Western Australia and Queensland, both high users of groundwater resources, knowledge and management of groundwater systems are well developed. In other States (e.g. New South Wales and Victoria), with the limit of surface water supply being reached, demands have substantially increased for access to groundwater resources.

Key sustainability considerations:

Maintenance of water level and/or pressure. Short-term declines of water level and pressure occur with any groundwater development. Ensuring that long-term or unplanned decline does not occur is a key issue in sustainable groundwater management.

Maintenance of water quality. Water quality can be degraded by excessive abstraction flows or intrusions from adjoining aquifers containing saline water, or from land uses that result in contamination.

Determination of environmental water provisions and setting sustainable limits. Sustainable yield needs to be assessed and agreed as a basis for managing the sharing of the resource between consumptive and in situ users.

Progress towards sustainable groundwater management

Broad-scale identification of groundwater resources undertaken as part of the Audit, including the compilation of resource data and definition of the groundwater management units, provides an important baseline for improved management of Australia's groundwater resources.

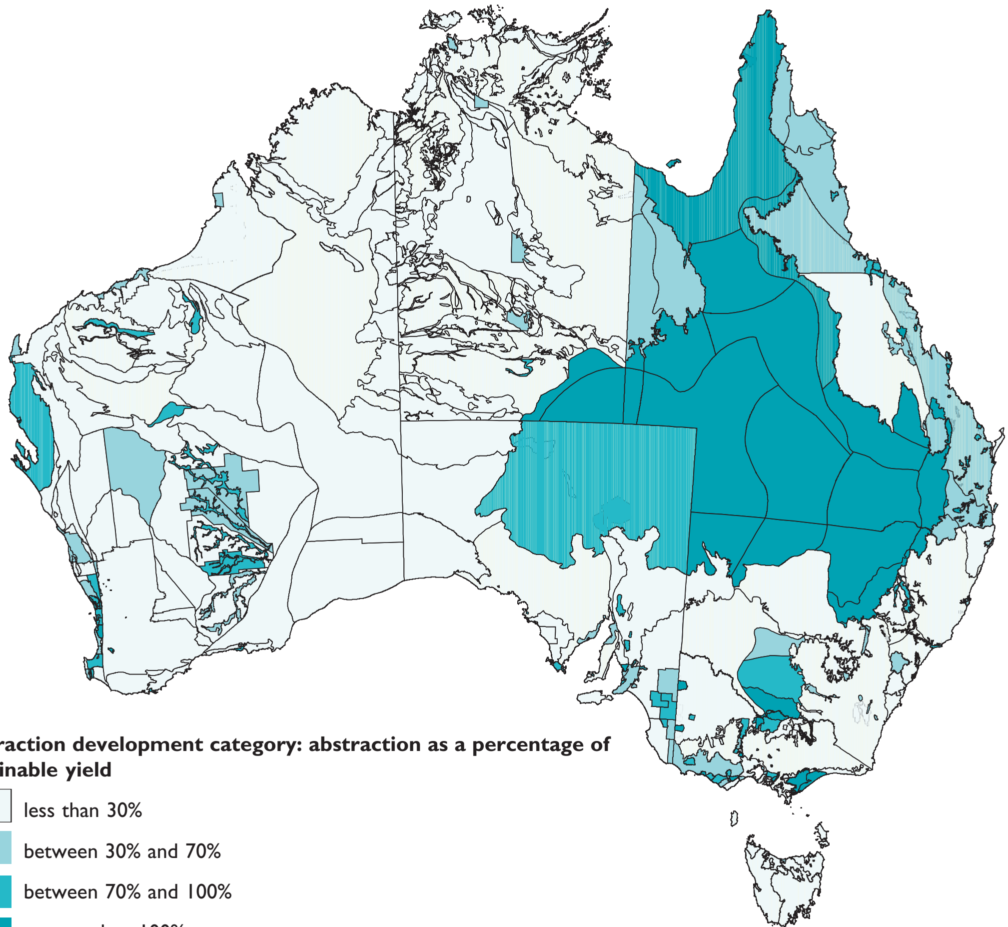
Although a concept of sustainable yield has been agreed for groundwater, the basis of the calculation of sustainable yield varies greatly between the States and Territories, with varying degrees of consistency with the emerging approach to sustainable yield (incorporating consideration of all potential demands in the allocation of the resource).

Assessment of groundwater systems against sustainable yield is difficult. Assessment must consider use, allocation and environmental water requirements in the context of resource characterisation. A precise assessment cannot be made for many of the groundwater systems in Australia as characterisation data for groundwater management units are partially or completely lacking.

Based on the methods detailed in Appendix 3, this assessment of sustainability for Australia's groundwater management units found that:

- Approximately 96% of groundwater management units have use information. 57 (10%) of Australia's 535 groundwater management units are overused (Appendix 2).
- Three of the groundwater management units in Victoria (less than 1% across Australia) were reported as having formal environmental allocations. However, environmental considerations are known to be part of allocation decisions in other States (e.g. the Swan Coastal Plain wetlands in Western Australia).

Figure 31. Groundwater province abstraction development categorisation (2000).



Abstraction development category: abstraction as a percentage of sustainable yield

- less than 30%
- between 30% and 70%
- between 70% and 100%
- greater than 100%
- no data

Data sources:

National Land and Water Resources Audit, Water Resource Assessment 2000 Database

Data used are assumed to be correct as received from the data suppliers.

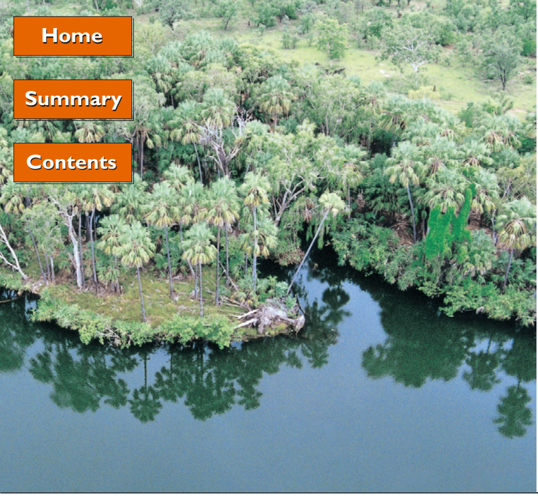
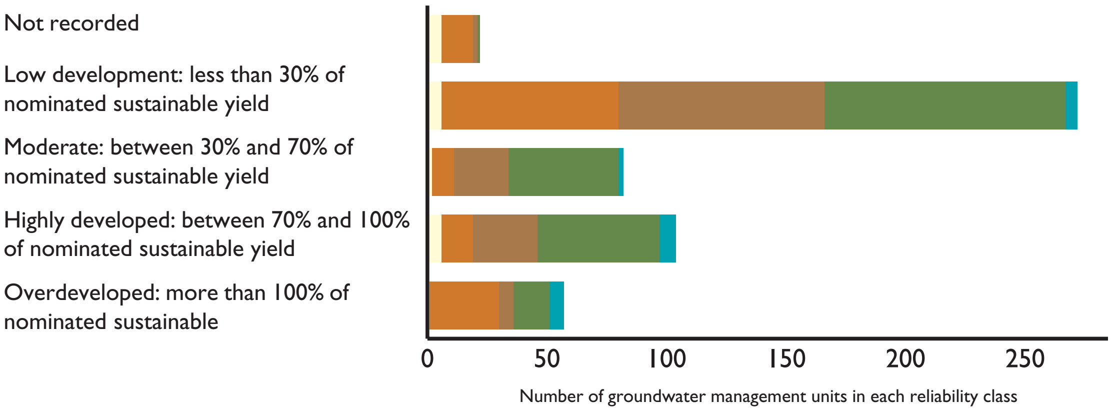


Figure 32. Groundwater management units in each abstraction development category by reliability class (see Appendix 2).



Reliability class

- Class A — Based on reliable recorded and surveyed data that have required little or no extrapolation or interpolation. Estimated accuracy: ± 10%.
- Class B — Based on approximate analysis and limited surveys. Some measured data and some interpolation/extrapolation to derive the dataset. Estimated accuracy: ± 10% to 25%.
- Class C — Little measured data, based on reconnaissance data. Estimated accuracy: ±25% to 50%.
- Class D — Derived without investigation data. Figures estimated from data in nearby catchments, or extrapolated/interpolated from any available data. Estimated accuracy: ± 50%
- not recorded

Table 29. Groundwater management units in each nominated abstraction development category.

	Number of groundwater management units	Percent of total number of groundwater management units
Low development: less than 30% of nominated sustainable yield	274	51
Moderate: between 30% and 70% of nominated sustainable yield	81	15
Highly developed: between 70% and 100% of nominated sustainable yield	104	19
Overdeveloped: more than 100% of nominated sustainable	57	11
Not recorded	22	4

Licence arrangements: differences between allocation and use

Allocation, or rights to use water established under licence, may differ greatly from actual use. On average across Australia, water allocation exceeds use by approximately 11%. However the variation across Australia is significant (Table 30). The differences between allocation and use place particular challenges before water resource managers.

One challenge is the changing status of 'sleepers' (allocations that are not being used) and 'dozers' (allocations that are being occasionally used). Where capping is based on use, we need to recognise water rights while avoiding trading 'sleepers' and 'dozers' where possible. Otherwise, once traded, they become an additional use of the resource.

Through the Audit, Australia has commenced identification and characterisation of over-allocated surface and groundwater systems. For surface water systems, allocation data were able to be provided for 63% of all surface water management areas. Two of these are judged as over-allocated in terms of meeting sustainable flow regimes (Appendix 1).

We have allocation information for approximately 95% of groundwater management units. Eighty-three (15%) of Australia's 535 groundwater management units are judged to be over-allocated (Appendix 2).

Table 30. Total annual water allocation (GL) in Australia (1996/97).

	Surface water allocation (GL)	Groundwater allocation (GL)	Total allocation (GL)	Total water use (GL)	Volume difference between allocation and use (GL)[1]	Percent difference between allocation and use (% change)
New South Wales	9 825	2 665	12 490	10 004	2 486	25
Victoria	5 469	780	6 249	5 788	461	7
Queensland	3 202	983	4 185	4 591	-406	-9
Western Australia	855	1 138	1 993	1 796	197	10
South Australia	740	630	1 370	1 266	104	8
Tasmania[2]	416	20	423	471	-48	-11
Northern Territory	53	73	126	179	-53	-42
Australian Capital Territory	70	7	83	73	10	12
Total	**20 630**	**6 296**	**26 919**	**24 071**	**2 848**	**11**

1 Positive figures indicate where, for the entire State/Territory as a summary analysis, use is less than the amount licenced (allocated); negative figures indicate where use exceeds the amount licensed.

2 All groundwater allocation in Tasmania is informal. Allocation and use information was for 1996/97—the only year for which estimates of water use were made—and a number of rights to water were not defined as volumetric allocations and hence not reported on under allocation. The only allocations reported were those issued as Commissional Water Rights (water licences under the Water Act 1957).

Conjunctive use: a management challenge

Interaction between surface and groundwater systems is an important issue for sustainable water resources management. Some irrigation areas (e.g. Burdekin, Queensland) manage conjunctive use as part of water supply. Nevertheless, administrative arrangements and technical understanding of the complex interactions between surface water and groundwater are still developing for most of Australia. Resource allocation and management decisions are requiring more detailed information of our entire water resources (e.g. as understanding increases, initiatives such as the Murray–Darling surface water cap will probably need to be amended to include conjunctive use).

Sustainable development

Water development is at different stages across Australia. Australian Water Resources Assessment 2000 has identified areas where potential for sustainable development exists. In summary, water resources agencies have identified the following opportunities:

Surface water development

- **Australian Capital Territory**. Water use is predicted to double by 2050 and a cap on diversion is being set. Any development will result from more efficient water use, particularly in urban use.
- **New South Wales**. The potential to develop coastal streams will be quantified as flow management plans are developed.
- **Northern Territory**. Only 0.5% of the sustainable surface water resources are being used and potential for development is high. Implementation of sustainable development of surface water is occurring through the 'beneficial uses' process. The main development need is in augmenting existing water supplies to the Darwin and Greater Darwin areas. In the past, several potential dam sites have been analysed without any consideration for sustainable development.
- **Queensland**. Water Allocation and Management Plans (WAMP) and Water Management Plans are being completed. The Fitzroy and draft Condamine–Balonne WAMP, Moonie, and Warrego–Paroo–Bulloo–Nebine Water Management Plans have been completed, identifying areas for development while maintaining environmental requirements.
- **Tasmania.** Private developers have identified a number of sites for irrigation and the State Government is assisting in environmental investigations to assess opportunities.

- **Victoria**. Very limited opportunities for increases in diversions exist north of the Great Dividing Range. Any new development will be sourced from traded water or from achieving efficiency savings. There is potential for development in south-east Victoria, south of the Great Dividing Range. In the west of the State the resource development is limited by salinity and availability of the resource.
- **South Australia**. The Mt Lofty Ranges and the more efficient use of Murray River water provide the greatest potential for surface water development.
- **Western Australia**. Investigations over the last decade have increased knowledge of surface water resource development opportunities in the Indian Ocean Drainage Division. There is still capacity for surface water development while making provisions for the environment in the more populated South-West Division of the State.

Groundwater development

- **New South Wales**. Potential for groundwater development is limited to aquifers of some of the smaller inland river tributaries and valleys, some of the coastal sand and alluvial aquifer systems and the wider unincorporated areas*.
- **Northern Territory**. The Northern Territory has a low ratio of current use to available sustainable groundwater resources. Potential for development is limited by environmental values, existing supporting infrastructure, population, land capability and heritage issues. Main opportunity for development is for high return horticultural industries.
- **Tasmania.** No formal guidelines restricting groundwater development exist and constraints would only occur if groundwater extraction demonstrated an impact on other users.
- **Victoria**. Approximately one-third of the groundwater management units are highly or fully developed. Potential for groundwater development remains in the south-west of the State, the alluvial systems in the north-east and the South Australian/ Victoria border zones in the north and south.

* Unincorporated areas are those areas outside designated groundwater management units and within a Groundwater Province (as defined in Water Review '85).

- **Western Australia.** Around 18% of the State's groundwater sustainable yield is currently being utilised indicating a significant scope for further groundwater development. The highest level of resource utilisation at the divisional scale occurs in the Perth Basin (39%), which reflects the high accessibility and economic utility of that particular resource. Growth in groundwater use is expected in the Perth groundwater division due to growth in public water systems and self-supplied use for urban, mining and industrial use, as well as growth in the vigorously and generally high value developing irrigation industry on the Coastal Plain. Growth is expected in areas away from Perth and will be dominated by mining development including significant mine dewatering and mining of hypersaline groundwater.
- **South Australia.** While many of the major groundwater resources are already fully allocated there remains significant unused allocation for development in the State. The majority of the groundwater development potential lies in the south-east of the State and the Murray Basin. However, in these areas soil conditions, salinity and depth to watertable may ultimately constrain some developments. As the large resources are becoming increasingly regulated, other resources (e.g. the Mt Lofty Ranges) are coming under increasing pressure to meet demands for irrigation water. Development pressures are increasingly leading to regulation of the groundwater resources.

Achieving sustainable management

Work is under way in all States and Territories towards sustainable water resources management. Examples of initiatives include:

Environmental, economic, social and engineering assessment criteria for assessing development proposals. Several States are assessing large-scale water resource development proposals using assessment criteria developed by the Audit (e.g. the Tasmanian policy is based on these guidelines for water resource development assessment <www.affa.gov.au/water-reform/publications.html>).

Further development through efficiency gains. Examples include the South Australian Highland Irrigation districts with 15% efficiency gains through infrastructure improvements; piping of part of the Wimmera Mallee stock and domestic system; and the pipelining of the Woorinen supply system in Victoria.

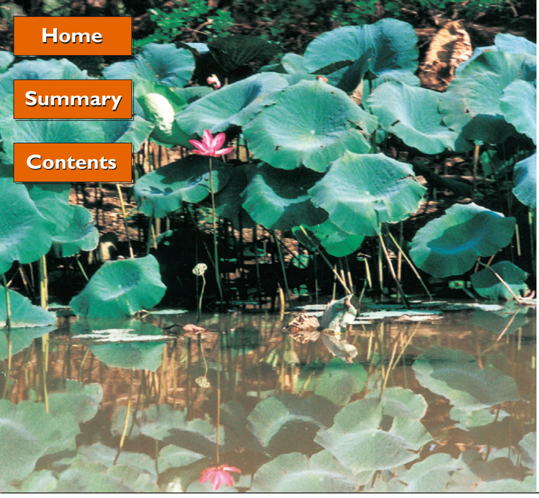
Improved and coordinated management of groundwater. Management of the groundwater resource of the Great Artesian Basin is shared between four jurisdictions and has suffered from lack of coordination in the past—it has tended to be managed as four separate resources. Key issues for management are the continued decline in artesian pressure, the deterioration in the water infrastructure to the point where extractions are substantially in excess of requirements, the difficulty in making water available for new and high-value users, and loss of key groundwater-dependent ecosystems. The recently released *Strategic Management Plan* provides for its management as a single resource. The plan identifies the need for expansion of joint water users and government bore rehabilitation and a bore drain replacement program (costed at around $220 m) to enable a higher level of control to be exercised over the extractions. Another need is for recovery of artesian pressure to achieve pastoral and biodiversity outcomes, make water available for new users and reduce adverse impacts of water distribution on natural resources and biodiversity.

National Water Reform. All State and Territory water management agencies are working towards meeting requirements for environmental allocations through legislation, planning and assessment processes (e.g. streamflow management plans, stressed rivers programs, riparian vegetation management and nutrient management strategies).

Significant surface water provisions for the environment (e.g. in Western Australia, a State-wide average of 88% of total mean stream flow and 65% of potentially divertible water has been allocated for the environment).

Provisions for groundwater dependent ecosystems. Detailed assessment and formal determination of environmental water provisions has been undertaken for the groundwater areas of the Swan Coastal Plain. This assessment provides for protection of wetlands and sustainable use of a large groundwater resource in the centre of Perth.

Urban demand management. Urban water authorities in all States and Territories have introduced two-part tariffs based on a pay for use principle. It is made up of a service fee and volumetric charge for services. Full cost recovery is also being implemented to yield efficiency gains across most of Australia's major cities.



SUPPORTING WATER RESOURCE MANAGEMENT DECISIONS

Basing management decisions on best available and routinely updated information

The last decade has seen a marked improvement in our understanding of natural resource management issues. Water resources management is becoming increasingly challenging with greater and sometimes conflicting demands for use. The community also has increasing expectations and awareness of what constitutes a healthy river, lake, estuary, aquifer or catchment, and appears prepared to support policies that provide high quality water for the environment at some expense to production.

As community expectations change and management objectives broaden, we encounter continuing deficiencies in knowledge and information. Requirements for more detailed understanding of the environmental, social and economic outcomes of management action and water use increase.

Australia requires an ongoing commitment to data collection, research, extension and innovation if we are to continue to adapt and improve the way we manage, use and benefit from our natural resources. Investment in information and knowledge generation to underpin decision making is vital.

Water resources information systems

Previous reviews of Australia's water resources (in 1963, 1977 and 1985) concentrated on characterisation. No mechanisms were put in place to maintain and update these data as inputs to decision making. As water resources were developed, data became out of date and irrelevant. Changing community needs also mean that data have ceased to meet decision-maker needs for information.

It is imperative that the Audit delivers not only a compilation of data but also systems for ongoing data management. The most important legacy of this water resources assessment is to ensure that data on water quantity and quality:

- are routinely updated; and
- remain accessible and informative to the community, as well as meeting the needs of water resource managers.

The National Water Reform Framework (HLSG 1999) has set a policy framework for water quantity management. Considerable progress has been made in changing licensing arrangements. Data management systems must also improve. They must provide timely and relevant information and overcome current constraints caused by budget cutbacks, changes in personnel, in responsibility and management arrangements.

Data and information gaps

Australian Water Resources Assessment 2000 has been designed and implemented in full recognition that many issues could not be covered within the available timeframe and resources. Some of the issues excluded from detailed assessment included:

- the impact of farm dams on catchment water yield;
- the interaction between water quantity and quality management;
- the status of lakes and wetlands; and
- chemical contaminants, particularly pesticide and herbicide derivatives.

The assessment concentrated on making best use of existing data for those issues selected for assessment. As part of this process, many inadequacies in data coverage were identified.

Maps in previous chapters displayed the limitations in Australia's water quality monitoring coverage. For water quantity, State and Territory agencies have nominated a series of areas for improvement.

Table 31. Knowledge and data gaps (depicted as ○) as identified by State and Territory agencies. Blank spaces indicate that a data gap was not identified.

ISSUE	NSW	VIC	QLD	WA	SA	TAS	NT	ACT
Data gaps								
Water use: type and volume – SW and GW, particularly unmetered and/or unregulated systems; water harvesting	○	○	○	○	○	○	○	○
Improving the baseline and long-term time series for water quality (particularly salinity) and quantity: SW and GW	○	○	○	○	○	○		
Groundwater characterisation – aquifer properties; hydrology recharge, storage and yield; vulnerability assessment		○		○	○	○	○	○
Lack of readily useable economic data (on a basin basis)	○		○					
Environmental								
Environmental water provisions: assessment methods (particularly for ephemeral streams); performance measures	○	○	○	○	○	○	○	○
Impact of farm dams: yield; cumulative impact	○	○		○	○	○		
Surface water and groundwater interactions: processes; impacts and use	○	○		○	○		○	○
Forestry impacts on streamflow	○	○						
Research and development								
Improved streamflow estimation models for ungauged and/or unregulated catchments	○	○	○			○	○	
Decision tools for ungauged catchments	○		○					
Environmental impact of flow pulsing: mimic of natural patterns	○							
Ecological value of small streams: as food supply and colonisation to main stream	○							
Arid systems hydrology: impact of water use			○	○	○			
Ecological and social impacts of bore drains in the Far North (SA)					○			
Monitoring								
Improved stream gauging network		○	○		○	○		
Improved bore monitoring network: particularly for regional systems in unincorporated areas		○	○	○	○			○
Information management								
Accessibility to groundwater information systems: quality control, timeliness	○			○		○		
Lack of integrated information systems – particularly surface water allocation data			○					

Implementing a water resources information system for Australia

Monitoring and data collection

Overall, data completeness and quality remain issues for comprehensive reporting of Australia's water resources. On average only 77% of the groundwater management units have information on aquifer characteristics, allocation, use and extraction. Similarly 78% of all surface water management areas have information on water availability, allocation, use and water trading. However the reliability of this data is extremely variable with 8% of surface water management areas and 4% of groundwater management units having reliability Class 'A' for resource quantity assessments. Water quality and trend information is even further limited.

Australian Water Resources Assessment 2000 found:

Assessment capacity

> Limited routine capacity exists to comprehensively monitor or report on water resources in a targeted manner and at a level appropriate for Australia-wide or State/Territory policy development and evaluation. Progress is being made such as in evaluating implementation of the Murray–Darling Basin Cap.

Water use

> Limited reporting mechanisms for reporting on water use and management activities exist at operational scales (e.g. for irrigation schemes) and we have no ability to provide comparable and detailed information on water use across Australia.

Surface water quantity

> Although still able to be improved, data management systems for surface water quantity are comparatively better resourced and managed than those for groundwater.

Groundwater quantity

> Data management systems for groundwater are fragmented and difficult to access. Groundwater characterisation is also incomplete. Significant effort was required as part of the Audit's work to define Australia's groundwater management units. States and Territories recognise that further investment is required to adequately characterise groundwater and to provide management-oriented information such as interactions between groundwater and ecosystems.

Water quality

> Data management systems for surface and groundwater quality are fragmented, based on various measuring criteria, not comparable and difficult to access.

Institutional arrangements

> Groundwater and surface water quantity databases are often held by different agencies or groups within agencies. Groups collecting and managing surface water and groundwater quality information may also be different. This impedes integration and conjunctive use management.

Information to assist decision making

> Capacities of State and Territory agencies to provide up-to-date, management-relevant information on the status and management of water resources vary. Information systems have yet to be developed nationally that link and integrate surface water and groundwater information, or link water quality with water quantity.

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Data content and quality

Data are extremely variable. Monitoring systems are often no longer adequate due to changing environmental and community information needs. There is a mismatch between data availability and quality, and the requirements of decision makers.

Lack of comparability

Definitions and approaches across Australia for resource management concepts such as environmental water provisions/sustainable flow regime/sustainable yield and water quality guidelines remain, at best, only partially resolved. Documentation of the diversity of approaches and methods was achieved in this assessment and demonstrates the need for comparability of approaches and definitions.

Integrated resource management

Ground and surface waters are inextricably linked. Conjunctive use is a key issue in many of the highly developed areas of Australia. Management in many organisations still separates groundwater from surface water in terms of inventory, data, reporting and, most importantly, licensing requirements.

The way forward

Australia requires a systematic, and Australia-wide approach for water resource data collection to provide a foundation for improved water resources management. Data analysis and access need to be compatible and comparable.

Work and outputs from Australian Water Resources Assessment 2000 (e.g. definition of groundwater management units) provide a good foundation for a water resources information system.

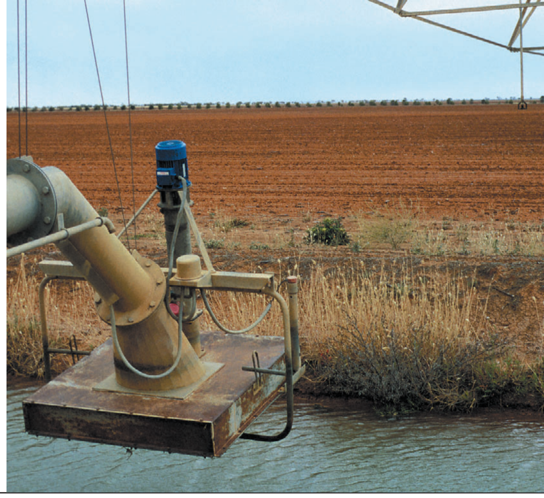
The surface water management industry is well advanced in developing and applying hydrological protocols and standards for data collection and management. These allow comparability in hydrological characterisation across Australia's jurisdictions. A national groundwater data exchange protocol—yet to be implemented—has also been developed through the Australian Groundwater Data Infrastructure.

Many water resource agencies are being proactive and building on the Audit investment to develop and implement water management databases (e.g. Western Australian Water and Rivers Commission).

Monitoring and reporting on the range of National and State/Territories water resource issues detailed in this assessment could be used as a measure of compliance with water management objectives and targets. Linking licensing information and other water management information would improve assessment and reporting.

The full value of Australian Water Resources Assessment 2000 would then be realised with data maintained and enhanced to meet client needs. Information products generated from these data would track progress and trends in water reform and respond to emerging quality and quantity issues.

The first step in this process is the formalisation of national sponsorship and the development of a strategic plan to implement an Australia-wide water resources information system based on the substantial investment to date.



CHALLENGES FOR WATER RESOURCE MANAGEMENT

Water resource characterisation

Australia has excellent hydrological information on its surface water availability as a result of a long period of strategic investment, fostered and encouraged through previous Commonwealth initiatives such as the Australian Water Resources Council. Continued and comprehensive data collection for surface water and groundwater quality and quantity is essential. Priority needs to be given to:

Resource characterisation of groundwater—the assembly of data of adequate reliability and frequency to meet management needs. Most groundwater data will be used within their own jurisdiction. Differences between jurisdictions are not critical. However, occasions will occur when data will need to be assembled and analysed across jurisdictions. This will be easier if common standards can be agreed and adopted. The proposed Australian Groundwater Data Infrastructure (National Groundwater Committee 1999) will facilitate efficient assembly and analysis of such data.

Strategic design and implementation of water quality monitoring programs to serve catchment, river and estuary management needs, particularly the collection of water quality trend and loads information—nutrients, turbidity, and salinity.

Tactical water quality monitoring to respond to specific and localised water quality issues (e.g. toxic chemicals and pathogens).

Selected investment in water quality monitoring programs in less disturbed basins to improve understanding of 'natural' system dynamics and provide a basis for comparative water quality assessments (e.g. Indian Ocean, Timor Sea, Gulf of Carpentaria and Lake Eyre Drainage Divisions).

Surface water quality management

Under the framework provided by Australian and New Zealand Environment and Conservation Council, Australia has progressed surface water quality management against water quality guidelines set for particular rivers and environments. We need to build on these initiatives with:

Specific investigations and tools development to link water quality and quantity with catchment land uses and practices, and provide a basis for integrated catchment management programs and setting of targets and priorities for improved land use practice and allocation.

Refinement of water quality guidelines at a basin or region-specific level.

Management objectives and monitoring programs that recognise the natural variability in Australia's rivers and catchments.

Water use and water use efficiency

Data collection systems and water use documentation that encourage and implement improved water use efficiency are key to the sustainable management and development of Australia's water resources.

Water use efficiency will be achieved through improved water use practices and water recycling—on farm, in industry and for urban uses. Water use efficiency will also be improved by optimising efficiency of supply infrastructure particularly at irrigation scheme and farm operation scales (e.g. lining irrigation channels and piping of open channels to reduce significant water losses, replacing groundwater distribution drains with polyethylene pipes, bore capping). Priority activities include:

Full cost pricing, including environmental cost, as promoted by the National Water Reform Framework.

Implementing water use monitoring as part of water administration and allocation activities.

Progressively implementing volumetric allocation, metering, recording systems and reporting (through water supply companies, management authorities and government agencies) at least for highly- and over-committed surface and groundwater systems.

Setting targets for water use efficiency to reduce water consumption in urban areas and improve water use efficiency in irrigation practice, and then undertaking initiatives to meet these targets.

Water resource sustainability

The National Water Reform Agenda has provided the lead for the progressive development of sustainable water management across Australia. Audit findings show that much still needs to be done on a needs basis: including more precisely defining sustainability and developing assessment methods. Priority areas for further activities include:

Developing systems to assess and report on sustainability, surface and groundwater systems.

Agreeing and adopting Australia-wide comparable definitions and methods for determining sustainable flow regimes for surface water, and sustainable yield for groundwater resources. This must recognise the complex relationships between river, wetland, estuary, aquifer and catchment health, and water quantity and quality.

Developing and applying tools that quantify and link impacts of land use practices and patterns on catchment water yield (e.g. on-farm storages, changes in irrigated crops and afforestation).

Developing and applying methods to understand and then manage at a basin scale conjunctive use, and to integrate surface water and groundwater management within an overall context of sustainability.

Designing and implementing a range of administrative measures that build on current instruments such as caps on water use and licence rationalisation, to support implementation of sustainability.

Water resource assessment and reporting

Australia needs to routinely maintain and update data, assess condition of water resources and report regularly on management progress to ensure cost-effective and efficient investment in water resource management. Data quality must be improved through better standards and quality assurance processes. Minimum standards and units of measurement and methods are essential so that data across Australia are comprehensive and comparable. Australian Water Resources Assessment 2000 has provided the baseline and framework for tracking progress. Priority activities to build on this investment include:

Five-yearly cooperative and Australia-wide assessment of progress towards achieving sustainable water resource management.

National sponsors that coordinate data management and implementation of standards, and work with State and Territory data custodians to continually improve assessment, reporting and data access capabilities across water quality and quantity.

AUSTRALIAN WATER RESOURCES ASSESSMENT 2000

Australian Water Resources Assessment 2000 has:

- Collated and presented information on Australia's surface water and groundwater quality and quantity at management scales in the Australian Natural Resources Atlas and as summarised in this report. This is key information for regional groups as they develop, implement and evaluate regional natural resources management strategies.

  Addresses Audit objective 1: *Providing a clear understanding of the status of, and changes in, the nation's land, vegetation and water resources and implications for their sustainable use*

- Defined surface and groundwater management units. Data for these areas have been compiled in standardised databases as part of the Audit's Data Library. It is accessible as summary information products through the Australian Natural Resources Atlas.

  Addresses Audit objective 3: *Developing a national information system of compatible and readily accessible resource data*

- Undertaken assessments of the sustainability of Australia's surface water and groundwater use and whether it meets surface water quality guidelines. These assessments have been undertaken in the wider context of natural resources management and are inputs to other Audit integrated assessments.

  Addresses Audit objective 4: *Producing national land, vegetation and water—surface and groundwater—assessments as integrated components of the Audit*

- Worked closely with most water resources management agencies to build on their data collection and management activities and provide these agencies with data management systems that improve their ability to present management-orientated information on Australia's water resources. The Audit has collaborated with the National Competition Council in its role to oversee the National Water Reform Agenda and the Australian Bureau of Statistics in its role to produce National Environmental Accounts (e.g. ABS 2000).

  Addresses Audit objective 5: *Ensuring integration with, and collaboration between, other relevant initiatives*

- Provided a framework and directions for monitoring, assessment and reporting on Australia's water resources. This includes definition of management units, collation of benchmark information and provision of database structures that can be implemented as part of water management administration within State and Territory water resource agencies.

  Addresses Audit objective 6: *Providing a framework for monitoring Australia's land and water resources in an ongoing and structured way*

Australian Water Resources Assessment 2000 has highlighted major areas for further investment as key inputs to the improved management of Australia's water resources.

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APPENDIX 1. SUMMARY BY SURFACE WATER MANAGEMENT AREA

Assessment reliability

The quality of Australian Water Resources Assessment varies across attributes. It was evaluated using a qualitative scale. Appendices 4 & 5 provide a summary of extent, completeness and reliability estimate of the databases that supports this water resource assessment.

Data presented are as supplied by the States and Territories. While every effort has been taken to identify errors in the data, users should verify the data with the agencies.

Data presented are as supplied by the State and Territory data custodians. While every effort has been made to identify and rectify any obvious errors in the data, it is recommended that users of this report verify the data with the data custodians. Readers should also refer to Appendix 3 for explanation of the assessment methods used by State and Territory agencies.

Estimates of data reliability.

Class	Surface water quantity
A	Based mainly on reliable recorded and surveyed data and detailed storage analysis.
B	Based on approximate hydrologic analysis and limited surveys.
C	Based largely on reconnaissance data Little measured data.
D	Derived without investigation data.

In the following tables, n/a signifies that data was either not assessed or not available.

Table A1. Summary data for surface water management areas.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
1 North-East Coast Drainage Division									
Queensland									
Albert River	n/a	n/a	15 359	1	15 359	B	15 359	1	n/a
Baffle Creek	n/a	n/a	7 821	1	7 821	B	7 822	1	n/a
Barker/Barambah	27 900	B	28 651	3	28 651	B	40 163	3	n/a
Barratta	n/a	n/a	11 185	3	11 185	B	11 185	3	n/a
Barron River	187 800	B	103 989	3	57 789	B	125 343	3	n/a
Belyando/Suttor	n/a	n/a	78 638	1	83 777	A	78 654	1	n/a
Black River	n/a	n/a	12 464	1	12 464	B	12 464	1	n/a
Bowen/Broken	48 546	B	16 077	2	10 938	B	33 397	2	n/a
Boyne	31 200	B	36 681	3	36 705	B	47 228	3	n/a
Boyne River	54 300	B	58 735	2	43 343	B	58 735	2	n/a
Brisbane River	497 350	A	78 960	3	230 772	A	242 478	3	n/a
Bundaberg Irrigation Area	234 700	B	89 855	3	135 535	A	162 240	3	n/a
Burdekin River	867 300	B	493 158	2	490 208	B	591 388	2	n/a

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
1 North-East Coast Drainage Division (continued)									
Queensland (continued)									
Burrum River	10 270	A	6 134	2	6 134	B	13 293	2	n/a
Callide	4 680	B	7 186	3	22 578	A	7 988	3	n/a
Calliope River	n/a	n/a	3 287	1	3 287	B	3 287	1	n/a
Curtis Island	n/a	n/a	0	1	0	n/a	0	1	n/a
Daintree River	n/a	n/a	1 706	1	1 706	B	1 706	1	n/a
Dawson River	57 530	B	54 758	3	54 758	B	71 374	3	n/a
Don River	n/a	n/a	6 410	1	9 367	B	6 410	1	n/a
Elliott	n/a	n/a	6 811	1	6 811	B	7 238	1	n/a
Endeavour River	n/a	n/a	1 945	1	1 945	B	1 945	1	n/a
Fitzroy River (Qld)	74 000	B	62 890	3	62 890	B	83 722	3	n/a
Fraser Island	n/a	n/a	0	1	0	n/a	0	1	n/a
Gregory	n/a	n/a	7 903	1	7 903	B	7 903	1	n/a
Haughton River	n/a	n/a	213	3	3 163	A	315	3	n/a
Herbert River	n/a	n/a	49 107	1	49 107	B	49 107	1	n/a
Hinchinbrook Island	470	n/a	500	1	500	B	470	1	n/a
Isis	n/a	n/a	1 042	2	1 042	B	1 279	2	n/a
Jacky Jacky Creek	n/a	n/a	0	1	0	n/a	0	1	n/a
Jeannie River	n/a	n/a	35	1	35	B	35	1	n/a
Johnstone River	n/a	n/a	10 915	1	10 915	B	10 915	1	n/a
Kolan River	75 500	B	84 678	3	38 998	B	46 248	3	n/a
Lockhart River	n/a	n/a	0	1	0	n/a	0	1	n/a
Lockyer River	13 083	A	12 279	3	12 279	A	13 735	3	n/a
Logan River	8 200	A	38 789	2	38 789	A	46 719	2	n/a
Maroochy River	9 880	A	14 986	1	32 986	B	14 722	1	n/a
Mary River (Qld)	97 406	A	127 222	2	80 722	B	172 398	2	n/a
Mossman River	n/a	n/a	3 783	1	3 783	B	3 783	1	n/a
Mulgrave River	n/a	n/a	8 438	1	8 438	B	8438	1	n/a
Murray River (Qld)	n/a	n/a	1 493	1	1 493	B	1 493	1	n/a
Nogoa/Mackenzie	209 044	B	148 314	3	148 314	A	226 340	3	n/a
Noosa River	n/a	n/a	4 971	2	33 471	B	4 971	2	n/a
Normanby River	n/a	n/a	1 596	1	1 596	B	1596	1	n/a
O'Connell River	n/a	n/a	15 936	1	16 646	B	15 936	1	n/a
Olive/Pascoe Rivers	n/a	n/a	0	1	0	n/a	0	1	n/a
Pine River	59 250	A	39 248	2	71 299	B	59 186	2	n/a
Pioneer River	130 879	n/a	46 278	3	20 077	A	23 079	3	n/a

Refer to page 90 for explanatory notes.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
1 North-East Coast Drainage Division (continued)									
Queensland (continued)									
Plane Creek	51 000	n/a	12 218	2	38 419	A	51 749	2	n/a
Proserpine River	50 700	A	25 051	3	21 384	A	60093	3	n/a
Ross River	48 750	A	46 601	3	46 601	B	49 618	3	n/a
Russell River	n/a	n/a	1 480	1	1 480	B	1 480	1	n/a
Shoalwater Creek	n/a	n/a	0	1	0	n/a	0	1	n/a
South Coast	93 100	A	47 383	1	47 383	B	47 383	1	n/a
Stewart River	n/a	n/a	0	1	0	n/a	0	1	n/a
Stradbroke Island	n/a	n/a	31 233	1	31 233	B	31233	1	n/a
Styx River	n/a	n/a	1 343	1	1 343	B	1 343	1	n/a
Three Moon Creek	6 200	B	1 795	3	1 795	B	1782	3	n/a
Tully River	n/a	n/a	1 395	1	1 395	B	1 395	1	n/a
Upper Burnett River	32 700	B	24 425	2	24 425	A	27 831	2	n/a
Water Park Creek	n/a	n/a	13 185	1	13 185	B	13 185	1	n/a
Whitsunday Island	n/a	n/a	20	1	20	B	20	1	n/a
Total	**2 981 738**	**–**	**2 006 555**	**–**	**2 144 242**	**–**	**2 516 037**	**–**	**n/a**
2 South-East Coast Drainage Division									
New South Wales									
Bega River – regulated	n/a	n/a	5 000	4	5 000	n/a	15 257	n/a	n/a
Bega River – unregulated	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Bellinger River	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Brunswick River	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Clarence River	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
Clyde River – Jervis Bay	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
East Gippsland (NSW part only)	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
Hastings River	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Hawkesbury River	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Hunter River – regulated	n/a	n/a	113 041	4	113 041	n/a	205 128	n/a	113 041
Hunter River – unregulated	n/a	n/a	n/a	3	n/a	n/a	n/a	n/a	n/a
Karuah River	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
Macleay River	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Macquarie – Tuggerah Lakes	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Manning River	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
Moruya River	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a

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Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
2 South-East Coast Drainage Division (continued)									
New South Wales (continued)									
Richmond River – regulated	n/a	n/a	137	1	137	n/a	6 836	n/a	n/a
Richmond River – unregulated	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
Shoalhaven River	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Snowy River (NSW part only)	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Sydney Coast – Georges River	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Towamba River	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
Tuross River	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
Tweed River	n/a	n/a	n/a	2	n/a	n/a	n/a	n/a	n/a
Wollongong Coast	n/a	n/a	n/a	1	n/a	n/a	n/a	n/a	n/a
South Australia									
Glenelg River (SA)	0	n/a	0	1	0	n/a	0	n/a	0
Millicent Coast (SA), sub-catchment 1	0	D	0	1	0	D	0	n/a	45 000
Millicent Coast (SA), sub-catchment 2	0	n/a	0	1	0	D	0	n/a	2 000
Millicent Coast (SA), sub-catchment 3	0	n/a	0	1	0	n/a	0	n/a	38 000
Millicent Coast (SA), sub-catchment 4	0	n/a	0	1	3 220	B	0	n/a	0
Victoria									
Avon River	7 650	B	7 650	3	47 025	B	7 650	3*	7 650
Barwon River	45 700	B	40 060	2	32 150	B	45 700	2	70 600
Bunyip River	46 280	B	10 640	1	150 640	A	46 280	2	98 280
East Gippsland (Vic)	1 230	B	520	1	520	B	1 230	1	142 400
Glenelg River (Vic)	72 770	B	71 710	3	3 960	C	72 770	3	84 770
Hopkins River	10 440	B	6 980	2	13 570	C	10 440	3*	10 440
Lake Corangamite	750	C	750	3	4 380	C	750	3*	750
Latrobe River	261 560	B	160 300	2	194 100	A	221 560	3*	261 560
Maribyrnong River	9 980	B	7 060	1	22 080	B	9 980	2	32 300
Millicent Coast (Vic)	210	B	210	3	210	A	210	3	210
Mitchell River (Vic)	18 900	B	11 640	2	11 640	B	18 900	3*	18 900
Moorabool River	45 270	B	16 270	2	22 530	B	45 270	3*	45 270

* The developed allocation is 100% of the sustainable yield. This includes cases where the sustainable yield has been nominally set at the current allocation and requires more vigorous assessment. See the Victorian State Overview Report for further details.

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Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
2 South-East Coast Drainage Division (continued)									
Victoria (continued)									
Otway Coast	26 100	B	19 360	1	12 180	C	26 100	1	204 100
Portland Coast	1 100	B	1 100	1	1 100	C	1 100	1	11 100
Snowy River (Vic)	5 400	B	2 130	2	2 130	A	5 415	3*	5 415
South Gippsland	21 870	B	11 860	1	11 860	A	21 870	1	135 400
Tambo River	6 880	B	2 850	2	2 850	B	6 880	3*	6 880
Thomson – Macalister Rivers	427 370	B	341 380	3	178 925	C	427 370	3*	427 370
Werribee River	35 900	B	32 250	3	82 300	B	33 000	3*	35 900
Yarra River	466 300	B	420 570	3	326 230	A	466 300	3*	466 300
Total	**1 511 660**	**–**	**1 283 468**	**–**	**1 241 778**	**–**	**1 695 246**	**–**	**2 263 636**
3 Tasmania Drainage Division									
Tasmania									
Arthur River	22 000	D	21 627	1	21 627	D	21 627	1	1 919 386
Coal River	4 600	B	3 231	1	3 231	B	4 625	1	26 271
Derwent River	812 000	D	750 142	3	111 142	D	777 346	3	n/a
East Coast	15 000	D	14 196	1	14 196	D	13 612	1	1 183 168
Flinders – Cape Barren Islands	600	D	533	1	533	C	533	1	121 800
Forth River	15 000	D	14 577	2	14 577	D	4 967	2	n/a
Gordon River	0	D	0	3	0	n/a	0	3	n/a
Huon River	1 394 000	D	1 383 979	2	3 019	D	1 383 979	2	2 509 566
King Island	600	D	263	1	263	A	229	1	152 483
King – Henty Rivers	205 000	D	204 390	3	4 370	D	204 390	3	n/a
Kingston Coast	6 400	D	6 400	1	6 400	D	6 412	1	169 980
Mersey River	761 000	C	759 519	3	19 519	D	759 519	3	n/a
Pieman River	8 190	D	8 190	3	8 190	D	0	3	n/a
Piper – Ringarooma Rivers	67 000	D	52 520	1	52 520	D	54 239	1	984 528
Rubicon River	10 000	D	10 000	1	10 000	D	8 694	1	137 398
Sandy Cape Coast	0	D	0	3	0	n/a	0	3	n/a
Smithton – Burnie Coast	101 000	D	89 658	1	89 658	D	75 403	1	2 137 449

* The developed allocation is 100% of the sustainable yield. This includes cases where the sustainable yield has been nominally set at the current allocation and requires more vigorous assessment. See the Victorian State Overview Report for further details.

Refer to page 90 for explanatory notes.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
3 Tasmania Drainage Division (continued)									
Tasmania (continued)									
South-West Coast	300	D	300	1	300	D	274	1	6 153 175
Tamar River	120 000	D	91 188	3	91 188	D	60 137	3	2 056 980
Total	**3 542 690**	**–**	**3 410 713**	**–**	**450 733**	**–**	**3 367 757**	**–**	**17 552 184**
4 Murray–Darling Drainage Division									
Australian Capital Territory									
Murrumbidgee River A	1 500	A	1 100	2	51 800	B	2 000	2	124 400
Murrumbidgee River B	53 700	A	50 900	1	200	B	50 900	1	7 000
Murrumbidgee River C	30 000	A	15 500	1	15 500	C	17 500	1	68 100
New South Wales									
Barwon Darling Management Area	191 894	B	191 894	4	191 894	n/a	n/a	n/a	n/a
Benanee	0	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Border Rivers (NSW part only)	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Border Rivers (NSW) – regulated	195 800	B	195 800	4	195 800	n/a	268 193	n/a	n/a
Castlereagh River	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Condamine – Culgoa Rivers (NSW part only)	0	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Darling River – regulated	146 324	B	146 324	4	146 324	n/a	48 562	n/a	n/a
Darling River – unregulated	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Gwydir River – regulated	402 768	B	359 923	4	359 923	n/a	529 007	n/a	359 923
Gwydir River – unregulated	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Lachlan River – regulated	270 081	B	258 769	4	258 769	n/a	664 526	n/a	258 769
Lachlan River – unregulated	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Lake George	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Lower Murray River (NSW part only)	0	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Macquarie River – regulated	464 027	B	406 840	4	406 840	n/a	673 611	n/a	406 840
Macquarie River – unregulated	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a

Refer to page 90 for explanatory notes.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
4 Murray–Darling Drainage Division (continued)									
New South Wales (continued)									
Moonie River (NSW part only)	0	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Murray (Hume to Border) – regulated (NSW part only)	1 913 600	B	1 913 600	4	1 913 600	n/a	2 230 369	n/a	n/a
Murrumbidgee River – regulated	2 186 325	B	2 144 271	4	2 144 271	n/a	2 789 721	n/a	2 144 271
Murrumbidgee River – unregulated	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Namoi River – regulated	239 352	B	226 164	4	226 164	n/a	263 977	n/a	226 164
Namoi River – unregulated	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Paroo River (NSW part only)	0	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Upper Murray River (NSW part only)	0	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Warrego River (NSW part only)	n/a	n/a	n/a	4	n/a	n/a	n/a	n/a	n/a
Queensland									
Balonne/Condamine	183	A	2 870	3	2 870	A	4 012	3	n/a
Bokhara River – Distributary Area (Qld)	0	n/a	108 211	3	108 211	A	1 645	3	n/a
Macintyre/Dumaresq Rivers	94 249	A	89 358	3	89 358	A	85 329	3	n/a
Macintyre Brook	18 130	A	4 839	3	4 839	A	17 808	3	n/a
Maranoa	260	B	1 000	1	1 000	B	1 000	1	n/a
Moonie River (Qld)	n/a	n/a	1 209	2	1 209	B	1 209	2	n/a
Paroo River (Qld)	n/a	n/a	233	1	233	B	233	1	n/a
St George	66 562	n/a	201 253	3	201 253	A	77 258	3	n/a
Upper Condamine River	28 093	n/a	91 695	3	91 695	A	25 562	3	n/a
Wallum/Nebine/ Mungallala (Qld)	n/a	n/a	109 534	1	109 534	B	109 534	1	n/a
Warrego River (Qld)	n/a	n/a	112 920	1	112 920	B	112 920	1	n/a
South Australia									
Lower Murray River (SA), sub-catchment 1	595 000	A	595 200	3	461 154	n/a	736 000	4	704 000
Lower Murray River (SA), sub-catchment 2	6 700	C	6 690	1	7 940	D	0	n/a	30 800
Mallee (SA)	0	n/a	0	1	0	n/a	0	n/a	0

Refer to page 90 for explanatory notes.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
4 Murray–Darling Drainage Division (continued)									
Victoria									
Avoca River	3 380	B	3 380	3	39 840	B	3 380	3*	3 380
Broken River	32 000	B	32 000	3	897 125	B	32 000	3*	32 000
Campaspe River	121 000	B	121 000	3	441 980	B	121 000	3*	121 000
Goulburn River	1 943 000	B	1 943 000	3	919 770	B	1943000	3*	1 943 000
Kiewa River	9 000	B	9 000	3	14 910	B	9 000	3*	9 000
Loddon River	109 000	B	109 000	3	1 175 530	B	109 000	3*	109 000
Mallee (Vic)	0	B	0	3	362 420	B	0	3*	0
Mid-Murray River (Hume to SA Border) (Vic)	1 639 000	B	1 639 000	3	0	C	1 639 000	3*	1 639 000
Mitta Mitta River	834 500	B	834 500	3	20 835	B	834 500	3*	834 500
Ovens River	26 000	B	26 000	3	39 340	B	26 000	3*	26 000
Upper Murray River (Vic)	3 450	B	3 450	3	3 450	B	3450	3*	3 550
Wimmera – Avon Rivers	94 250	C	94 250	4	130 030	B	94 250	4	76 300
Total	**11 719 128**	**–**	**12 050 677**	**–**	**11 148 531**	**–**	**11 579 006**	**–**	**9 126 997**
5 South Australia Gulf Drainage Division									
South Australia									
Broughton River	7 000	B	3 350	2	6 726	n/a	900	1	12 500
Eyre Peninsula	2 250	C	2 250	2	593	n/a	0	n/a	7 000
Fleurieu Peninsula	1 360	C	1 358	1	3 741	D	0	n/a	29 000
Gawler River	21 800	B	21 800	4	31 162	D	3 550	2	12 100
Gawler River – sub-catchment Little Para	8 300	B	7 121	4	35 223	B	0	n/a	2 200
Kangaroo Island	2 500	C	2 500	1	2 500	D	0	n/a	43 000
Lake Torrens	550	D	550	1	550	B	0	n/a	8 500
Light River	1 068	B	1 067	2	3 510	D	100	1	3 600
Mambray Coast	2 300	D	2 300	2	3 964	B	0	n/a	6 000
Myponga River	10 880	B	10 876	4	1 003	D	0	n/a	4 500
Onkaparinga River	53 600	B	53 030	4	40 102	D	0	n/a	20 000

* The developed allocation is 100% of the sustainable yield. This includes cases where the sustainable yield has been nominally set at the current allocation and requires more vigorous assessment. See the Victorian State Overview Report for further details.

Refer to page 90 for explanatory notes.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
5 South Australia Gulf Drainage Division (continued)									
South Australia (continued)									
Spencer Gulf	0	n/a	0	1	5 223	B	0	n/a	0
Torrens River	36 300	B	36 279	4	130 707	D	0	n/a	13 000
Wakefield River	950	D	950	2	1 952	n/a	600	n/a	1 800
Willochra Creek	250	D	250	2	250	D	0	n/a	800
Yorke Peninsula	0	D	0	1	5 178	B	0	n/a	0
Total	**149 108**	–	**143 681**	–	**272 384**	–	**4 550**	–	**164 000**
6 South-West Coast Drainage Division									
Western Australia									
Albany Coast	4 129	B	3 176	1	3 320	B	n/a	1	33 569
Avon River	1 311	B	1 301	1	17 736	B	n/a	1	9 720
Blackwood River	13 786	C	13 568	1	17 421	A	n/a	1	183 531
Busselton Coast	6 547	C	6 547	1	6 547	B	n/a	1	134 931
Collie River	88 170	A	59 282	2	61 894	B	n/a	2	169 780
Denmark River	1 280	B	1 000	1	1 071	A	n/a	1	50 895
Donnelly River	10 440	B	1 632	1	2 450	B	n/a	1	90 520
Esperance Coast	258	C	211	1	211	B	n/a	1	4 218
Frankland River	1 107	C	1 097	1	1 165	A	n/a	1	5 817
Harvey River	92 610	A	66 944	2	51 500	B	n/a	2	137 218
Kent River	610	C	606	1	606	B	n/a	1	60 400
Moore – Hill Rivers	3 446	B	3 446	1	3 472	B	n/a	1	20 435
Murray River (WA)	127 373	A	82 023	2	25 405	A	n/a	3	142 773
Ninghan	28	C	28	1	28	B	n/a	1	1 000
Preston River	3 810	B	3 043	1	10 292	B	n/a	1	50 180
Shannon River	4 960	C	4 803	1	4 803	B	n/a	1	63 102
Swan Coast	115 663	A	115 663	2	145 765	B	n/a	2	241 715
Warren River	31 220	B	8 781	1	7 963	B	n/a	1	207 142
Yarra Yarra Lakes	63	C	61	1	195	B	n/a	1	1 002
Total	**506 811**	–	**373 212**	–	**361 844**	–	**0**	–	**1 607 948**

Refer to page 90 for explanatory notes.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
7 Indian Ocean Drainage Division									
Western Australia									
Ashburton River	0	C	0	1	0	n/a	n/a	1	27 580
De Grey River	0	C	0	1	0	n/a	n/a	1	124 000
Fortescue River	10 000	A	6 290	2	6 290	A	n/a	3	10 000
Gascoyne River	0	C	0	1	0	n/a	n/a	1	196 000
Greenough River	1 596	C	1 592	1	1 592	B	n/a	1	37 916
Lyndon – Minilya Rivers	0	C	0	1	0	n/a	n/a	1	3 760
Murchison River	27	C	27	1	27	B	n/a	1	510
Onslow Coast	0	C	0	1	0	n/a	n/a	1	11 100
Port Hedland Coast	15 000	A	4 500	1	4 500	A	n/a	2	29 240
Wooramel River	0	C	0	1	0	n/a	n/a	1	0
Total	**26 623**	**–**	**12 409**	**–**	**12 409**	**–**	**0**	**–**	**440 106**
8 Timor Sea Drainage Division									
Northern Territory									
Bathurst and Melville Islands	210	C	184	1	184	B	n/a	n/a	588 000
Blyth River	n/a	n/a	0	1	0	n/a	0	n/a	220 000
Buckingham River	n/a	n/a	0	1	0	n/a	0	n/a	440 000
Daly River	7 465	B	7 465	1	7 465	C	9 488	1	1 110 000
Darwin/Blackmore Rivers	38 200	B	35 265	2	465	D	37 400	2	70 000
East Alligator River	n/a	n/a	0	1	0	n/a	0	n/a	900 000
Finniss/Elizabeth/Howard Rivers	160	D	160	1	34 960	D	141	1	480 000
Fitzmaurice River	10	D	10	1	10	C	n/a	n/a	280 000
Goomadeer River	n/a	n/a	0	1	0	n/a	0	n/a	490 000
Goyder River	n/a	n/a	0	1	0	n/a	0	n/a	302 800
Keep River (NT)	45	D	45	1	45	B	n/a	n/a	78 000
Liverpool River	n/a	n/a	0	1	0	n/a	0	1	570 000
Mary River (NT)	103	D	103	1	103	D	40	1	400 000
Moyle River	n/a	n/a	0	1	0	n/a	0	n/a	110 000
Ord River (NT)	85	n/a	85	1	85	n/a	n/a	n/a	166 000
South Alligator River	n/a	n/a	0	1	0	n/a	0	n/a	0
Victoria River	1 010	C	1 004	1	1 004	C	n/a	n/a	560 000
Wildman River	n/a	n/a	0	1	0	n/a	0	n/a	60 000

Refer to page 90 for explanatory notes.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
8 Timor Sea Drainage Division (continued)									
Western Austalia									
Cape Leveque Coast	236	C	236	1	236	B	n/a	1	1 000
Drysdale River	127	C	127	1	127	B	n/a	1	166 000
Fitzroy River (WA)	730	C	730	1	730	B	n/a	1	736 600
Isdell River	295	C	295	1	295	B	n/a	1	160 800
Keep River (WA)	63	C	63	1	63	B	n/a	1	1 000
King Edward River	127	C	127	1	127	B	n/a	1	176 500
Lennard River	266	C	266	1	266	B	n/a	1	281 600
Ord River (WA)	320 934	A	270 087	1	270 087	A	n/a	1	1 294 101
Pentecost River	380	C	380	1	380	B	n/a	1	196 000
Prince Regent River	122	C	122	1	122	B	n/a	1	145 000
Total	**370 568**	**–**	**316 754**	**–**	**316 754**	**–**	**46 888**	**–**	**9 983 401**
9 Gulf of Carpentaria Drainage Division									
Northern Territory									
Calvert River	18	C	18	1	18	C	n/a	n/a	180 000
Groote Eylandt	3 000	B	2 443	1	2 443	A	2 450	n/a	130 000
Koolatong River	n/a	n/a	0	1	0	n/a	0	n/a	310 000
Limmen Bight River	25	C	25	1	25	C	n/a	n/a	300 000
McArthur River	239	C	239	1	239	C	495	n/a	630 000
Nicholson River (NT)	18	n/a	18	1	18	C	n/a	n/a	134 000
Robinson River	12	C	12	1	12	C	n/a	n/a	180 000
Roper River	526	C	526	1	526	C	360	n/a	950 000
Rosie River	5	C	5	1	5	C	n/a	n/a	90 000
Settlement Creek (NT)	12	n/a	12	1	12	C	0	n/a	160 000
Towns River	n/a	n/a	0	1	0	n/a	0	n/a	100 000
Walker River	n/a	n/a	0	1	0	n/a	0	n/a	660 000
Queensland									
Archer River	n/a	n/a	82	1	82	B	82	1	n/a
Coleman River	n/a	n/a	0	1	0	n/a	0	1	n/a
Ducie River	n/a	n/a	360	1	360	B	360	1	n/a
Embley River	n/a	n/a	0	1	0	n/a	0	1	n/a
Flinders River	n/a	n/a	7 695	1	7 695	B	7 695	1	n/a
Gilbert River	n/a	n/a	6 414	1	6 414	B	6 414	1	n/a
Holroyd River	n/a	n/a	0	1	0	n/a	0	1	n/a
Horne Island	761	B	1 022	2	0	B	1 022	2	n/a

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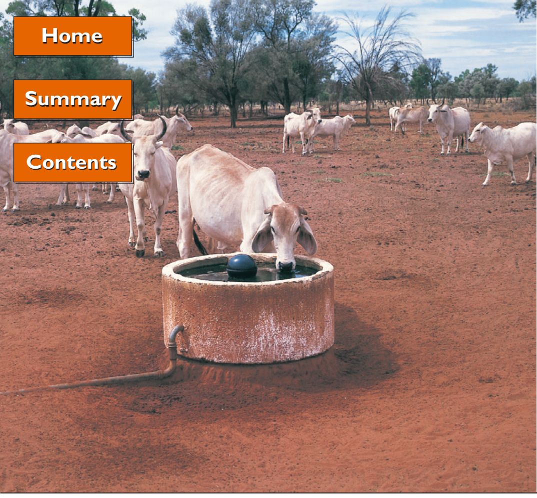
9 Gulf of Carpentaria Drainage Division (continued)									
Queensland (continued)									
Jardine River	n/a	n/a	87	I	87	B	87	I	n/a
Leichhardt River	53 700	A	20 957	I	20 957	B	38 899	I	n/a
Mitchell River (WA)	n/a	n/a	9 029	I	55 229	B	9 029	I	n/a
Morning Inlet	n/a	n/a	0	I	0	n/a	0	I	n/a
Mornington Island	210	A	440	I	440	B	440	I	n/a
Nicholson River (Qld)	n/a	n/a	I 108	I	I 108	B	I 108	I	n/a
Norman River	n/a	n/a	I 067	I	I 067	B	I 067	I	n/a
Settlement Creek (Qld)	n/a	n/a	0	I	0	n/a	0	I	n/a
Staaten River	n/a	n/a	0	I	0	n/a	0	I	n/a
Thursday Island	138	B	0	2	I 022	B	0	2	n/a
Watson River	n/a	n/a	0	I	0	n/a	0	I	n/a
Wenlock River	n/a	n/a	0	I	0	n/a	0	I	n/a
Total	**58 664**	**–**	**51 559**	**–**	**97 759**	**–**	**69 508**	**–**	**3 824 000**
10 Lake Eyre Drainage Division									
New South Wales									
Cooper Creek (NSW)	0	D	0	I	0	n/a	0	n/a	0
Lake Frome (NSW)	0	D	0	I	0	n/a	0	n/a	0
Northern Territory									
Finke River (NT)	75	C	75	I	75	C	n/a	n/a	8 000
Georgina River (NT)	150	n/a	150	I	150	C	n/a	n/a	125 000
Hay River (NT)	50	C	50	I	50	C	n/a	n/a	7 000
Todd River	100	C	100	I	100	C	n/a	n/a	4 000
Queensland									
Cooper Creek (Qld)	n/a	n/a	6 841	I	6 841	B	6 841	I	n/a
Diamantina River (Qld)	n/a	n/a	17	I	17	B	17	I	n/a
Georgina River (Qld)	n/a	n/a	99	I	99	B	99	I	n/a
Hay River (Qld)	0	n/a	0	I	0	n/a	0	I	n/a
Lake Frome (Qld)	0	n/a	0	I	0	n/a	0	I	n/a
South Australia									
Cooper Creek (SA)	0	n/a	0	I	0	n/a	0	n/a	0
Diamantina River (SA)	0	n/a	0	I	0	n/a	0	n/a	0

Refer to page 90 for explanatory notes.

Surface water management area	Developed yield Volume (ML)	Developed yield Reliability class	Diversion Volume (ML)	Diversion Development category	Water use Volume (ML)	Water use Reliability class	Water allocation Volume (ML)	Water allocation Development category	Sustainable yield (ML)
10 Lake Eyre Drainage Division (continued)									
South Australia (continued)									
Finke River (SA)	0	n/a	0	I	0	n/a	0	n/a	0
Georgina River (SA)	0	n/a	0	I	0	n/a	0	n/a	0
Hay River (SA)	0	n/a	0	I	0	n/a	0	n/a	0
Lake Frome (SA)	0	n/a	0	I	0	n/a	0	n/a	9 000
Total	**375**	**–**	**7 332**	**–**	**7 332**	**–**	**6 957**	**–**	**153 000**
11 Bulloo – Bancannia Drainage Division									
New South Wales									
Bulloo River (NSW part only)	0	D	0	I	0	n/a	0	n/a	0
Lake Bancannia	0	D	n/a	I	n/a	n/a	n/a	n/a	n/a
Bulloo River (Qld)	n/a	n/a	135	I	135	B	135	I	n/a
Total	**0**	**–**	**135**	**–**	**135**	**–**	**135**	**–**	**0**
12 Western Plateau Drainage Division									
Northern Territory									
Barkly	575	C	575	I	575	C	n/a	n/a	30 000
Burt	85	C	85	I	85	C	n/a	n/a	3 800
Mackay (NT)	145	C	145	I	145	C	n/a	n/a	1 100
Warburton (NT)	n/a	n/a	0	I	0	n/a	n/a	n/a	n/a
Wiso	320	C	320	I	320	C	n/a	n/a	40 000
Gairdner	0	n/a	0	I	1 505	B	0	n/a	0
Mackay (SA)	0	n/a	0	I	0	n/a	0	n/a	0
Nullarbor (SA)	0	n/a	0	I	0	n/a	0	n/a	0
Warburton (SA)	0	n/a	0	I	0	n/a	0	n/a	0
Mackay (WA)	0	C	0	I	0	n/a	n/a	I	0
Nullarbor (WA)	0	C	0	I	0	n/a	n/a	I	0
Salt Lake	40	C	40	I	11 406	A	n/a	I	1 031
Sandy Desert	0	C	0	I	0	n/a	n/a	I	0
Warburton (WA)	0	C	0	I	0	n/a	n/a	I	0
Total	**1 165**	**–**	**1 165**	**–**	**14 036**	**–**	**0**	**–**	**75 931**
Grand total	**20 868 530**	**–**	**19 657 660**	**–**	**16 067 937**	**–**	**19 286 084**	**–**	**45 191 203**

Refer to page 90 for explanatory notes.



APPENDIX 2. GROUNDWATER AVAILABILITY

Assessment reliability

The quality of Australian Water Resources Assessment varies across attributes. It was evaluated using a qualitative scale. Appendices 4 & 5 provide a summary of extent, completeness and reliability estimate of the databases that supports this water resource assessment.

Data presented are as supplied by the States and Territories. While every effort has been taken to identify obvious errors in the data, users should verify the data with the agencies.

Readers should also refer to Appendix 3 for explanation of the assessment methods used by State and Territory agencies.

In the following tables, n/a signifies that data was either not assessed or not available.

Estimates of data reliability.

Class	Groundwater quantity
A	Based on reliable recorded and surveyed data that have required little or no extrapolation or interpolation. Estimated accuracy: ±10%.
B	Based on approximate analysis and limited surveys. Some measured data and some interpolation/extrapolation to derive the dataset. Estimated accuracy: ±10% to 25%.
C	Little measured data, based on reconnaissance data. Estimated accuracy: ±25% to 50%.
D	Derived without investigation data. Figures estimated from data in nearby catchments, or extrapolated/interpolated from any available data. Estimated accuracy: ±50%.

Categories are defined by the percentage of water abstracted from the groundwater management unit and sustainable yield.

Table A2. Summary data for groundwater management units.

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
1F Coen Groundwater Province						
Queensland						
Unincorporated area – Coen	n/a	n/a	n/a	n/a	n/a	n/a
2S Laura Groundwater Province						
Queensland						
Unincorporated area – Laura	n/a	n/a	n/a	n/a	n/a	n/a
3F Tasman Groundwater Province						
Queensland						
Alligator Creek	4 000	n/a	n/a	n/a	1	D
Atherton	14 500	14 500	3	11 023	4	B
Barambah Creek	1 800	1 650	3	n/a	1	C

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
3F Tasman Groundwater Province (continued)						
Queensland (continued)						
Barker Creek	6 200	5 750	3	n/a	1	C
Barron Delta	3 440	131		3 086	4	B
Black River alluvium	6 000	7 500	4	10 683	4	D
Boyne River	7 000	n/a	n/a	n/a	1	D
Braeside/Nebo	2 500	2 800	4	4 443	4	D
Bribie Island	25 000	1 610	1	n/a	1	C
Burdekin River Delta	350 000	n/a	n/a	n/a	1	B
Burdekin River Irrigation Area (left bank)	40 000	29 130	3	66 232	3	D
Burdekin River Irrigation Area (right bank)	20 000	n/a	3	n/a	1	D
Callide Valley	12 000	16 614	4	32 107	4	A
Cattle Creek	400	n/a	1	415	4	D
Cooloola	1 130	n/a	n/a	n/a	1	A
Cooyar Creek	100	n/a	n/a	n/a	1	D
Cressbrook Creek	3 800	2 924	3	n/a	1	B
Dawson River (Cracow to Theodore)	8 000	n/a	n/a	n/a	1	D
Don and Dee Rivers	11 800	n/a		12 966	4	D
Don River	17 000	12 792	3	19 395	4	B
Duck Farm	n/a	28	n/a	135	n/a	n/a
Farnborough/Waterpark	1 200	1 670	4	1 669	4	D
Fraser Island	216 000	253	1	253	1	D
Gooburrum	25 000	9 658	3	22 564	3	A
Herbert River	64 000	600	1	n/a	1	B
Isaac River	30 000	n/a	n/a	1 274	1	D
Isis River	3 000	n/a		n/a	1	D
Johnstone River	63 500	n/a	1	n/a	1	C
Koumala	4 000	4 000	4	5 640	4	D
Mary River	1 000	n/a		n/a	1	D
Mossman	19 000	4	1	2 367	1	B
Mt Larcom	2 000	n/a	n/a	n/a	1	D
Mulgrave River	20 000	35	1	9 847	2	A
Nangur Creek	8 000	4 900	4	n/a	1	C
North Stradbroke Island	100 000	14 552	2	58 662	1	B
Pioneer River	67 660	16 255	1	88 770	4	C

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
3F Tasman Groundwater Province (continued)						
Queensland (continued)						
Proserpine River	19 600	10 000	2	21 745	4	B
Rochedale	1 300	2 000	4	n/a	1	C
Russell River	25 000	n/a	1	n/a	1	D
Stanley River	9 700	2 500	3	n/a	1	C
Stuart River	500	n/a	3	n/a	1	C
Three Moon Creek	22 500	8 658	2	20 535	3	D
Townsville/Thuringowa	12 500	n/a	n/a	1 425	1	D
Tully/Murray Rivers	19 000	2 000	1	n/a	1	B
Unincorporated area – Bowen	260 000	n/a	1	n/a	1	D
Unincorporated area – Hodgkinson	250 000	n/a	n/a	n/a	1	D
Unincorporated area – Ravenswood	n/a	n/a	n/a	n/a	1	n/a
Unincorporated area – Yarraman	170 000	n/a	n/a	n/a	1	D
Woongarra	30 000	17 539	2	37 810	4	A
4S Clarence – Moreton Groundwater Province						
New South Wales						
Alstonville Basalt	22 000	4 700	2	8 200	2	C
North coast fractured rocks	80 000	1 200	1	2 248	1	D
Richmond coastal sands	68 000	6	1	6	1	D
Richmond River alluvium	13 000	3 608	1	4 593	1	I
Unincorporated area – Clarence – Moreton Basin	427 500	4 515	1	8 420	1	D
Queensland						
Central Lockyer Valley	14 000	13 607	3	n/a	1	A
Condamine – Condamine Groundwater management unit Sub-area 4	1 930	1 302	2	3 694	4	A
Condamine River alluvium (Cunningham to Ellangowan)	9 400	6 000	2	8 080	3	B
Condamine River alluvium (Killarney to Murray Bridge)	2 300	1 500	2	2 061	3	B
Condamine River alluvium (Murray Bridge to Cunningham)	7 000	4 000	2	4 165	2	B
Dalrymple Creek alluvium	7 560	3 111	2	4 315	3	B
Flagstone Creek	700	700	3	n/a	1	D
Glengallan Creek	4 330	8 090	4	6 775	4	A

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Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
4S Clarence – Moreton Groundwater Province (continued)						
Queensland (continued)						
King's Creek alluvium	4 230	1 200	1	1 780	2	B
Laidley Creek (upper reach)	2 500	n/a	3	n/a	1	D
Lockyer – Helidon	1 500	1 500	3	n/a	1	D
Logan/Albert Rivers	13 950	11 000	3	n/a	1	C
Lower Lockyer Creek	3 000	4 000	4	n/a	1	B
Lower Oakey Creek alluvium	6 500	2 500	2	6 013	3	D
Ma Ma Creek	970	970	3	n/a	1	D
Myall/Moola Creek North	3 500	2 000	2	2 341	2	B
Myall Creek	5 300	n/a	1	1 096	1	B
Nobby Basalts	2 400	3 712	4	2 775	4	B
Oakey Creek Management Area	7 000	4 205	2	9 663	4	B
Sandy Creek	580	580	3	n/a	1	C
Swan Creek alluvium	900	800	3	1 365	4	B
Tenthill Creek	2 400	2 400	3	n/a	1	D
Toowoomba City Basalt	6 500	2 500	2	5 544	3	C
Unincorporated area – Clarence – Moreton Basin	79 000	n/a	n/a	n/a	n/a	D
Upper Hodgson Creek	4 800	473	1	2 518	2	B
Upper Lockyer Creek	4 000	4 000	3	n/a	1	D
5F New England Groundwater Province						
New South Wales						
Bellinger coastal sands	2 080	2	1	2	1	D
Hastings River alluvium	12 710	973	1	999	1	D
Inverell basalt	8 600	1 549	1	3 015	1	D
Macleay alluvium and coastal sands	25 000	14 171	2	15 296	2	D
Miscellaneous tributaries of the Namoi River (alluvium)	5 000	4 321	3	14 906	4	D
Peel River alluvium	10 000	8 000	2	33 000	4	C
Unincorporated area – New England Province	1 864 544	32 195	1	45 422	1	D
Viney Creek alluvium and coastal sands	21 000	1 005	1	1 001	1	D
Queensland						
Border Rivers	30 000	3 946	1	30 890	4	B

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6S Sydney Groundwater Province						
New South Wales						
Blue Mountains sandstone	39 000	10 780	2	2 509	2	C
Botany sand beds	22 500	11 000	2	5 859	1	B
Coolaburragundy – Talbragar Valley alluvium	7 000	1 800	1	7 189	3	D
Hunter Valley alluvium	57 000	34 491	2	104 529	4	D
Mangrove Mountain	26 600	674	1	2 336	1	B
Maroota tertiary sand	200	182	3	182	3	C
Maules Creek alluvium	7 000	665	1	8 833	4	C
Southern Highlands	221 000	9 762	1	21 494	1	C
Tomago/Stockton/Tomaree sandbeds	45 000	34 816	3	52 616	4	C
Unincorporated area – Gunnedah Basin	208 000	4 069	1	7 293	1	D
Unincorporated area – Oxley Basin	179 000	6 818	1	12 350	1	D
Unincorporated area – Sydney Basin	555 000	7 047	1	5 857	1	D
Upper Namoi alluvium	118 000	81 800	3	279 176	4	B
7F Lachlan Groundwater Province						
Australian Capital Territory*						
Murrumbidgee	9 900	2 450	1	3 550	1	D
Namadgi	54 600	300	1	450	1	D
Queanbeyan and Molonglo	38 250	2 100	1	3 300	1	D
New South Wales						
Araluen alluvium and weathered granite	1 700	570	2	494	2	C
Bell Valley alluvium	7 000	1 050	1	5 918	3	C
Belubula River alluvium	6 000	3 000	2	19 152	4	C
Billabong Creek alluvium	20 000	2 330	1	7 461	1	C
Cudgegong Valley alluvium	12 000	3 200	1	15 769	4	C
Lower Macquarie alluvium	48 200	34 006	3	154 021	4	C
Mid and upper Murrumbidgee Catchment fractured rocks	6 000	2 004	2	1 577	2	C
Mid Murrumbidgee alluvium	89 000	36 956	2	50 823	2	C
Molong Limestone	7 000	800	2	4 000	3	D
Mudgee Limestone	2 000	510	1	2 459	3	D

* Includes information relating to the Queanbeyan River Catchment in New South Wales.

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7F Lachlan Groundwater Province						
New South Wales						
Orange Basalt	17 000	6 400	1	7 684	1	D
Unincorporated area – Lachlan Fold Belt Province	428 900	23 552	1	47 101	1	D
Upper Lachlan alluvium	205 000	47 559	1	174 474	3	C
Upper Macquarie alluvium	30 000	11 000	2	43 127	4	C
Young Granite	15 500	7 095	2	18 010	4	D
Victoria						
Alexandra	5 025	720	1	935	1	B
Ascot	8 100	5 590	3	8 226	3	B
Bullarook	5 015	n/a	1	n/a	1	B
Bungaree	4 400	4 337	4	5 870	4	B
Glengower	6 550	n/a	1	n/a	1	n/a
King Lake	3 800	943	1	1 906	1	B
Lancefield	1 480	739	3	972	2	B
Moolort	6 650	2 560	2	3 340	2	B
Spring Hill Groundwater Supply Protection Area	5 100	610	1	1 500	1	B
Tourello	2 730	n/a	1	n/a	1	B
Unincorporated area – Lachlan	440 000	22 780	1	23 140	1	B
Wandin Yallock	3 300	1 935	3	2 580	3	B
8S Gippsland Groundwater Province						
Victoria						
Denison Groundwater Supply Protection Area	12 000	11 325	4	12 115	4	B
Giffard	3 700	2 241	2	2 980	3	B
Leongatha	11 000	683	1	912	1	B
Moe	8 200	1 158	1	1 545	2	B
Rosedale	14 000	14 969	4	19 948	4	B
Sale Groundwater Supply Protection Area	13 000	9 014	3	14 828	4	B
Seacombe	100 000	113 575	4	113 785	4	B
Tarwin	3 350	1 115	2	1 490	2	B
Unincorporated area – Gippsland (lower tertiary aquifer)	n/a	n/a	1	n/a	2	n/a
Unincorporated area – Gippsland (middle tertiary aquifer)	61 875	n/a	1	n/a	1	B

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
8S Gippsland Groundwater Province						
Victoria						
Unincorporated area – Gippsland (upper tertiary aquifer)	n/a	680	1	680	1	n/a
Unincorporated area – Gippsland (watertable aquifer)	360 000	17 690	1	17 690	1	B
Wa De Lock	31 850	8 861	3	11 653	2	B
Wy Yung	9 070	5 004	2	6 754	3	B
9S Westernport Groundwater Province						
Victoria						
Corinella	3 600	545	1	723	1	B
Koo-wee-rup Dalmore Groundwater Conservation Area	10 608	5 750	3	7 050	3	D
Lang Lang	4 080	3 434	4	3 645	4	B
Unincorporated area – Westernport	20 000	2 880	1	2 880	1	B
10S Port Phillip Groundwater Province						
Victoria						
Cut Paw Paw	4 750	662	1	870	1	B
Deutgam	2 400	3 394	4	4 518	4	B
Frankston	4 950	1 134	2	1 391	2	B
Jan Juc	6 800	3 009	2	4 012	2	B
Merrimu	450	356	3	362	3	B
Moorabbin	4 300	1 860	2	2 495	2	B
Nepean	10 300	3 051	3	4 016	2	B
Unincorporated area – Port Phillip (lower tertiary aquifer)	48 800	n/a	1	n/a	1	B
Unincorporated area – Port Phillip (middle tertiary aquifer)	11 400	650	1	650	1	B
Unincorporated area – Port Phillip (watertable aquifer)	121 700	7 570	1	7 570	1	B
11S Otway Highlands Groundwater Province						
Victoria						
Unincorporated area – Otway Highlands	86 000	20	1	20	1	B

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Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
12S Otways Groundwater Province						
South Australia						
Comaum Caroline 1	85 400	33 800	2	69 800	2	B
Comaum Caroline 2	28 500	n/a	1	S34*	2	C
Lacepede – Kongorong 1	546 000	66 500	1	150 500	1	C
Lacepede – Kongorong 2	62 500	18 200	1	27 600	1	C
Victoria						
Colangulac	14 200	1 679	1	2 248	1	C
Condah	8 700	909	3	1 208	2	B
Gellibrand	0	30	3	n/a	3	B
Gerangamete	4 000	9 447	4	12 619	4	B
Glenormiston	5 000	1 137	2	1 533	2	B
Heywood	21 700	4 465	2	5 974	2	B
Lake Mundi	48 000	10 584	2	14 060	2	B
Newlingrook	41 650	n/a	1	159	1	B
Nullawarre Groundwater Supply Protection Area	25 100	16 915	3	22 551	3	B
Paaratte	4 600	1 001	3	1 093	1	B
Portland	20 600	4 645	1	4 787	1	B
Unincorporated area – Otways (lower tertiary aquifer)	131 340	60	1	60	1	B
Unincorporated area – Otways (middle tertiary aquifer)	900	426	2	426	2	B
Unincorporated area – Otways (watertable aquifer)	740 200	31 760	1	31 760	1	B
Warrion	16 500	8 343	3	11 150	3	C
Yangery Groundwater Supply Protection Area	11 500	7 930	4	10 605	4	B
13SF1 Tasmania 1 Groundwater Province						
Tasmania						
Burnie	135 000	2 155	1	2 155	1	B
Smithton	60 000	832	1	832	1	B
Unincorporated area – West	1 315 046	1 906	1	1 906	1	B

* S43: refer to Curdimurka (Wellfield A) in 55S Groundwater Province in South Australia.

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Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
13SF2 Tasmania 2 Groundwater Province						
Tasmania						
Llandherne	3 039	29	1	29	1	B
Longford	25 661	1 116	1	1 116	1	B
Sorell	449	302	2	302	2	B
Spreyton	2 500	183	1	183	1	B
St Marys	458	81	1	81	1	B
Unincorporated area – Central South East	728 383	10 236	1	10 236	1	B
Wesley Vale	4 825	2 649	2	2 648	2	B
13SF3 Tasmania 3 Groundwater Province						
Tasmania						
Flinders Island	38 322	80	1	80	1	B
Ledgerwood	1 017	29	1	29	1	B
Ringarooma	1 017	60	1	60	1	B
Scottsdale	963	56	1	56	1	B
Tomahawk	38 138	5	1	5	1	B
Unincorporated area – North East	175 191	498	1	498	1	B
Winnaleah	763	35	1	35	1	B
14S Murray Groundwater Province						
New South Wales						
Lower Lachlan alluvium	94 000	28 011	2	237 452	4	C
Lower Murray alluvium	136 000	102 870	4	331 646	4	C
Lower Murrumbidgee alluvium	226 000	184 063	3	384 376	4	B
Unincorporated area – Murray Basin	480 000	2 100	1	2 100	1	D
Upper Murray alluvium	30 300	13 093	2	39 476	4	C
South Australia						
Angas Bremer	5 000	1 700	2	6 500	3	B
Mallee 1	52 800	17 500	2	35 900	2	B
Mallee 2	7 500	n/a	1	S20*	2	C
Marne	n/a	n/a	3	n/a	n/a	n/a
Naracoorte Ranges 1	81 700	41 000	2	78 700	3	B
Naracoorte Ranges 2	4 500	n/a	1	S28**	3	C

* S20: refer to Mallee 1 in 14S Groundwater Province in South Australia.

** S28: refer to Naracoorte Ranges 1 in 14S Groundwater Province in South Australia.

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use Total abstraction (ML)	Groundwater use Development category	Groundwater allocation Total allocation (ML)	Groundwater allocation Development category	Sustainable yield assessment reliability
14S Murray Groundwater Province (continued)						
South Australia (continued)						
Padthaway 1	35 100	24 200	3	35 100	3	A
Padthaway 2	1 000	n/a	1	S26*	3	C
Tatiara 1	86 500	60 900	3	90 500	3	B
Tatiara 2	4 000	n/a	1	S24**	3	C
Tintinara 1	n/a	17 500	3	17 500	3	n/a
Tintinara 2	n/a	8 000	3	8 000	3	n/a
Unincorporated area 1 – Murray Group Limestone	20 000	5 500	1	n/a	n/a	D
Unincorporated area 2 – Renmark Group	20 000	1 000	1	n/a	n/a	D
Victoria						
Balrootan (Nhill)	1 000	910	3	1 550	4	B
Barnawartha	2 400	83	1	102	1	B
Berrook	1 100	n/a	1	n/a	1	B
Boikerbert (Apsley)	24 300	990	1	1 380	1	B
Bridgewater (Loddon)	14 200	13 321	3	17 742	4	B
Campaspe Groundwater Supply Protection Area	19 850	31 040	4	38 670	4	B
Ellesmere	2 400	436	1	841	1	B
Goorambat	4 850	655	1	1 270	1	B
Katunga Groundwater Supply Protection Area	12 500	33 141	4	50 292	4	B
Kialla	4 770	1 435	1	1 759	2	B
Lillimur (Kaniva)	6 950	1 510	1	1 760	1	B
Mullindolingong	6 980	760	1	1 270	1	B
Murmungee	16 710	7 500	1	12 250	2	B
Murrayville Groundwater Supply Protection Area	1 815	1 950	4	5 110	4	B
Nagambie	5 650	1 393	1	7 214	1	B
Neuarpur Groundwater Supply Protection Area	10 307	12 660	4	18 430	4	B
Salisbury West	9 200	153	1	233	1	B
Shepparton Groundwater Supply Protection Area	170 000	127 880	3	180 678	3	A
Telopea Downs	8 970	490	1	640	1	B

* S26: refer to Padthaway 1 in 14S Groundwater Province in South Australia.

** S24: refer to Tatiara 1 in 14S Groundwater Province in South Australia.

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
14S Murray Groundwater Province (continued)						
Victoria (continued)						
Unincorporated area – Murray (lower tertiary aquifer)	27 000	n/a	1	n/a	1	B
Unincorporated area – Murray (middle tertiary aquifer)	42 000	5 070	1	5 070	1	B
Unincorporated area – Murray (watertable aquifer)	770 000	20 450	1	20 450	1	B
15F Olary Groundwater Province						
New South Wales						
Unincorporated area – Olary Province	153 000	265	1	501	1	D
16F Mt Lofty – Flinders Ranges Groundwater Province						
South Australia						
Adelaide Metropolitan T1	3 400	n/a	2	n/a		D
Adelaide Metropolitan T2	1 100	200	2	n/a	n/a	D
Northern Adelaide plains T1	8 000	18 400	4	26 500	4	n/a
Northern Adelaide plains T2	n/a	S10*	4	S10*	4	D
Unincorporated area	n/a	n/a	1	n/a	n/a	n/a
Willunga Embayment	6 000	6 500	3	6 000	3	B
17F St Vincent Groundwater Province						
South Australia						
Unincorporated area	1 250	n/a	1	n/a	n/a	D
18F Yorke Peninsula Groundwater Province						
South Australia						
Unincorporated area	1 000	n/a	2	n/a	n/a	D
19S Pirie – Torrens Groundwater Province						
South Australia						
Unincorporated area	n/a	n/a	1	n/a	n/a	n/a
21 F Gawler Groundwater Province						
South Australia						
Carribie Basin	800	6	1	n/a	n/a	D
Para Wurlie Basin	800	200	3	n/a	n/a	D
Penong	2	4	3	n/a	n/a	B
Robinson	240	230	3	n/a	n/a	A
Unincorporated area	1 000	n/a	1	n/a	n/a	D

* S10: refer to Northern Adelaide Plains T2 in 16F Groundwater Province in South Australia.

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Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
22S Eucla Groundwater Province						
South Australia						
Unincorporated area	5 000	n/a	1	n/a	n/a	D
Western Australia						
Eucla North	5 323	n/a	1	0	1	C
Eucla South	83 315	n/a	1	0	1	C
23.1F Albany – Fraser 1 Groundwater Province						
Western Australia						
Albany – Fraser East	135 133	212	1	212	1	C
Gibson	3 344	25	1	25	1	C
23.2F Albany Fraser 2 Groundwater Province						
Western Australia						
Albany – Fraser West	64 629	n/a	1	0	1	C
24.1S Bremer 1 Groundwater Province						
Western Australia						
Bremer East	28 016	n/a	1	0	1	C
Condingup	51	n/a	1	0	1	C
Esperance	4 549	3 378	3	3 378	3	C
Hopetoun	592	144	1	144	1	C
24.2S Bremer 2 Groundwater Province						
Western Australia						
Albany	4 647	4 647	3	4 647	3	C
Bremer Bay	231	134	2	134	2	C
Bremer West	29 161	111	1	111	1	C
25F Leeuwin Groundwater Province						
Western Australia						
Blackwood – Leeuwin	4 922	1 836	2	1 836	2	B
Busselton Capel – Naturaliste	4 938	190	1	190	1	B
26S Perth Groundwater Province						
Western Australia						
Arrowsmith – Cockleshell Gully North	2 955	n/a	1	0	1	B
Arrowsmith – Cockleshell Gully South	3 500	86	1	86	1	B
Arrowsmith – Lesueur	2 000	837	2	837	2	B
Arrowsmith – Mullingarra	2 067	n/a	1	0	1	B
Arrowsmith – Parmelia	52 000	888	1	888	1	B

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26S Perth Groundwater Province (continued)						
Western Australia (continued)						
Arrowsmith – Superficial	8 000	3 868	2	3 868	2	B
Arrowsmith – Yarragadee	83 500	35 019	2	35 019	2	B
Blackwood – Leederville	110 788	3 919	1	3 919	1	B
Blackwood – Lesueur	8 934	8 621	3	8 621	3	B
Blackwood – Sue	1 398	549	2	549	2	B
Blackwood – Superficial	92 253	470	1	470	1	B
Blackwood – Yarragadee	25 380	6 537	1	6 537	1	B
Bunbury – Leederville	17 000	6 797	2	6 797	2	B
Bunbury – Superficial	19 700	3 830	1	3 830	1	B
Bunbury – Yarragadee	33 000	19 705	2	19 705	2	B
Busselton Capel – Leederville	23 400	19 880	3	19 880	3	B
Busselton Capel – Sue	4 000	847	1	847	1	B
Busselton Capel – Superficial	35 800	4 962	1	4 962	1	B
Busselton Capel – Yarragadee	67 000	16 418	1	16 418	1	B
Cockburn – Leederville	6	6	3	6	3	B
Cockburn – Superficial	29 230	29 230	3	29 230	3	A
Cockburn – Yarragadee	5 786	5 786	3	5 786	3	B
Gascoyne – Yarragadee	14 972	282	1	282	1	C
Gascoyne – Yuna	41 238	377	1	377	1	C
Gingin – Leederville	34 390	14 004	2	14 004	2	B
Gingin – Leederville – Parmelia	37 500	30 520	3	30 520	3	B
Gingin – Superficial – Plateau	8 040	5 402	2	5 402	2	B
Gingin – Superficial – Coastal Plain	255 440	64 796	1	64 796	1	B
Gingin – Yarragadee	37 550	3 882	1	3 882	1	B
Gnangara – Leederville	23 840	23 840	3	23 840	3	B
Gnangara – Superficial	65 880	31 859	2	31 859	2	B
Gnangara – Yarragadee	25 150	25 150	3	25 150	3	B
Gwelup – Leederville	4 680	4 680	3	4 680	3	B
Gwelup – Superficial	14 060	14 060	3	14 060	3	B
Gwelup – Yarragadee	3 500	3 500	3	3 500	3	B
Jandakot – Leederville	1 973	1 973	3	1 973	3	B
Jandakot – Superficial	23 850	18 308	3	18 308	3	B
Jandakot – Yarragadee	0	n/a	1	0	1	B
Jurien – Cockleshell Gully	8 800	n/a	1	0	1	B
Jurien – Leederville	20 800	2 272	1	2 272	1	B

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use Total abstraction (ML)	Groundwater use Development category	Groundwater allocation Total allocation (ML)	Groundwater allocation Development category	Sustainable yield assessment reliability
26S Perth Groundwater Province (continued)						
Western Australia (continued)						
Jurien – Lesueur	3 000	n/a	1	0	1	B
Jurien – Superficial	48 500	982	1	982	1	B
Jurien – Yarragadee	25 100	1 016	1	1 016	1	B
Mirrabooka – Leederville	4 002	4 002	3	4 002	3	B
Mirrabooka – Superficial	26 850	24 281	3	24 281	3	B
Mirrabooka – Yarragadee	2 000	2 000	3	2 000	3	B
Murray – Cockleshell Gully	2 597	3 775	4	3 775	4	B
Murray – Leederville	28 272	4 547	1	4 547	1	B
Murray – Superficial	62 324	2 012	1	2 012	1	B
Perth – Leederville	17 297	17 297	3	17 297	3	B
Perth – Superficial	129 109	129 109	3	129 109	3	B
Perth – Yarragadee	15 940	15 940	3	15 940	3	B
Rockingham – Cockleshell Gully	141	n/a	1	0	1	B
Rockingham – Leederville	487	486	3	486	3	B
Rockingham – Superficial	34 960	25 505	3	25 505	3	B
Rockingham – Yarragadee	0	n/a	1	0	1	B
Rottnest – Superficial	998	51	1	51	1	B
Serpentine – Cockleshell Gully	284	240	3	240	3	B
Serpentine – Leederville	3 140	3 141	3	3 141	3	B
Serpentine – Superficial	35 163	12 463	2	12 463	2	B
Serpentine – Yarragadee	135	135	3	135	3	B
Southwest coastal – Cockleshell Gully	847	n/a	1	0	1	B
Southwest coastal – Leederville	25 407	2 921	1	2 921	1	B
Southwest coastal – Superficial	60 000	23 416	2	23 416	2	B
Swan – Leederville	5 659	5 659	3	5 659	3	B
Swan – Superficial	22 200	14 926	2	14 926	2	B
Swan – Yarragadee	1	1	3	1	3	B
Unincorporated area – Cookernup	37 320	600	1	600	1	B
Wanneroo – Leederville	0	n/a	1	0	1	B
Wanneroo – Superficial	58 600	34 828	2	34 828	2	B
Wanneroo – Yarragadee	0	n/a	1	0	1	B
Yanchep – Leederville	400	400	3	400	3	B
Yanchep – Superficial	10 373	1 758	1	1 758	1	B
Yanchep – Yarragadee	0	n/a	1	0	1	B

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use Total abstraction (ML)	Groundwater use Development category	Groundwater allocation Total allocation (ML)	Groundwater allocation Development category	Sustainable yield assessment reliability
27S Collie Groundwater Province						
Western Australia						
Collie	8 300	23 520	4	23 520	4	A
28F Yilgarn Groundwater Province						
Western Australia						
Arrowsmith – Coorow	2 360	n/a	1	0	1	B
Bolgart – Bolgart East	342	43	1	43	1	B
Dwellingup	20	16	3	16	3	B
East Murchison – Ningham	28 464	5 953	1	5 953	1	C
Gascoyne – Mullewa	35 676	2 785	1	2 785	1	C
Gingin – Superficial – Scarp	1 248	855	2	855	2	B
Goldfields – Deborah	40 419	7 308	1	7 308	1	C
Happy Valley	128	85	2	85	2	B
Jurien – Watheroo	1 918	650	2	650	2	B
Kondinin – Ravensthorpe	15 580	235	1	235	1	C
New Norcia	333	30	1	30	1	B
Swan – Superficial – Scarp	2 805	615	1	615	1	B
Westonia	23 761	1 040	1	1 040	1	C
Yenart	333	86	1	86	1	B
Yerecoin	950	30	1	30	1	B
Yilgarn – Southwest	406 178	3 700	1	3 700	1	C
29F Yilgarn – Gold Fields Groundwater Province						
Western Australia						
East Murchison – Wiluna	62 073	5 421	1	5 421	1	C
East Murchison – Wiluna Superficial	6 540	6 540	3	6 540	3	C
Goldfields – Lake Carey	31 340	10 107	2	10 107	2	C
Goldfields – Lake Carey – Superficial	30 672	30 672	3	30 672	3	C
Goldfields – Lefroy – Dundas	48 381	5 332	1	5 332	1	C
Goldfields – Lefroy – Dundas – Superficial	13 709	6 690	2	6 690	2	C
Goldfields – Minigwal	59 292	28	1	28	1	C
Goldfields – Raeside	20 311	8 125	2	8 125	2	C
Goldfields – Raeside – Superficial	10 515	10 514	3	10 514	3	C
Goldfields – Rebecca	37 276	3 313	1	3 313	1	C
Goldfields – Rebecca – Superficial	6 315	6 315	3	6 315	3	C
Goldfields – Roe	12 206	12 205	3	12 205	3	C
Goldfields – Roe – Superficial	30 173	30 173	3	30 173	3	C

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
30F Yilgarn– Murchison Groundwater Province						
Western Australia						
East Murchison – Cue	56 041	29 796	2	29 796	2	C
Gascoyne – Byro	50 515	15	1	15	1	C
31.F Northampton Groundwater Province						
Western Australia						
Northampton Complex	15 553	1 946	1	1 946	1	C
Northampton Town	876	186	1	186	1	C
32S Carnarvon Groundwater Province						
Western Australia						
Gascoyne – alluvium	4 417	4 417	3	4 417	3	C
Gascoyne – Bidgienaya	33 002	90	1	90	1	C
Gascoyne – Birdrong	27 907	19 986	3	19 986	3	C
Gascoyne	5 581	5 581	3	5 581	3	C
Gascoyne – Exmouth	2 402	1 560	2	1 560	2	C
Gascoyne – Superficial	100 540	227	1	227	1	C
Gascoyne – Tumblagooda	19 656	366	1	366	1	C
Pilbara – Peedamulla	3 300	n/a	1	0	1	C
Pilbara – Peedamulla Superficial	47 656	350	1	350	1	C
33.1F Capricorn 1 Groundwater Province						
Western Australia						
Nabberu	63 353	n/a	1	0	1	C
33.2F Capricorn 2 Groundwater Province						
Western Australia						
Glengarry	18 496	2 160	1	2 160	1	C
33.3F Capricorn 3 Groundwater Province						
Western Australia						
Gascoyne – Province	89 326	10	1	10	1	C
33.4F Capricorn 4 Groundwater Province						
Western Australia						
Ashburton – Province	63 246	164	1	164	1	C
34F Marymia Groundwater Province						
Western Australia						
Marymia	6 250	6 250	3	6 250	3	C

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use Total abstraction (ML)	Groundwater use Development category	Groundwater allocation Total allocation (ML)	Groundwater allocation Development category	Sustainable yield assessment reliability
35F Banemall Groundwater Province						
Western Australia						
Banemall	65 686	14 082	1	14 082	1	C
36F Calyie – McFadden Groundwater Province						
Western Australia						
Savory	94 335	n/a	1	0	1	C
37F Sylvania Groundwater Province						
Western Australia						
Sylvania	5 244	n/a	1	0	1	C
38F Hamersley Groundwater Province						
Western Australia						
Hamersley – Carawine	31 500	31 500	3	31 500	3	C
Hamersley – Fortescue	15 100	15 100	3	15 100	3	C
Hamersley – Wittenoom	16 130	319	1	319	1	C
Hamersley East	75 920	16 400	1	16 400	1	C
Hamersley West	174 995	15 500	1	15 500	1	C
39S Pilbara Groundwater Province						
Western Australia						
Pilbara – Coast alluvium	12 808	5 000	2	5 000	2	C
Pilbara – East	100 990	3 020	1	3 020	1	C
Pilbara – West	45 027	475	1	475	1	C
40F Paterson Groundwater Province						
Western Australia						
Paterson	19 181	n/a	1	0	1	C
41S Canning Groundwater Province						
Western Australia						
Canning – Broome Town	15 770	6 513	2	6 513	2	B
Canning	296 305	n/a	1	0	1	C
Canning – Dora	37 428	n/a	1	0	1	C
Canning – Erskine	21 153	n/a	1	0	1	B
Canning – Erskine Southeast	5 520	n/a	1	0	1	C
Canning – Lagrange	79 596	1 533	1	1 533	1	B
Canning – Napier	29 222	3 390	1	3 390	1	C
Canning – Pardoo	13 005	227	1	227	1	C
Canning – Pender	105 517	2 258	1	2 258	1	B

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
41S Canning Groundwater Province (continued)						
Western Australia (continued)						
Canning – Wallal	218 073	n/a	1	0	1	C
Derby	5 406	2 699	2	2 699	2	B
42F Kimberly Groundwater Province						
Western Australia						
Kimberley	83 185	n/a	1	0	1	C
43F Halls Creek Groundwater Province						
Northern Territory						
Unincorporated area – metamorphic rock (Kununurra)	443	n/a	1	n/a	1	D
Western Australia						
Halls Creek Province	217 811	6 996	1	6 996	1	C
44S Bonaparte Groundwater Province						
Northern Territory						
Unincorporated area – Alluvial sands	1 403	10	1	10	1	1
Unincorporated area – Palaeozoic sandstone (Wadeye)	1 139 063	686	1	221	1	D
Unincorporated area – Palaeozoic shale (Kununurra)	570	5	1	n/a	1	D
Western Australia						
Bonaparte	122 504	2 000	1	2 000	1	C
45F Ord – Victoria Groundwater Province						
Northern Territory						
Unincorporated area – Palaeozoic basalt (Lajamanu)	144 649	3 072	1	2 795	1	D
Unincorporated area – Proterozoic dolomite (Yarralin)	3 395	275	1	275	1	D
Unincorporated area – Proterozoic sedimentary rock (Timber Creek)	205 046	2 270	1	1 973	1	D
Unincorporated area – Proterozoic sedimentary rock, low yield (Kalkarind)	14 930	1 287	1	656	1	D
Unincorporated area – tertiary sedimentary rock (Yarralin)	715	68	1	68	1	D
Ord – Argyle	82 080	n/a	1	n/a	1	C
Ord – Bungle Bungle	19 024	n/a	1	n/a	1	C
Ord – Nicholson	90 724	n/a	1	n/a	1	C

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
46F Pine Creek Groundwater Province						
Northern Territory						
Berry Springs Dolomite	7 480	4 761	2	471	1	C
Koolpinyah Dolomite	44 642	18 920	2	10 691	1	C
Unincorporated area – Cretaceous sedimentary rock (Anura Bay)	5 231	n/a	1	n/a	1	D
Unincorporated area – granite (Goomadeer)	96 758	393	1	393	1	D
Unincorporated area – Palaeozoic limestone (Daly River)	106 275	171	1	171	1	D
Unincorporated area – Proterozoic dolomite (Bark Hut Inn)	412 988	561	1	131	1	D
Unincorporated area – Proterozoic sedimentary (Adelaide River)	249 375	17 048	1	3 830	1	C
47S Melville Groundwater Province						
Northern Territory						
Unincorporated area – Cretaceous sedimentary rock (Murgenella)	129 938	864	1	n/a	1	D
Unincorporated area – Van Diemen sandstone	115 519	355	1	n/a	1	D
48S Arafura Groundwater Province						
Northern Territory						
Unincorporated area – Buckingham Bay sandstone	55 613	17	1	17	1	D
Unincorporated area – Marchinbar sandstone	37 688	1 422	1	72	1	D
Unincorporated area – Raiwalla Shale	27 503	12	1	12	1	I
49S McArthur Groundwater Province						
Northern Territory						
Gove Water Control District	12 150	10 145	3	12 000	3	C
Unincorporated area – Cretaceous sedimentary rock (Camburinga)	778 275	5 728	1	27	1	D
Unincorporated area – Proterozoic dolomite (Bulman)	257 475	53	1	53	1	D
Unincorporated area – Proterozoic rocks low yielding (Bulman)	55 605	300	1	300	1	D
Unincorporated area – Proterozoic sedimentary rock (north-east Northern Territory)	1 256 760	4 466	1	1 410	1	D
Queensland						
Unincorporated area – McArthur	n/a	n/a	n/a	n/a	1	n/a

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Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
50S Daly River Groundwater Province						
Northern Territory						
Tindall-Katherine Water Control District	27 053	12 692	2	576	1	C
Unincorporated area – Jinduckin Formation	165 615	4 545	1	295	1	C
Unincorporated area – Oolloo Limestone	324 863	1 673	1	73	1	C
Unincorporated area – Tindall Limestone	131 625	487	1	203	1	C
51S Wiso Groundwater Province						
Northern Territory						
Tennant Creek Water Control District	5 079	1 792	2	2 161	2	C
Unincorporated area – Palaeozoic limestone (central Northern Territory)	104 621	2 094	1	1 645	1	D
Unincorporated area – Proterozoic sedimentary rock (Green Swamp Well)	6 035	88	1	88	1	D
52F Tennant Creek Groundwater Province						
Northern Territory						
Unincorporated area – granite (Tennant Creek)	2 356	14	1	14	1	D
Unincorporated area – Proterozoic sedimentary rock (Tennant Creek)	26 453	633	1	423	1	D
53S Georgina Groundwater Province						
Northern Territory						
Unincorporated area – Palaeozoic Limestone (Eastern Northern Territory)	171 087	8 794	1	8 656	1	D
Queensland						
Unincorporated area – Georgina	n/a	n/a	2	n/a	1	n/a
54F Mt Isa – Cloncurry Groundwater Province						
Queensland						
Unincorporated area – Mt Isa	n/a	n/a	2	n/a	1	n/a

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Groundwater management unit	Sustainable yield (ML)	Groundwater use Total abstraction (ML)	Groundwater use Development category	Groundwater allocation Total allocation (ML)	Groundwater allocation Development category	Sustainable yield assessment reliability
55S Great Artesian Groundwater Province						
New South Wales						
Great Artesian Basin – Central – New South Wales	5 750	6 580	4	6 580	4	D
Great Artesian Basin – Southern Recharge	10 100	11 580	4	36 490	4	D
Great Artesian Basin – Surat (NSW)	53 640	70 780	4	70 780	4	D
Great Artesian Basin – Warrego (NSW)	38 770	44 390	4	44 390	4	D
Lower Gwydir alluvium	35 000	40 762	4	99 032	4	C
Lower Namoi alluvium	95 000	43 849	3	213 264	4	A
Queensland						
Condamine – Condamine Groundwater management unit Sub-area 1	1 440	2 157	4	3 560	4	A
Condamine – Condamine Groundwater management unit Sub-area 2	2 490	4 252	4	10 723	4	A
Condamine – Condamine Groundwater management unit Sub-Area 3	14 810	19 179	4	49 562	4	A
Condamine – Condamine Groundwater Management Area Sub-area 5	1 500	154	1	1 126	3	A
Condamine River (down-river of Condamine Groundwater Management Area)	3 500	1 800	3	1 898	2	C
Great Artesian Basin – Barcaldine – Queensland	36 310	44 170	4	44 170	4	D
Great Artesian Basin – Central – Queensland	16 680	28 000	4	28 000	4	D
Great Artesian Basin – Eastern Recharge A – Queensland	1 400	1 600	4	1 600	4	D
Great Artesian Basin – Eastern Recharge B – Queensland	32 450	37 140	4	37 140	4	D
Great Artesian Basin – Eastern Recharge C – Queensland	15 690	17 950	4	17 950	4	D
Great Artesian Basin – Flinders – Queensland	39 270	48 710	4	48 710	4	D
Great Artesian Basin – Gulf – Queensland	18 570	21 260	4	21 260	4	D
Great Artesian Basin – Mimosa – Queensland	13 970	15 990	4	15 990	4	D
Great Artesian Basin – Northwest – Queensland	10 680	12 230	4	12 230	4	D
Great Artesian Basin – Surat – Queensland	71 960	96 720	4	96 720	4	D

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Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
55S Great Artesian Groundwater Province (continued)						
Queensland (continued)						
Great Artesian Basin – Warrego – Queensland	48 960	59 400	4	59 400	4	D
Great Artesian Basin – Western – Queensland	80	90	4	90	4	D
Great Artesian Basin – Western Recharge – Queensland	80	90	4	90	4	D
St George alluvium	18 000	2 000	1	6 340	2	C
Weipa	64 000	63 000	3	210	1	D
Winton/Mackunda Formations	24 000	n/a	4	n/a	1	D
South Australia						
Curdimurka (Wellfield A)	n/a	2 000	3	15 000	3	n/a
Total Great Artesian Basin – South Australia	60 000	54 800	3	63 800	3	D
Muloorina (Wellfield B)	n/a	5 500	3	S43*	3	n/a
Unincorporated area – Hamilton	n/a	n/a	1	n/a	n/a	D
Unincorporated area – Peake Denison	n/a	n/a	1	n/a	n/a	n/a
NorthernTerritory						
Great Artesian Basin – Western – Northern Territory	490	570	4	570	4	D
Great Artesian Basin – Western Recharge – Northern Territory	330	380	4	380	4	D
56S Officer Groundwater Province						
South Australia						
Unincorporated area	100	n/a	1	n/a	n/a	D
Western Australia						
Officer	182 189	n/a	1	0	1	C
57F Musgrave Groundwater Province						
Northern Territory						
Unincorporated area – Cretaceous sedimentary	878	38	1	38	1	D

* S43: refer to Curdimurka (Wellfield A) 55S Groundwater Province in South Australia.

Refer to page 103 for explanatory notes.

Groundwater management unit	Sustainable yield (ML)	Groundwater use: Total abstraction (ML)	Groundwater use: Development category	Groundwater allocation: Total allocation (ML)	Groundwater allocation: Development category	Sustainable yield assessment reliability
57F Musgrave Groundwater Province (continued)						
Northern Territory (continued)						
Unincorporated area – metamorphic rock (south-west Northern Territory)	19 955	185	1	175	1	D
Unincorporated area – tertiary sedimentary rock (south-west Northern Territory)	3 282	80	1	80	1	D
South Australia						
Unincorportated Area	1 000	n/a	1	n/a	n/a	C
Western Australia						
Musgrave	38 553	n/a	1	0	1	C
58S Amadeus Groundwater Province						
Northern Territory						
Mereenie sandstone – Alice Water Control District	1 408	11 739	3	13 848	3	C
Unincorporated area – Palaeozoic sedimentary (southern Northern Territory)	78 727	1 411	1	1 067	1	D
Unincorporated area – tertiary sedimentary rock (Yulara)	19 700	917	1	278	1	D
Western Australia						
Amadeus	29 798	n/a	1	0	1	C
59F Arunta Groundwater Province						
Northern Territory						
Alice Springs Town Basin Water Control District	300	842	4	651	4	C
Ti Tree	3 897	2 567	2	3 884	3	C
Unincorporated area – metamorphic rock (Harts Range)	94 675	1 732	1	1 484	1	D
Unincorporated area – Proterozoic sedimentary rock (Kintore)	21 694	430	1	365	1	D
Unincorporated area – tertiary sedimentary rock (The Granites)	24 748	484	1	393	1	D
Unincorporated area – Ti Tree	2 878	97	1	97	1	D
Queensland						
Unincorporated area – New England	n/a	n/a	n/a	n/a	1	n/a
Arunta	10 026	n/a	1	n/a	1	C

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60S Ngalia Groundwater Province						
Northern Territory						
Unincorporated area – Proterozoic sedimentary rock (Laramba)	3 237	39	1	39	1	D
Unincorporated area – tertiary sedimentary rock (Nyirripi)	7 676	124	1	124	1	D
61F Tanami Groundwater Province						
Northern Territory						
Unincorporated area – granite (The Granites)	13 597	243	1	43	1	D
Unincorporated area – Proterozoic sedimentary rock (central west Northern Territory)	18 526	143	1	143	1	D
Unincorporated area – tertiary sedimentary rock (Didjiedoonkuna Hills)	1 307	8	1	8	1	I
Western Australia						
Tanami 1	94 500	n/a	1	0	1	C
Tanami 2	570	n/a	1	0	1	C
Tanami 3	246	n/a	1	0	1	C
Tanami 4	18 650	n/a	1	0	1	C
Tanami 5	4 938	n/a	1	0	1	C
SA1 Adelaide Geosyncline Groundwater Province						
South Australia						
Barossa fractured rock	2 000	340	1	340	1	D
Barossa Valley sediments	3 500	4 100	3	4 860	3	B
Booborowie Valley	1 000	1 000	3	n/a	n/a	C
Clare Valley	n/a	2 650	3	2 650	3	n/a
Unincorporated area – Flinders Ranges	n/a	n/a	1	n/a	n/a	n/a
Unincorporated area – Mt Lofty Ranges	47 000	25 000	2	n/a	n/a	B
Walloway Basin	300	50	1	n/a	n/a	D
Willochra Basin	600	550	3	n/a	n/a	D
SA2 Eyre Peninsula Groundwater Province						
South Australia						
County Musgrave	6 400	900	1	6 000	3	B
Southern Basins	12 100	10 300	3	12 010	3	B
Unincorporated area	3 200	n/a	1	n/a	n/a	D

Refer to page 103 for explanatory notes.

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APPENDIX 3. WATER AVAILABILITY ASSESSMENT METHODS

This Appendix provides summary tables and text descriptions of the methods used by the States and Territories to estimate sustainable yield for surface and groundwater resources. Methods vary. Further detail is provided in the National Technical Report and State and Territory Technical Reports accessible through the Australian Natural Resources Atlas.

Table A3. Surface water availability assessment methods.

Surface water: sustainable yield

New South Wales

Sustainable yield	Rivers with estimated environmental flow rules in place: current yield.
Environmental water requirement	Where environmental flow rules have not been identified: the sustainable yield is the yield determined under the MDBMC Cap. The environmental flow requirement at each reporting location is the total flow in the river at that location for current Water Reform management and infrastructure conditions.

Victoria

Sustainable yield	Surface water management areas located in the Murray–Darling Drainage Division: sustainable yield was assumed to be equivalent to the levels of average annual (also equivalent to developed yield) diversions available under the MDBMC cap. Surface water management areas located in southern Victoria: where environmental values could potentially be threatened by further allocations, the sustainable yield was limited to the allocation volume pending the outcome of detailed investigations of environmental water requirements. Remaining surface water management areas: the sustainable yield was assessed such that the degree of change to the natural flow regime is not 'unacceptable' as defined by a rating of 5 for the hydrology sub-index of the Index of Stream Condition.
Environmental water requirement	Difference between the total available water and the estimated sustainable yield. The total available water is determined as the sum of the mean annual flow, inflow from upstream catchments and cross catchment transfers that contribute to the available resource in the waterway.

Queensland

Sustainable yield	Not determined
Environmental water requirement	Not determined

Western Australia	
Sustainable yield	Yields were reported by considering likely development scenarios and the application of management objective factors (including environmental water provisions) for individual sites.
Environmental water requirement	Not reported in technical report
South Australia	
Sustainable yield	Defined as divertible yield, takes into account the environmental flow requirement.
Environmental water requirement	Fifty percent of median annual run-off (relating to farm dam development only).
Tasmania	
Sustainable yield	Difference between annual median flow and the estimated environmental flow.
Environmental water requirement	Annual assessment of sustainable yield: 30% of the annual flow Critical Period assessment of sustainable yield: 40% of the summer flow (December–April) and 20% of the winter flow (May–November).
Northern Territory	
Sustainable yield	Based on rainfall–recharge as estimates. Humid zone: 20% of divertible yield (median annual flow). Arid zone: 5% of divertible yield.
Environmental water requirement	Humid zone: 80% of divertible yield (mean annual flow). Arid zone: 95% of divertible yield.
Australian Capital Territory	
Sustainable yield	Total water resource less environmental water requirements
Environmental water requirement	Environmental flows are based on the ACT environmental flow guidelines. Water supply catchments. Flows in rivers and streams below the eightieth percentile are environmental flows (protection of low flow). Flows above the eightieth percentile are available for diversion except for spawning flows. Remaining catchments. Ten percent of the flow volume in events above the eightieth percentile is assumed to be available for diversion. The remaining flow is allocated to the environment (protection of flushing flows).

Table A4. Groundwater availability assessment methods.

Groundwater: sustainable yield

New South Wales

Sustainable yield methodology	Based on rainfall recharge, river recharge estimates and any other available information.
Groundwater dependent ecosystems	Nominal 30% of annual recharge is assigned to ecosystem maintenance (according to precautionary principle).

Victoria

Sustainable yield methodology	Sustainable yield estimates are based on rainfall recharge, throughflow rates, well interference, sea water intrusion, river recharge/discharge, and numerical groundwater modelling (where available).
Groundwater dependent ecosystems	Environmental allowances for groundwater dependent ecosystems are made for each groundwater management unit according to conditions in that groundwater management unit. Systems included in the calculation include: river baseflow; wetlands; and marine and estuarine systems (in terms of saltwater intrusion limits only).

Queensland

Sustainable yield methodology	Groundwater dependent ecosystems were included. Rainfall recharge, aquifer throughflow rates and extractions were used to determine the sustainable yield (or net recharge to aquifer).
Groundwater dependent ecosystems	None in sub-artesian aquifers. In the Great Artesian Basin where artificial ecosystems have developed around mound springs, groundwater dependent ecosystems are considered in the sustainable yield estimate. In some specific groundwater management units, groundwater dependent ecosystems have been considered, e.g. Sand Islands, Cooloola which is a heritage area. In these areas allowance has been made for cave and aquifer system and fauna.

Western Australia	
Sustainable yield methodology	Sustainable yield estimates are based on throughflow estimates, chloride analyses, rainfall recharge estimates and land use and determination of impact of land use on recharge.
Groundwater dependent ecosystems	Environmental allowance is made for each groundwater management unit according to conditions in that groundwater management unit. Basic allowance is 5% of total recharge. For significant wetlands it is approximately 40% of the total recharge, and for others it varies between 25–70% of total recharge. Groundwater dependent ecosystems allowed for in groundwater management units include terrestrial vegetation, river baseflow (Kimberley, Pilbara, Carnarvon), wetlands, cave and in aquifer systems, fauna (where known) and marine and estuarine systems.
South Australia	
Sustainable yield methodology	In general no groundwater mining allowed, but there are some exceptions. Sustainable yield estimates are based on groundwater use, water level and salinity information, and recharge analyses. The recharge analyses included rainfall recharge estimates, lateral throughflow, chloride analyses and numerical groundwater modelling.
Groundwater dependent ecosystems	Groundwater dependent ecosystems allowed for include maintenance of mound springs in Great Artesian Basin.
Tasmania	
Sustainable yield methodology	Rainfall recharge method used, with most of State assuming a 3% recharge rate.
Groundwater dependent ecosystems	None.
Northern Territory	
Sustainable yield methodology	Northern areas: rainfall recharge rates of 0.2–5.0 ML/ha/yr; southern areas: rates of 0.02–2.5 ML/ha/yr were used.
Groundwater dependent ecosystems	50% of annual recharge assigned to groundwater dependent ecosystems
Australian Capital Territory	
Sustainable yield methodology	Water balance method.
Groundwater dependent ecosystems	Nominal 90% of annual recharge due to lack of information on recharge and aquifer yields (using precautionary principle). Includes allowance for in-cave systems and terrestrial vegetation.

New South Wales

Lead agency

Resource Information Unit, Department of Land and Water Conservation, New South Wales

Surface water

Context

The New South Wales Water Reforms, which are being developed and implemented by the New South Wales Government, are aimed at improving water management within the State.

Sustainable water provision estimate: method

To adequately address current water management in New South Wales, the Department of Land and Water Conservation has developed monthly and—more recently—daily simulation models that are capable of modelling water quantity in an integrated manner. The later models operate on a daily time step and are known as integrated quantity/quality models. The Department has integrated quantity/quality models for most of the major regulated surface water management areas in New South Wales and the Barwon–Darling.

Using these hydrologic models, the Department has started to define the volumes of water that can be extracted from each of its regulated surface water management areas. These management practices do not correspond directly to the concept of annual yields, as defined by the Audit. New South Wales has still provided an assessment of the yields, where possible, by attempting to align its current management practices with Audit concepts.

As a result of the Murray–Darling Basin Ministerial Council Cap (Cap) and water reforms, no further headwater storage development or issues of licensed entitlements is proposed for the Murray–Darling Basin. For the purposes of the Audit, the ultimate level of development has therefore been taken to be equivalent to the Cap level of development. New South Wales considers the divertible yield and developed yield to be equivalent. Furthermore, the range of environmental flow rules that have been introduced to most of the regulated surface water management areas within the Murray–Darling Basin result in long-term average diversions (or yield) below the Cap levels. This yield has been taken to represent the current best estimate of sustainable yield. The sustainable yield for those regulated valleys within the basin that do not have environmental flow rules implemented has been assumed to be the Cap yield.

Sustainable yield: assumptions, reliability and errors

Regulated surface water management areas

The integrated quantity/quality model developed by the Department of Land and Water Conservation, was run with Cap or 1993/94 conditions of infrastructure development and 1993/94 management rules in place. The current yield in New South Wales (current = developed = divertible) was determined to be the average annual diversion over the full period of record (generally about 100 years). This annual diversion includes both on-allocation and off-allocation use. This yield may change as models are updated or new information comes to light.

The understanding of the links between flow and sustainability of river ecological systems is also still developing. Ecological sustainability can be affected by factors other than quantity and timing of flow. Therefore, the sustainable yield estimates provided cannot be considered as the amount of water that can be diverted from rivers in perpetuity.

Unregulated surface water management areas

New South Wales is introducing volumetric licences for the management of unregulated valleys and is collecting a range of data in unregulated basins. New South Wales current management practices view the sustainable yield as an allowable daily extraction volume as opposed to an annual yield figure. Future reviews of the performance of the management rules to be adopted in each valley may result in changes to the rules and hence changes to the 'sustainable yield'. Given the limited data, sustainable yield has not been calculated for unregulated basins in New South Wales.

An attempt was made to obtain a categorisation for the catchment, based on the work done for the stressed streams.

A variable P was determined for the total catchment on the basis of the combined stress classification results from the stressed streams analysis:

$$P = \frac{\text{Total area of sub-catchments with high combined stress}}{\text{Total area of classified sub-catchments in basin}}$$

The development category that was assigned to these areas was based on the variable P as defined above, rather than the proportion of use (or allocation) to sustainable yield.

Groundwater

Sustainable yield estimate: method

Assessment was based on the following definition:

> *Sustainable yield is that proportion of the long-term average annual recharge which can be extracted each year without causing unacceptable impacts on the environment or other groundwater users.*

The actual value for proportion stated is not specifically given. This proportion will change according to each situation and is assigned differently to each aquifer system. Recharge calculations with 'sustainability factors' applied to them act as interim sustainable yield figures. These 'sustainability factors' are a proportion of long-term annual average recharge. Sustainability factors are chosen according to level of knowledge of an aquifer system, level of use of that resource, the magnitude of perceived risk to that aquifer system and the environment, and the reliability of recharge to that system. As better understanding is developed, the sustainable yields can be adjusted accordingly.

Sustainable yield: assumptions, reliability and errors

Most groundwater systems have not been modelled. Inputs (or recharge) to the system have generally been kept to rainfall and river components of recharge. Three systems—the Lower Lachlan, the Lower Murrumbidgee, and the Great Artesian Basin—have been handled differently with regard to sustainable yield determinations. This reflects the greater level of knowledge about these systems. 'Throughflow' and 'underflow' have in most cases been omitted from calculations for simplicity and conservatism. Likewise, irrigation 'returns' have not been considered even though in some situations a certain proportion of irrigated water might be expected to access the underlying aquifer.

Two equations were used to estimate recharge. Both have a limited number of terms and allow recharge values to be assigned respectively to those sourced from rainfall and those from rivers.

Rainfall recharge was calculated according to assessed rainfall, area and proportion of rainfall accessing the aquifer. River recharge was estimated using a modified form of the 'Darcy' equation. An additional factor was applied as an 'adjustment' factor intended to reduce the theoretical river recharge and is set as *the fraction of the year* and/or *the fraction of river reach—that is considered as a 'losing stream'.* In this way an actual river recharge component is produced.

Once recharge values were estimated, some proportion of that recharge was taken as the sustainable yield. As a 'default', 70% of average annual rainfall is taken as the proportion that can be extracted from the aquifer annually on a sustainable basis.

Victoria

Lead agency

Department of Natural Resources and Environment

Context

The Victorian Government is committed to striking a balance between satisfying existing demands to urban centres and irrigation industries, and improving the environmental flow regime of rivers.

Surface water

Sustainable water provision estimate: method

The sustainable yield is the estimated maximum volume of water that can be diverted after taking account of in-stream environmental water requirements. It is calculated as a long term average annual volume. While this concept is apparently relatively straightforward as defined, in practice the sustainable yield is very difficult to determine. Once environmental flow requirements at particular points within a surface water management area have been determined, using simulation models it is possible to derive an estimate of the average volumetric environmental allocation and the sustainable yield for the surface water management area. While Victoria has a variety of programs under way aimed at identifying, improving and protecting environmental flow requirements, the necessary investigations take considerable time and resources.

Given the short time frame of the Audit, it was necessary to make some broad assumptions, and use a variety of approaches, to derive estimates of the sustainable yield for surface water management areas in Victoria. Consideration was given to environmental water requirements (known and likely), existing users' rights, and related social and economic impacts.

In summary:

- within the Murray–Darling Basin, sustainable yields were equated to the average annual diversions from each surface water management area with the Murray–Darling Basin Cap in place;
- for surface water management areas in the southern part of Victoria where environmental values could potentially be threatened by further allocations, the sustainable yield was limited to the allocation volume, pending the outcomes of further detailed investigations of environmental water requirements; and
- for the remaining southern surface water management areas, the sustainable yield was determined by calculating the total volume of water that can be extracted from the river system (during May to November) such that the degree of change to the natural flow regime is not 'unacceptable' as defined by a rating of 5 for the hydrology sub-index of the Index of Stream Condition. Where the yield estimated using this method exceeded the assessed divertible yield of the surface water management area, the sustainable yield was limited to the divertible yield.

Further details on the methods used to estimate sustainable yield are provided in the *State Technical Report*.

Sustainable yield: assumptions, reliability and errors

Where sustainable yields have been limited in accordance with the Cap or the current allocations within a surface water management area, it is assumed that the current environmental water provisions represent the volume of water that can currently be made available to the environment after consideration is given to current users' rights and related social and economic impacts.

In the longer term, there may be further scope for improving environmental regimes where necessary (e.g. by providing additional water through improving distribution and water use efficiency). In surface water management areas where a significant portion of the available resource is committed to a downstream surface water management area, there is also potential for trading of entitlements between the two surface water management areas. This will result in a change to both the sustainable yield and the environmental allocation in both surface water management areas. Trade out of a surface water management area would decrease the sustainable yield of that area and a trade of water rights into a surface water management area would increase sustainable yield. However, the sum of the sustainable yields for the two surface water management areas would remain unchanged.

The estimates of sustainable yield made using the Index of Stream Condition hydrology sub-index are considered to be relatively conservative, as the methodology assumes that diversions occur only during the period May to November (i.e. the flow regime for the period December through to April must remain unchanged). However, the approach was found to give inconsistent results across the State and could not be universally applied. The estimates of sustainable yields determined using this approach can therefore only be considered to be interim measures, pending the outcome of detailed environmental flow assessments.

The major limitation associated with the concept of the sustainable yield for a surface water management area is that the assessment is undertaken at the furthest downstream location on rivers/streams within a surface water management area. Therefore the sustainable yield represents an average and does not take into account the impact of diversions on specific river reaches within the catchment. Consequently, where the sustainable yield of a surface water management area is specified as being equal to or greater than the allocated volume, there still could be river reaches within the surface water management area that are over-allocated, potentially overused and therefore stressed. These situations will be identified and addressed in the context of established programs (in particular, the Streamflow Management Plan and Stressed Rivers programs) aimed at addressing the provision of water for the environment. These programs are described in the *State Overview Report*. Conversely, where the sustainable yield is specified as being equal to the allocated volume, there may still be 'spare' capacity on some river reaches, in the sense that further diversions could occur without stressing the particular river reaches. A further complication is that where surface water management areas are nested (as in the Murray–Darling Basin), a portion of the flows from upstream surface water management areas are often required to meet commitments to downstream surface water management areas. This means that current allocations for use within the upstream surface water management area (and therefore the defined sustainable yields) are relatively low compared to what they would be if resources generated within the upstream surface water management area were to be utilised only within this (upstream) surface water management area.

For the reasons outlined above, the concept of sustainable yield for a surface water management area is not a particularly useful management tool, as proper management requires consideration of the environmental flow requirements for specific river reaches.

Groundwater

Sustainable yield estimate: method

Victoria's groundwater management regime is based on sustainable development through the establishment of community driven Groundwater Management Plans. The process begins with the identification of groundwater management units which are areas where groundwater development has already occurred or where there is a potential for groundwater development. For these groundwater management units a permissible annual volume for groundwater extraction has been set to reflect the sustainable yield of the aquifer. For the purposes of the Audit, these groundwater management units have been adopted as the basic reporting unit or groundwater management unit.

While a nationally agreed definition of sustainable yield for groundwater systems is now available, there is as yet no agreed methodology for determining sustainable yields. In Victoria, the sustainable yield methodology varies across the State according to the aquifer characteristics being investigated.

In most cases, because of the lack of use data and, in many cases bore hydrograph data, the sustainable yield has been determined as a percentage of rainfall, with adjustments made to take account of environmental requirements to the extent possible given currently available information. Checks on aquifer storage, river recharge/discharge, aquifer throughflow, well interference, sea water intrusion and pressure/head loss are incorporated into the methodology. The most commonly considered issues are baseflow to river systems and the intrusion of sea water. The requirements of groundwater dependent ecosystems have not generally been considered explicitly in this process, as their requirements are as yet poorly understood. However, in setting sustainable yields for groundwater management units, efforts have been made to avoid significant interference with groundwater dependent ecosystems. As the requirements of groundwater dependent ecosystems are evaluated, current government policy will allow for variation of the sustainable yield if the prospect of a detrimental impact emerges (e.g. sea water intrusion, which may result in aquifer salinisation).

Further details on the methods used to estimate sustainable yield are provided in the *State Technical Report.*

Sustainable yield: assumptions, reliability and errors

The derived estimates of sustainable yield for the groundwater management units are relatively subjective. Until there are hard use data it will not be possible to assess the water balance for groundwater management units, and determine the recharge that provides the basis for sustainable yield. Similarly, the lack of information about the requirements of groundwater dependent ecosystems has meant that some fairly broad assumptions about these requirements have had to be made. Because of these, and other uncertainties such as the impact of climate variability and the likely impacts of plantation forestry on sustainable yields, a conservative approach has been taken in the estimation of sustainable yields for groundwater management units.

When resource commitments in a groundwater management unit reach 70% of the estimated sustainable yield, the area is declared a Groundwater Supply Protection Area, groundwater community management groups are established and more intensive management is triggered. This includes the development of a

Groundwater Management Plan for the Groundwater Supply Protection Area, which includes the implementation of more detailed metering of use and monitoring of groundwater levels to allow better determination of the sustainable yield. Review of the sustainable yield in currently over-allocated systems and other highly developed systems is being given a high priority to ensure that they do not become overused, or have adverse impacts on any groundwater dependent ecosystems.

In areas outside of the groundwater management units the sustainable yield estimates are of low reliability, especially in the fractured rock systems. In areas such as the volcanic rises, sustainable yield estimates can be misleading due to the high recharge rates and low aquifer yields and, hence, low extraction capabilities. Care must be taken when determining resource availability in fractured rock systems, as it will not necessarily be the same as the sustainable yield. The salinity of the resource should also be considered at all times when determining groundwater resource availability, particularly in areas outside of the groundwater management units where the resource can be highly saline (>14 000 mg/L) and of little beneficial use.

Queensland

Lead agency

Department of Natural Resources.

Surface water

Context

General acceptance that water is a limited resource has led to the Department of Natural Resources introducing a water allocation and management planning process. The water allocation and management planning process is flexible and a plan will be revised at regular intervals as the needs of the catchment change. All stakeholders are involved in the process.

Water allocation and management planning has a proactive, basin-wide approach and sets it apart from the present licensing system by placing a high priority on community consultation and sustainability of the resource.

Sustainable water provision estimate: method

Water allocation and management planning adopts an integrated approach that is based on the best available ecological, social and economic data, and involves extensive basin-wide hydrologic analysis. It provides the opportunity for local catchment communities to work on draft plans in partnership with agencies, primarily through a Community Reference Panel, but also through public consultation. This ensures the best and fairest mix of present and future uses, while finding a balance with environmental needs in accordance with the principles of sustainable ecological development.

Groundwater

Sustainable yield estimate: method

The sustainable yield figures have been derived using a variety of methods and represent the aquifer yield over a long-term critical period. The figures quoted are the best currently available and were derived from analysing the aquifer response to changes in storage, that is use, recharge, in-flow and outflow. The adopted figure attempted to maximise the water available for use while ensuring that there was no detrimental effect caused to any user or no unacceptable degradation of the resource or the environment.

With the introduction of the Water Allocation Management Program process, sustainable yield is now being defined as the 'groundwater extraction regime', measured over a specified planning timeframe and that allows acceptable levels of stress and protects the higher value uses associated with the total resource. The estimates of yield results from a negotiation process to ensure that all users have input into the determination of the agreed figure and are aware of the implications.

The definition is framed around an extraction regime, not just an extraction volume. The concept is that a regime is a set of extractions that is defined over time, and that sustainability is measured over a timeframe. Extraction limits may be volumetric, extraction rates are related to maintaining water levels and water quality or a combination of the above.

Western Australia

Lead agency

Water and Rivers Commission

Surface water

Sustainable water provision estimate: method

Estimation of sustainable yields was undertaken as a two-stage process.

The first stage involved accumulating data for the surface water management area to determine the likely development scenario. The second stage involved further analysis of selected sites and adjustment of environmental water provisions accordingly. While it involved subjectivity, the refinements made were based on accumulated regional planning experience, and are reflect realistic outcomes at surface water management area levels.

Sustainable yield: assumptions, reliability and errors

Sustainable yield estimates are indicative of the broad outcomes of a planning process which has approached sustainability through application of precautionary principles for determination of environmental flow provisions.

While calculated at the sub area level, sustainable yield estimates at this level do not have sufficient technical standing to be prescriptive, except in those identified areas, where environmental water provisions have been formally established.

Groundwater

Sustainable yield estimate: method

In the first instance, sustainable groundwater yields were based on results derived from existing groundwater area allocation plans, (water) management plans, or on the outcomes of long-term monitoring of groundwater levels within an aquifer and associated abstraction volumes. This yield includes groundwater from fresh to hypersaline quality. For groundwater management units where detailed studies or long-term monitoring data were not available, the sustainable yield for each was given by the renewable groundwater resource minus an allowance for wetlands and, where appropriate, for sea water intrusion. The renewable groundwater resource was determined from the area of land surface or aquifer multiplied by the mean annual rainfall and the applicable recharge factor for each defined area. Recharge factors for the Perth groundwater division were derived from existing management plans. For the remainder of the State, they were either derived from groundwater investigations or were estimated by reference to other areas and consideration of rainfall, topography and aquifer type.

The total sustainable yield for the State was estimated to be 6304 GL/yr, with 3279 GL/yr available from the sedimentary basins and 3025 GL/yr, from the fractured rock divisions. Across the State, the Audit estimate of sustainable yield is around 14% lower than the Review ’85 estimate of divertible yield. This is largely attributable to the Audit inclusion of environmental water provisions for groundwater dependent ecosystems, but also reflects improvements in data availability and assessments. Changes in land use such as clearing, urbanisation and drainage also affect sustainable yield estimates. For Perth, the Review ’85 estimates were conservative and already gave implicit recognition to an allowance for wetlands which masked the full effect of allocating water to the environment in that division.

The estimates of sustainable yield are generally considered to be conservative but it is important to note, particularly with respect to the fractured rock divisions, that they include resources which Review ’85 classed as minor sources. These minor sources are distributed resources only able to be developed using small bores and spear systems. These systems are extremely important to pastoral supplied, but because of their dispersed nature, they are not reliable nor amenable to high utilisation. The minor sources tend to dominate the sustainable yield assessments in the fractured rock provinces simply because of their areal extent in comparison with free yielding resources. Care should therefore be taken not to assume that there is potential for intensive development from the fractured rock divisions, despite the apparent high availability of water.

South Australia

Lead agency

Department of Water Resources

Surface water

Context

The surface water resources within South Australia are required to be managed so that those who rely on the resource will obtain the best environmental, social and economic gain from them, whilst not compromising the ability of future generations to enjoying the same benefits. The South Australian *Water Resources Act 1997* places prime importance on protecting water resources against the detrimental effects of use and development and preserving ecosystems that depend on them.

Sustainable water provision estimate: method

For the Murray River, the sustainable yield has been assumed to equal the extraction defined by the Cap.

For all other areas further analysis was required and needs to take into account emerging factors such as the impact of farm dams. Farm dams were included in the South Australian assessments as they represent the majority of new surface water development in the State. The concept of sustainable yield was difficult to apply to such structures because of the high losses expected due to evaporation, dams may partially empty and refill throughout the year, and the low security of supply at which farm dams operate. Catchments containing large reservoirs were treated the same as those with only farm dam development.

Studies of two South Australian surface water prescribed areas in the Barossa and Clare Valleys indicated that the maximum total volume of farm dam development within a catchment should not exceed 50% of the natural median annual run-off. The studies showed that 30–50% of the annual volume captured in a farm dam could be diverted on a reasonably consistent basis, but that divertible yield ultimately depended on annual rainfall, the amount of unregulated area in the catchment, dam size and design, all of which may vary significantly. The remaining 50–70% of dam capacity was lost as evaporation, recharge/ leakage or could be accounted as carry over volume and unfilled storage.

Sustainable yield from surface water management areas was therefore calculated as 50% of the water captured or 25% of the median annual run-off from the surface water management area. This figure has become widely accepted in controlling farm dam development and represents a reasonable estimation of expected rates of supply.

Ephemeral streams require further detailed investigation. A number of studies targeted at assessing the environmental flow requirements of ephemeral streams under the maximum permitted levels of farm dam development (50% median natural run-off) have been initiated. Preliminary results based on limited data indicate that while such levels reduce the mean annual flow in the order of 20%, environmental flow requirements are maintained.

Monitoring procedures are being developed to enable environmental flows to be more accurately assessed across all key South Australian surface water resources.

Groundwater

Sustainable yield estimate: method

The following general definition for sustainable yield has been used:

> *The groundwater extraction regime, measured over a specified planning timeframe that allows acceptable levels of stress and protects the higher-value uses associated with the total resource. The sustainable yield is determined by the rate at which groundwater can be pumped without causing long-term decline of potentiometric surface (or watertable) or undesirable effects—such as salinity increases. This may mean extraction rates less than recharge as sustainability from the salinity view point may be considerably less than sustainability from the hydraulic perspective.*

For sedimentary aquifers where abstraction data exists, sustainable yield has been determined using water level, salinity and metered use records in combination with recharge analysis involving rainfall recharge estimates, lateral throughflow estimation, chloride analysis, and numerical groundwater modelling.

Very little is known about how water is stored and transported in fractured rock aquifers and there are no reliable methods for estimating sustainable yield from them. Fractured rock aquifers are characterised by high spatial variability in hydraulic conductivity, making traditional hydraulic methods for estimating groundwater flow difficult to apply. Specific yield may also be extremely variable and difficult to measure, making groundwater recharge estimation from hydrographs unreliable. Sufficiently accurate data on aquifer thickness or porosity is generally not possible for reliable determination of aquifer storage. Numerical values given for sustainable yield in these units are an estimate.

In 15 groundwater management unit/unincorporated areas, sustainable yield investigations have not been conducted, and the numerical value given for sustainable yield has been based on estimated abstractions or educated guesses.

Mallee: Mining of groundwater has been included in the sustainable yield estimate for the unconfined aquifer of the Mallee. The existing permissible annual volume for the Mallee is based on components of recharge, lateral throughflow and groundwater 'mining'. The resultant drawdown is 5 cm/year averaged over the whole region. The current controlled mining policy for irrigation extraction is forecast to deplete the resource by up to 15% over the next 300 years.

Great Artesian Basin: Ecosystems are included in the sustainable yield estimation for the Great Artesian Basin. In the two formally managed areas within the Great Artesian Basin—Curdimurka and Muloorina Prescribed Well Areas—groundwater extraction is subject to restrictions including drawdown limits, which ensure the protection of ecologically significant mound springs nearby.

As the environmental requirements become clearer in other areas, greater emphasis will be placed on sustainable yields—particularly to ensure the maintenance of stream baseflow. For example, in the Mt Lofty Ranges the sustainable yield has been set at 75% of the recharge, to account for environmental flows in streams.

Tasmania

Lead agency

Department of Primary Industries, Water and Environment

Surface water

Sustainable water provision estimate: method

Sustainable yield was calculated by taking the difference between the annual median flow and the estimated environmental flow.

- Identify the median critical period and annual flows for the area in question.
- Adopt 30% of the annual flow as the recommended environmental water requirement to maintain good habitat.
- Adopt 40% of the summer flow (December – April) as the recommended environmental water requirement for that period.
- Adopt 20% of the winter flow (May – November) as the recommended environmental water requirement for that period.
- If the critical period is different from summer or winter then adopt a weighted average of the relevant flows.

Reliability and errors

The environmental flow method used is broadly based on the Montana Method (Tennant 1976) and is only being used as an expedient means of assessing environmental water requirements for the Audit. The estimates should not be taken to represent true environmental water requirements.

Groundwater

Sustainable yield estimate: method

The sustainable yield for each of the groundwater management units and unincorporated areas was set at the average annual recharge to the aquifer. For all groundwater management units and unincorporated areas, the estimation of recharge was based on a percentage of the area-weighted average rainfall volume falling within the area. For 12 out of 14 groundwater management units and all three unincorporated areas within Tasmania, recharge was assigned as 3% of rainfall. The remaining two groundwater management units were on beach sand deposits, where the annual recharge was estimated at 30% of rainfall.

Northern Territory

Lead agency

Department of Lands, Planning and Environment

Surface water

Sustainable water provision estimate: method

The paucity of scientific knowledge on water requirements of ecosystems across the humid, arid and semi-arid regions of the Northern Territory is acknowledged.

For this assessment the Northern Territory has been divided into two zones: the humid zone (Northern Territory portions of the Timor Sea and Gulf of Carpentaria drainage divisions) and the arid zone (Northern Territory portions of the Western Plateau and Lake Eyre drainage divisions). Sustainable surface water provision is directly linked to these zones. At any location along a stream in the humid zone, the amount of surface water extraction has been limited to a maximum of 20%. For streams in the arid zone, the maximum extraction percentage is 5%.

Sustainable yield: assumptions, reliability and errors

In the absence of any scientific basis, environmental flow requirement is assumed to be 80% of the flow in rivers of the humid zone and 95% in rivers of the arid zone. The sustainable yield is therefore estimated as 20% of the flow in rivers of the humid zone, and 5% in rivers of the arid zone.

Currently the surface water requirements of the environment can not be determined. Also only limited flow data exists for the rivers of the Northern Territory. The reliability of the sustainable yield estimate is low.

Groundwater

Sustainable yield estimate: method

The Northern Territory has adopted two approaches for sustainable yield estimation—one each for Groundwater Management Units and Unincorporated Areas.

For Groundwater Management Units, sustainable yield has been defined as the groundwater extraction regime, measured over a specified planning timeframe which allows acceptable levels of stress and protects dependent economic, social, and environmental values.

For unincorporated areas the sustainable yield has been defined as 50% of the average annual aquifer recharge. Effectively this is stating that of the available groundwater resources for the greater part of the Northern Territory, 50% is required to be allocated to sustain groundwater dependent ecosystems.

Generally to determine aquifer recharge, the Northern Territory was subdivided into four zones based on the likely dominant mechanism of recharge. Within the zones the probable recharge rates (ML/ha/year) ranged from 0.2 to 5 ML/Ha/year in the northern most zone to 0.02 to 2.5 ML/ha/year in the southern most zone. The range of recharge mechanisms and rates combine to reflect relatively higher annual recharge in the north to lower and infrequent recharge in the south. The rate applied to the groundwater management units and unincorporated areas was based upon the level of understanding of the groundwater management unit/unincorporated area.

Sustainable yield: assumptions, reliability and errors

For unincorporated areas, 50% of average annual aquifer recharge is allocated to sustain groundwater dependent ecosystems. Subjectively assigned recharge values to the four zones based on likely recharge mechanisms. The recharge mechanisms are broadly based on rainfall pattern of the Northern Territory from the northern top end to the southern desert area.

Without further scientific knowledge, the groundwater requirements of the environment can not be determined. Also few aquifers in the Northern Territory have sufficient data to enable their sustainable yield to be accurately estimated. Reliability is low.

Australian Capital Territory

Lead agency

Environment Protection Unit, Environment ACT

Context

The Australian Capital Territory Government controls most water resources in the Australian Capital Territory. Water use is dominated by urban water supply, which represents over 90% of the total licensed volume. The remainder is represented by irrigation and rural use.

Surface water

Sustainable water provision estimate: method

The sustainable yield of the Australian Capital Territory Management Area was determined by the subtraction of environmental water requirements from the total water resource.

Environmental flows were determined using the *Environmental Flow Guidelines*. These refer to the flow regime necessary to sustain habitats, encourage spawning and migration, enable the processes on which succession and biodiversity depend, and maintain the desired nutrient structure within lakes, streams, wetlands and riparian areas.

For water supply catchments, the *Environmental Flow Guidelines* give priority to water supply needs, which could intrude on environmental flows during dry periods. For those catchments, flows in rivers and streams below the eightieth percentile flows are protected from abstraction. All the water above the eightieth percentile is available for use, except for spawning flows. In the remaining catchments, 10% of the water above the eightieth percentile is available for use.

Sustainable yield: assumptions, reliability and errors

The precise determination of environmental flows depends on availability, reliability and relevance of data. The percentile flow is based on 'time weighted' recorded flows and gauged data with an available record period of at least 10 years. Analysis assumes relatively undeveloped conditions with no significant dams or other flow modifications, and the characteristics of catchment hydrology approximating natural conditions.

Improved knowledge is required on the impact of increasing groundwater abstraction on river and streamflow (baseflows) and the flow requirements of local streams. Techniques also need to be developed to assess the effectiveness of environmental flows.

Groundwater

Sustainable yield estimate: method

Sustainable yield estimates were based on a water balance method. This included provision for evapotranspiration, aquifer throughflow, leakage from one aquifer to the other, and surface water – groundwater interactions. The results were checked against rainfall recharge estimates. In line with the precautionary principle a cautious approach was taken in the determination of environmental flow requirements. Groundwater abstraction was limited to 10% of average annual recharge to ensure supply for groundwater dependent ecosystems.

Sustainable yield: assumptions, reliability and errors

Groundwater information is very limited and is based largely on modelling of groundwater and surface water interaction. Sustainable yield estimates are of low reliability because most of the aquifers are contained in fractured rock systems where it is difficult to quantify the resource. This is due to high recharge rates and low aquifer yields (low storage capacity and low extractive ability).

The water balance method also has a low level of accuracy, due to the difficulty in estimating evapotranspiration and aquifer flows in fractured rock systems.

In the Australian Capital Territory, a linear relationship between annual rainfall and rates of recharge has been assumed. Verification of this relationship is required through comparison with other methods. The rainfall–recharge equation could be used as a comparative tool to determine aquifer performance and increase reliability of the sustainable yield estimates.

APPENDIX 4. WATER AVAILABILITY DATABASE

Database completeness

Table A5. Surface water availability database content.

Surface water: percentage of surface water management areas with data entries

Total number of surface water management areas = 325

	Median	Range	Number of surface water management areas reported	% of surface water management areas reported
Use records	100	100–100	325	100
Use volume	80	26–100	232	72
Use and allocation type	80	26–100	233	72
Use:sustainable yield category	100	100–100	325	100
Allocation records	100	100–100	325	100
Allocation volume	80	15–100	192	59
Allocation:sustainable yield category	100	12–100	206	63
Volume traded	19	3–34	42	13
Volume transferred	7	6–38	38	12
Total transactions	19	16–100	38	12
Developed yield	100	35–100	229	70
Divertible yield	100	35–100	189	58
Total allocation	94	26–100	253	78
Surface water management area	100	97–100	323	99
Potential for development	91	56–100	207	64
Forecast use 2020	77	2–100	129	40
Forecast use 2050	83.5	2–100	95	29
Developed yield 2020	77	15–100	136	42
Developed yield 2050	83.5	15–100	102	31
Categorisation 2020	100	54–100	195	60
Categorisation 2050	100	54–100	151	46

Continued on next page ...

Table A5. Surface water availability database content (continued).

Surface water: percentage of surface water management areas with data entries

	Median	Range	Number of surface water management areas reported	% of surface water management areas reported
Current management response: 1999				
Scale of allocation and planning	92.5	11–100	183	56
Inputs to allocation	100	4–100	182	56
Type of monitoring quantity	100	9–100	226	70
Type of monitoring quality	100	9–100	225	69
Distribution efficiency	24.5	2–100	58	18
Use efficiency	28.5	2–100	61	19
Resource management efficiency	21	1–100	30	9
Degree of licensing	90	9–100	180	55
Water trading	95	9–100	220	68
Mechanism of trading	3	2–18	20	6
Desired management response: 1999				
Scale of allocation and planning	100	6–100	24	7
Inputs to allocation	100	6–100	24	7
Type of monitoring quantity	100	6–100	24	7
Type of monitoring quality	100	6–100	24	7
Distribution efficiency	97.5	95–100	21	6
Use efficiency	95	6–100	23	7
Resource management efficiency	95	6–100	23	7
Degree of licensing	100	6–100	24	7
Water trading	100	6–100	24	7
Mechanism of trading	n/a	0–0	0	0

Continued on next page ...

Table A5. Surface water availability database content (continued).

Surface water: percentage of surface water management areas with data entries

	Median	Range	Number of surface water management areas reported	% of surface water management areas reported
Desired management response: 2020				
Scale of allocation and planning	100	59–100	106	33
Inputs to allocation	95.5	53–100	143	44
Type of monitoring quantity	100	59–100	150	46
Type of monitoring quality	100	59–100	150	46
Distribution efficiency	21	19–100	49	15
Use efficiency	47	19–100	58	18
Resource management efficiency	21.5	2–41	15	5
Degree of licensing	100	59–100	106	33
Water trading	100	41–100	144	44
Mechanism of trading	6	6–6	2	1
Desired management response: 2050				
Scale of allocation and planning %	100	100–100	126	39
Inputs to allocation	96	38–100	99	30
Type of monitoring quantity	100	100–100	126	39
Type of monitoring quality	100	100–100	126	39
Distribution efficiency	22	5–100	46	14
Use efficiency	22	5–100	46	14
Resource management efficiency	3.5	2–5	3	1
Degree of licensing	100	91–100	123	38
Water trading	100	100–100	126	39
Mechanism of trading	n/a	0–0	0	0

Table A6. Groundwater availability database content.

Groundwater: percentage of groundwater management units with data entries

Total number of groundwater management units = 535

	Median	Range	Number of groundwater management units reported	% of groundwater management units reported
Abstraction records 96	93	24–100	383	71
Abstraction type 96	93	24–100	383	71
Abstraction category 96	93	24–100	381	71
Abstraction volume	93	24–100	383	71
Allocation records 96	90	42–100	407	76
Allocation type 96	90	42–100	407	76
Allocation category	90	42–100	407	76
Allocation volume	90	42–100	407	76
Volume traded	2	2–2	1	0
Volume transferred	n/a	0–0	0	0
Total transactions	2	2–2	1	0
Sustainable yield	100	76–100	516	96
Median salinity	100	98–100	535	99
Potential for development	100	15–100	464	86
Forecast use 2020	87	15–100	419	78
Forecast use 2050	84	15–100	245	45
Median salinity	100	98–100	535	99
Groundwater management unit area	100	88–100	532	99
Saturated thickness	100	94–100	530	98
Depth to aquifer	100	96–100	535	99

Continued on next page ...

Table A6. Groundwater availability database content (continued).

Groundwater: percentage of groundwater management units with data entries

	Median	Range	Number of groundwater management units reported	% of groundwater management units reported
Current management response: 1999				
Scale of allocation and planning	73	8–100	249	46
Inputs to allocation	36	6–100	362	67
Type of monitoring quantity	82	8–100	423	79
Type of monitoring quality	82	8–100	423	79
Distribution efficiency	49	6–100	217	40
Use efficiency	53	8–100	226	42
Resource management efficiency	51	6–100	226	42
Degree of licensing	82	8–100	423	79
Water trading	82	8–100	422	78
Mechanism of trading	20	20–20	10	2
Desired management response: 1999				
Scale of allocation and planning	51	2–100	4	1
Inputs to allocation	51	2–100	4	1
Type of monitoring quantity	51	2–100	4	1
Type of monitoring quality	51	2–100	4	1
Distribution efficiency	100	100–100	3	1
Use efficiency	51	2–100	4	1
Resource management efficiency	100	100–100	3	1
Degree of licensing	51	2–100	4	1
Water trading	51	2–100	4	1
Mechanism of trading	n/a	n/a	0	0

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Table A6. Groundwater availability database content (continued).

Groundwater: percentage of groundwater management units with data entries

	Median	Range	Number of groundwater management units reported	% of groundwater management units reported
Desired management response: 2020				
Scale of allocation and planning	76	15–94	166	31
Inputs to allocation	75	15–100	329	61
Type of monitoring quantity	79	15–100	340	63
Type of monitoring quality	79	15–100	340	63
Distribution efficiency	76	8–82	123	23
Use efficiency	76	15–82	150	28
Resource management efficiency	76	15–82	144	27
Degree of licensing	79	15–100	340	63
Water trading	79	15–100	338	63
Mechanism of trading	50	50–50	25	5
Desired management response: 2050				
Scale of allocation and planning	78	4–82	115	21
Inputs to allocation	78	4–82	115	21
Type of monitoring quantity	77	4–82	114	21
Type of monitoring quality	77	4–82	114	21
Distribution efficiency	78	4–82	115	21
Use efficiency	78	4–82	115	21
Resource management efficiency	77	4–82	114	21
Degree of licensing	78	4–82	115	21
Water trading	78	4–82	115	21
Mechanism of trading	n/a	n/a	0	0

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APPENDIX 5. SURFACE WATER QUALITY ASSESSMENT

Water quality guidelines

Water quality guidelines provide a means to assess the capacity of surface waters to meet ecological, social and economic requirements. Specific guidelines have been established for indicators that reflect the water quality requirements for:

- protection of aquatic ecosystems;
- agricultural water;
- recreation and aesthetics; and
- drinking water.

In Australia, national water quality guidelines established by the Australian and New Zealand Environment and Conservation Council (ANZECC 1992, ANZECC in press) are supplemented by State and regional guidelines established to meet specific water quality management objectives.

Use of site or waterway-specific guidelines is recommended by ANZECC (in press) in recognition of the extreme natural variation in Australian waterways and the differing levels of protection afforded to waterways with varying levels of development and catchment modification. For the Audit assessment of surface water quality, State and Territory water quality guidelines (see table below) were used to compile the national overview. Where States or Territories did not have established guidelines for particular water quality variables National Guidelines ANZECC (1992) were used as the default.

Meeting guidelines

For the Audit assessment of water quality, individual monitoring sites were classified as 'good', 'fair' or 'poor' for each variable based on whether established guidelines (see below) were exceeded. Generally a good classification was achieved where water quality was within established guidelines for a greater period of time while a poor classification resulted where water quality did not fall within the guidelines for a greater period of time. A range of statistical measures including median, ninetieth percentile, and percent time exceedance were used by States and Territories for this determination dependent upon the variable concerned and whether the analysis was based on assessing acute (short-term extreme event) or chronic (long-term sustained event) water quality impacts.

Basin summaries

To be able to build an overview of State and national water quality it was necessary to aggregate water quality results from individual sites to whole river basins. To do this an 'upstream area weighting' method was used. Results obtained by an individual monitoring station are multiplied by the amount of catchment area that it samples. Weighted results from individual monitoring stations allows an entire reporting area (i.e. a basin) to be characterised in terms of the percentage of area classified as good, fair or poor, or in terms of the area undergoing increasing or decreasing trends for a particular water quality variable.

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This method was supported and adopted by State and Territory agencies when compiling the national assessment and can be rationalised in terms of the way water quality interacts within a basin. The potential for error generation was recognised. Generally when monitoring coverage is limited the opportunity for bias in the characterisation of basin water quality becomes an issue. This may lead to the underestimation of the extent of a water quality issue where monitoring stations are not placed within impacted areas, or alternatively overestimation where in the absence of upstream monitoring stations, results obtained by impacted lowland sites are used to characterise the upper basin.

Detecting trends

Detecting trends in surface water quality is complicated by seasonal climatic variation and the influence of stream flows on the observed concentrations of water contaminants. For these reasons a long term (~10 year) dataset containing relatively frequently collected water quality samples (monthly as a minimum) and concurrently collected flow data are required to support trend assessments. A range of statistical analyses were used by States and Territories to report on water quality trends, dependent upon the nature of the monitoring (i.e., flow based versus regular sampling) and quality of the data (i.e., the method's ability to accommodate missing data values). All used methods that accounted for seasonality and stream flow influences (ASoE & Audit, in prep.).

The significance of observed trends were assessed statistically. Significant trends were reported in terms of their magnitude (i.e., how much change per annum) and their direction i.e. whether they were increasing or decreasing. Results that indicated no trends were also reported.

The web based *Australian Natural Resources Atlas* provides a reporting capacity to interrogate data down to an individual monitoring site scale.

Full discussion of the methods used for water quality exceedance and trend assessment are presented in *A review of Australia's surface water quality* (ASoE & Audit, in prep.).

To compile an overview of surface water salinity guideline exceedances within Australia's river basins, the following definitions were used:

- 'major' issues occurred where guideline exceedances were calculated to occupy greater than a third (33%) of a basin area;
- 'significant' issues occurred where guideline exceedances were calculated to occupy greater than 5% but less than 33% of a basin area;
- 'not significant' issues occurred where monitoring coverage was greater than 50% of a basin area; and observed guideline exceedances represented less than 5% of a basin area.
- 'undetermined' issues occurred where monitoring coverage was less than 50% of a basin area; and observed guideline exceedances represented less than 5% of a basin area.

Table A7. State and Territory water quality guidelines.

	Units	Method	Good	Fair	Poor
Salinity					
New South Wales	(µS/cm)	median	<500	500 – 1500	>1500
Victoria	(µS/cm)	median[1]	<500	500 – 1500	>1500
Queensland	(µS/cm)	mean	<500	500 – 1500	>1500
South Australia	(µS/cm)	90th percentile	<1000	1 000 – 2000	>2000
South Australia (modified)	(µS/cm)	median	<800	800 – 1500	>1500
Western Australia	(TDS mg/L)	median	<1000	1 000 – 5000	>5000
Australian Capital Territory	(µS/cm)	median	<800	800 – 1100	>1100
Turbidity					
New South Wales	(NTU)	median	<5	5–50	>50
Victoria[1]	(NTU)	median	<5	5–50	>50
Queensland	(NTU)	median	<5	5–50	>50
South Australia	(NTU)	90th percentile	<20	20–50	>50
Western Australia	(TSS mg/L)	median	<10	10–30	>30
Australian Capital Territory	(NTU)	median	<10	10–15	>15
Total nitrogen					
New South Wales[2]	(mg/L)	median	<0.1	0.1–0.75	>0.75
Victoria[1]	(mg/L)	median	<0.35	0.35–0.5	>0.5
Queensland	(mg/L)	median	<0.375	0.375–0.75	>0.75
South Australia	(mg/L)	90th percentile	<1	1–10	> 10
South Australia (modified)	(mg/L)	modified median	<0.6	0.6–5	> 5
Western Australia	(mg/L)	median	<1.0	1.0–3.0	>3.0
Australian Capital Territory[2]	(mg/L)	median	<0.1	0.1–0.75	>0.75

Continued on next page ...

1 Catchment-specific guidelines and classification schemes exist for some Victorian catchments (under State environmental protection policies).

2 The ANZECC (1992) guideline was used as the basis for assessment.

Table A7. State and Territory water quality guidelines (continued)

	Units	Method	Good	Fair	Poor
Total phosphorus					
New South Wales	(mg/L)	median	<0.02	0.02–0.05	>0.05
Victoria[1]	(mg/L	median	<0.025	0.025–0.05	>0.05
Queensland	(mg/L)	median	<0.05	0.05–0.10	>0.10
South Australia	(mg/L)	90th percentile	<0.10	0.1–1.0	> 1
South Australia (modified)	(mg/L)	modified median	<0.05	0.05–0.5	>0.5
Western Australia	(mg/L)	median	<0.10	0.10–0.30	>0.30
Australian Capital Territory	(mg/L)	median	<0.08	0.08–0.10	>0.10
pH					
New South Wales			n/a	n/a	n/a
Victoria[1]	pH	% of months outside range 6.5–8.5	<10%	10–25%	>25%
Queensland	pH	% of months outside range 6.5–9	<10%	10–25%	>25%
South Australia	pH	median	6.5–9	n/a	<6.5 or >9
Western Australia	pH	% of months outside range 6.6–8.8	<10%	11–25%	>25%
Australian Capital Territory	pH	median	6.5–8.5	6–6.5 or 8.5–9	<6 or >9

1 Catchment-specific guidelines and classification schemes exist for some Victorian catchments (under State environmental protection policies).

n/a not available

GLOSSARY

Aquifer

A geological formation, group of formations, or part of a formation that stores and/or allows movement of groundwater.

Biodiversity

Variety of life forms including the different plants, animals and microorganisms, the genes they contain, and the ecosystems they form. Biodiversity is usually considered at three levels: genetic, species and ecosystem.

Catchment

An area that drains all the precipitation that falls on it to a single point.

Conjunctive use

Management of water as an integrated groundwater and surface water resource. Surface water and groundwater systems are often interconnected and cannot be managed separately.

Custodian

A **custodian** of a fundamental dataset (or a component of that dataset) is an agency recognised by Australia New Zealand Land Information Council as having the responsibility to ensure that the dataset is collected and maintained according to specifications and priorities determined by consultation with the user community. These are made available to the community under conditions and in a format that conform with standards and policies established for the ASDI.

To achieve the purposes behind custodianship, agencies designated as custodians will:

Data collection, maintenance and revision

- Consult with the national sponsor and the community to determine data needs and priorities prior to developing or defining collection or maintenance programs and standards for spatial information in their custody
- Avoid duplication of capture, by ensuring, in conjunction with the national sponsor, that data to be captured is not already held in the format required

Standards development

- Develop with the national sponsor and users, appropriate standards for the management and use of the fundamental datasets in their care.
- Ensure that the fundamental datasets under their custodianship conform to appropriate national, international or agreed standards.
- Propose standards to ANZLIC for the management of the spatial information for which they have custody.

Quality

- Provide full and frank quality statements regarding source, reliability, accuracy, completeness and currency.
- Maintain the quality of the fundamental datasets assigned to them.

Access

- Ensure the spatial information under their custodianship is both accessible and readily available.
- Ensure appropriate storage, maintenance, security and archival procedures for their spatial information.
- Safeguard Government interest in the use of its information through licensing agreements or letters of understanding to protect privacy and confidentiality and interpretation of the information.
- Act as the authoritative source for the information in their care.
- Encourage the proper use of spatial information to discourage duplication through ignorance.
- Nominate a single point of contact for inquiries about the fundamental datasets under their care.

Metadata

- Provide statements describing the data in their care to the jurisdiction and national nodes of the national land information directory system. The metadata must comply with ANZLIC guidelines.

Privacy

- The custodian must provide a level of appropriate security to protect the privacy of any personal data.

Negotiations

- Custodians shall not negotiate unilaterally with any party either on an exclusive basis or for the exclusive use of fundamental datasets. Agreements should wherever possible be negotiated according to these Guidelines; that is, to benefit the community as a whole, not any individual custodian.

Developed yield
Average annual volume of surface water that can be diverted for use with existing infrastructure. Developed yield represents the portion of the divertible yield that is currently available for use.

Development category
Classification used to define the status of diversion and allocation of Australia's water resources in relation to sustainable water management.

Diversion
Surface water diverted for use from the resources of a surface water river basin for supply to both within-basin and external basin consumers.

Divertible yield
Average annual volume of surface water that can be diverted utilising both existing infrastructure and potential infrastructure under ultimate level of development taking no account of environmental water requirements.

Drainage division
The drainage divisions are a series of non-overlapping polygons covering the whole of the Australian continent and some other areas such as Protected Territories. A drainage division may include areas that have no recorded surface run-off. The system of drainage divisions and river basins were defined by the former Australian Water Resources Council and more recently revised under the auspices of the Agriculture and Resource Management Council of Australia and New Zealand.

Ecosystems
Community of organisms that may include humans, interacting with one another. Incorporating the physical, chemical and biological processes inherent in that interaction and the environment in which they live.

Environmental water provisions
Water allocated to support the ecological functioning of aquatic and other dependent habitats based on environmental, social and economic considerations, including existing user rights.

Environmental water requirements
Descriptions of the flow regimes (e.g. volume, timing, seasonality, duration) needed to sustain the ecological values of aquatic ecosystems including their processes and biological diversity.

Gigalitre (GL)
1000 megalitres.

Groundwater
Water stored underground in rock fractures and pores.

Groundwater dependent ecosystems
Ecosystems that are dependent on groundwater for their existence and health.

Groundwater management unit
A hydraulically connected groundwater system that is defined and recognised by State and Territory agencies. This definition allows for management of the groundwater resource at an appropriate scale at which resource issues and intensity of use can be incorporated into local groundwater management practices.

Groundwater province

An area having a broad uniformity of hydrogeological and geological conditions identified as either predominantly sedimentary or fractured rock as defined by the former Australian Water Resources Council.

Groundwater yield

See 'sustainable yield'.

In-stream use

Water in the river and streams for the maintenance of aquatic ecosystems and for aesthetic and recreational purposes.

Mains supply

The water supply component consisting of units engaged in storage, purification or distribution of water by pipeline or carrier. Also includes the operation of irrigation systems.

Megalitre (ML)

1 000 000 litres.

MDBC Cap

The Murray–Darling Basin Commission Cap refers to the limit that has been placed on the volume of water that can be diverted from the surface water resources of the Murray–Darling Basin, in accordance with the Murray–Darling Basin Ministerial Council decision in June 1995. The Cap volume is limited to the amount of water that would have been extracted under 1993/94 levels of development and management rules.

Mean annual flow

The average annual streamflow passing a specified point on a stream.

Mean annual run-off

The streamflow generated as a result of direct precipitation on the area of interest.

National sponsor

A national sponsor is an agency having a special interest in ensuring that a particular set of fundamental data is widely available in all its forms to the community. It will be a part of the Australian Spatial Data Infrastructure, and will have a structure and resources to enable it to:

- consult with and coordinate the activities of the custodians of the various datasets to ensure that the data are collected, maintained and delivered to standards, specifications and user priorities that are consistent with the overall model for a national spatial data infrastructure
- cooperate with Australia New Zealand Land Information Council and other national sponsors in order to ensure that the national spatial data infrastructure is assembled, maintained and delivered in a nationally consistent way
- consult with the community of users to: disseminate information about the data, foster efficient use of the data, coordinate data collection to minimise duplication of effort, provide leadership in developing standards for content, quality and transfer.

pH

A measure of the concentration of free hydrogen ions and reported over a logarithmic scale of 1 to 14.

River basin

Catchment areas of major rivers draining to the sea; named after these rivers. The 245 river basins as defined by the former Australian Water Resources Council. These form sub-basins of the Drainage Divisions.

Self-extracted

Water extracted or diverted directly by the water user through privately owned infrastructure.

Surface water management area

Areas defined by the State and Territory water management agencies for the purposes of reporting on surface water resources. The boundaries of the reporting units commonly coincide with the Australian Water Resources Council river basins. In a number of cases the reporting units represent subdivisions of these river basins.

Sustainable flow regime

The limit on potentially divertible surface water that is allowed to be diverted from a resource after taking account of environmental values and making provision for environmental water needs.

Sustainable yield (surface water)

See 'sustainable flow regime'.

Sustainable yield (groundwater)

Level of extraction measured over a specified planning timeframe that should not be exceeded to protect the higher value social, environmental and economic uses associated with the aquifer.

Unincorporated area

A groundwater resource that is defined geographically by a groundwater province and excludes any designated groundwater management units within the groundwater province. Within the unincorporated area, low level input is required to provide effective management of the groundwater resource due to low levels of current or potential use or development.

Water allocation

Allocation refers to the volume of water allocated for use either within or external to a surface water management area by way of licensing arrangements and formal entitlements to water.

Water use

Volume of water used within a surface water management area irrespective of the source of the water resource.

REFERENCES

AATSE/IEA 1999, *Water and the Australian Economy*, Joint project of the Australian Academy of Technological Sciences and Engineering and the Institution of Engineers Australia.

ABS 2000 *Water Account for Australia 1993–94 to 1996-97*, Cat. No. 4610.0, Australian Bureau of Statistics, Canberra.

ASoE & Audit (in prep.) *A review of Australia's surface water quality,*. ASoE Technical Report, Joint project of the Australian State of the Environment Unit of Environment Australia and National Land and Water Resources Audit.

ANCID 2000 1998/99, *Australian Irrigation Water Provider – Benchmarking report*, a jointly funded publication of the Australian National Committee on Irrigation and Drainage (ANCID), Land and Water Resources Research and Development Corporation and Agriculture, Fisheries and Forestry – Australia.

ANZECC 1992, *National Water Quality Guidelines*, Australia and New Zealand Environment and Conservation Council.

ANZECC (in press) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality*, Australia and New Zealand Environment and Conservation Council.

ANZECC/ARMCANZ 1994, *National Water Quality Management Strategy*.

ANZECC/ARMCANZ (in press) *Australian Guidelines for Water Quality Monitoring and Reporting*, National Water Quality Management Strategy.

ATECH (in press) *Water Monitoring in Australia*, Draft report submitted to Environment Australia and the National Land and Water Resources Audit.

Department of Primary Industries and Energy 1987, *1985 Review of Australia's Water Resources and Water Use*, Australian Water Resources Council, vol. 1 and 2.

Harris G.H. 2000, *A nutrient dynamics model for Australian waterways – Land use, catchment biogeography and water quality in Australian rivers*, Draft report prepared for Environment Australia, State of Environment Reporting Section.

High Level Steering Group on Water 1999, *Implementing the COAG Freamework for Water Reform*, brochure published by the Natural Resource Management Policy Division, Agriculture, Fisheries and Forestry – Australia.

IEA 1999, *Water resources development in Australia, 1900–1999*, Water Broughton (ed.), Institution of Engineers, Australia.

Land & Water Resources Research & Development Corporation 2000, *Cost of Algal Blooms*, Occasional Paper 26/99. Land and Water Resources Research and Development Corporation, Canberra Australian Capital Territory.

MDBC 1995, *An audit of water use in the Murray–Darling Basin*, Murray–Darling Basin Commission.

MDBMC 1999 *The Salinity Audit of the Murray Darling Basin – a 100-year perspective*, a report of the Murray–Darling Basin Ministerial Council, Murray–Darling Basin Commission.

National Groundwater Committee 1999, *The Australian National Groundwater Data Transfer Standard Release 1.0* National Groundwater Committee Working Group on National Groundwater Data Standards, Canberra, http://www.brs.gov.au/land&water/groundwater/

National Land and Water Resources Audit 1999, *Large scale resource developments – an integrated assessment process*, prepared by National Land and Water Resources Audit for the Minister for Agriculture, Fisheries and Forestry, www.affa.gov.au/water-reform/publications.html

New South Wales EPA 1997, *Proporsed Interim Environmental Objectives for New South Wales Waters. North Coast Catchments*, Environmental Protection Agency, New South Wales.

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ACKNOWLEDGMENTS

State and Territory Water Resource Assessment

Water availability

Greg Keen—Australian Capital Territory Department of Urban Services

John Hayes, David Malone—New South Wales Department of Land and Water Conservation

Daryl Chin, Lakshman Rajaratnam—Northern Territory Department of Lands Planning and Environment

Stuart Wade, Ross Wieckhorst—Queensland Department of Natural Resources

David Cresswell, Stephen Howell—South Australia Department of Water Resources

Robert Phillips—Tasmania Department of Primary Industries, Water and Environment

Rae Moran—Victoria Department of Natural Resources and Environment

Roy Stone, Phil Cammander—Western Australia Water and Rivers Commission

Surface water quality

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Beth Overton, Amrit Kathuria, Helen Daly—New South Wales Department of Land and Water Conservation

Simon Townsend—Northern Territory Department of Lands Planning and Environment

Tony Horn—Queensland Department of Natural Resources

Peter Goonan—South Australia Department of Water Resources

David Fuller—Tasmania Department of Primary Industries, Water and Environment

Stuart Minchin—Victoria Department of Natural Resources and Environment

Robert Donohue, Brad Jakowyna—Western Australia Water and Rivers Commission

Streamflow extension

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Technical coordination and database development (Sinclair Knight Merz)

Assessment

Peter Erlanger, Fereal Addicott, Richard Evans, Ann Kollmorgen, Chris McAuley, Jonas Ball (surface water quality)

Database

Peter O’Neill, Catherine Hill, Joseph Bojilov

To the real unsung heroes of these projects, the project teams, we extend our sincere thanks.

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CSIRO Land and Water	Inside cover, pages v, ix, 2, 5, 21, 27, 32, 38, 49, 50, 67, 79, 86, 127
Murray–Darling Basin Commission	Front cover, pages vi, 1, 17, 23, 30, 37, 40, 43, 46, 53, 55, 64, 69, 73, 76, 88, 90, 103, 144, 150, 154, 158, 160
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NATIONAL LAND AND WATER RESOURCES AUDIT

Who is the Audit responsible to?

The Minister for Agriculture, Fisheries and Forestry has overall responsibility for the Audit as a program of the Natural Heritage Trust. The Audit reports through Minister Truss to the Natural Heritage Board comprising both Minister Truss and Senator the Hon. Robert Hill, Minister for the Environment and Heritage.

How is the Audit managed?

An Advisory Council manages the implementation of the Audit. Dr Roy Green, with a background in research, science policy and management chairs the Advisory Council. Members of the Advisory Council and the organisations they represent in December 2000 are: Alex Campbell (L&WA), Geoff Gorrie (AFFA), Stephen Hunter (EA), Bryan Jenkins (SCEP), John Radcliffe (CSIRO), Peter Sutherland (SCARM), Jon Womersley (SCC), Roger Wickes (SCARM) and Colin Creighton (Audit).

What is the role of the Audit Management Unit?

The Audit Management Unit's role has evolved over its five-year life. Phases of activity include:

Phase 1: Strategic planning and work plan formulation—specifying (in partnership with Commonwealth, States and Territories, industry and community) the activities and outputs of the Audit—completed in 1998–99.

Phase 2: Project management—letting contracts, negotiating partnerships and then managing all the component projects and consultancies that will deliver Audit outputs—a major component of Unit activities from 1998–99 onwards.

Phase 3: Reporting—combining outputs from projects in each theme to detail Audit findings and formulate recommendations—an increasingly important task in 2000–2001 and the early part of 2001–02.

Phase 4: Integration and implementation—combining theme outputs in a final report, working towards the implementation of recommendations across government, industry and community, and the application of information products as tools to improve natural resources management—the major focus for 2001–2002.

Phase 5: Developing long term arrangements for continuing Audit-type activities—developing and advocating a strategic approach for the continuation of Audit-type activities—complete in 2001–2002.

The Audit Management Unit has been maintained over the Audit's period of operations as a eight-person multidisciplinary team. This team as at December 2000 comprises Colin Creighton, Warwick McDonald, Stewart Noble, Maria Cofinas, Jim Tait, Rochelle Lawson, Sylvia Graham and Drusilla Patkin.

How are Audit activities undertaken?

As work plans were agreed by clients and approved by the Advisory Council, component projects in these work plans are contracted out. Contracting involves negotiation by the Audit to develop partnerships with key clients or a competitive tender process.

Facts and figures

• Total Audit worth, including all partnerships	in excess of $52 m
• Audit allocation from Natural Heritage Trust	$34.19 m
• % funds allocated to contracts	~ 92%
• Total number of contracts	130

Natural Heritage Trust
Helping Communities
Helping Australia
A Commonwealth Government Initiative

National Land and Water Resources Audit
A program of the Natural Heritage Trust

www.nlwra.gov.au/atlas