Government of **Western Australia**
Department of **Water**

WAter resources inventory 2014

Water availability, quality and trends

WAter resources inventory 2014

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Foreword

This report gives a state-wide picture of Western Australia's natural groundwater and surface water resources. Our stakeholders already access information on water quantity and water quality through our water information reporting portal, water plans and technical reports, or directly from our regional offices. This report brings information together for those state and commonwealth agencies, research and academic institutions and water industry organisations and individuals who are interested in an overview of Western Australia's water resources.

It covers all of the water resources where there is some level of water demand and answers the following questions:

- Where are the water resources?
- How is water used?
- What is the water quality?
- Is there more water available?
- What are the considerations in accessing the resource?
- How much technical information do we have on the water resource?

Our water resources are diverse and complex. This report reflects the different levels of water information, water use and water management around the state. Where water resources are (or are becoming) well developed we have drawn on high-level technical information and management considerations to establish annually sustainable volumes of water for abstraction. In other places, where demand has been lower or site-specific, our water availability estimates are appropriate to the current level and nature of water use. While this report reflects a point in time, water information is not static. We improve and update information through water monitoring and plan evaluation, and focus new groundwater and surface water investigations to support strategic growth initiatives.

The information in this report is based on currently available information, and current levels of management. It is provided as an indicative guide. To understand the local situation more accurately please contact the Department of Water's nearest regional office <www.water.wa.gov.au/Water+regions/default.aspx> or visit our water information reporting portal at <http://wir.water.wa.gov.au>.

Maree De Lacey
Director General

Contents

1 Introduction

This report gives a state-wide picture of Western Australia's natural groundwater and surface water resources. It covers all of the water resources where there is some level of water demand and answers the following questions:

- Where are the water resources?
- How is water used?
- What is the water quality?
- Is there more water available?
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1.1 Water resources of Western Australia

Water resources are not evenly distributed around Western Australia. Where local groundwater and surface water resources are available, they are used to meet local demand. Once these are fully utilised, the possibilities for meeting further needs are:

- increase the efficiency with which water is used
- commence water trading
- develop other possible sources of water
- move the demand to where water is available.

River systems in the south-west of Western Australia are well utilised for water supply. Most of the rivers flowing west from the Darling Scarp have been dammed for public water supply or irrigation schemes. Water from shorter, freshwater streams in the South West is obtained by using small on-stream dams to provide self-supply water for irrigated horticulture. Rivers in the South West are seasonal, flowing in response to winter rains. In some, groundwater contributes to baseflow. While lower flows are becoming more frequent in response to a drying climate, these rivers retain their seasonal pattern and their flows in the wetter years are becoming an increasingly important part of the solution to the drying climate.

Rivers in the north are also seasonal, having highly variable flows from year to year. The availability of water for any particular use depends as much on location, variability and cost as on the actual quantity of water in the resource. The Ord River in the East Kimberley is dammed to provide reliable water supplies for irrigation.

In other parts of the state, rivers tend to be ephemeral, responding to unreliable rainfall. Over half of Western Australia is desert landscape characterised by internal drainage where there is no freshwater flow.

Groundwater from sedimentary basins forms a reliable water source for much of Western Australia. The Perth Basin, extending along the coastal plain from the South West to north of Geraldton, is extremely important for public water supply, irrigated agriculture and public open space. As a drying climate further limits the sustainable supply from this resource, the focus is turning to more effective ways of using available water. Further north, the Carnarvon and Canning basins are potential water sources.

Sedimentary alluvial aquifers occur in the sandy sediments along major rivers in the Pilbara and Gascoyne regions. These alluvial aquifers are recharged after episodic flooding. In the Pilbara, groundwater stored in alluvial aquifers by flooding rivers is essential for water supply. In the Gascoyne, groundwater is essential for irrigated agriculture.

In the semi-arid central parts of the state there are large expanses of ancient bedrock where groundwater occurs in small but valuable quantities in fractures, joints, bedding planes and cavities in an otherwise solid rock mass. Groundwater yield from fractured rock is variable. In the mining areas of the Pilbara, Mid-West and Goldfields, groundwater in fractured rock and palaeochannels is essential to the mining industry.

Around the state, abstraction of surface water and groundwater is managed annually so that the water resources are not depleted in the long term. As demand increases the proportion of alternative sources (such as desalination and managed aquifer recharge) will increase, but local natural sources – managed sustainably – will continue to meet the major part of our water needs.

The main surface water resources, current allocation limits and their availability status are summarised in Figure 1. The location, allocation limits and availability status of groundwater resources are summarised in Figure 2.

The allocation limit is represented by the size of the circle and the volume figure within it.

The availability status is represented by circle colour:

- dark blue circles represent areas having no further water available
- circles with the lighter shade of blue represent areas with 70% to 99% water allocated and committed
- circles with the lightest blue shade represent areas with 70% or less allocated and committed.

For details of how the volumes represented in these figures (for surface water, groundwater and mine dewater) have been obtained refer to appendices A and B.

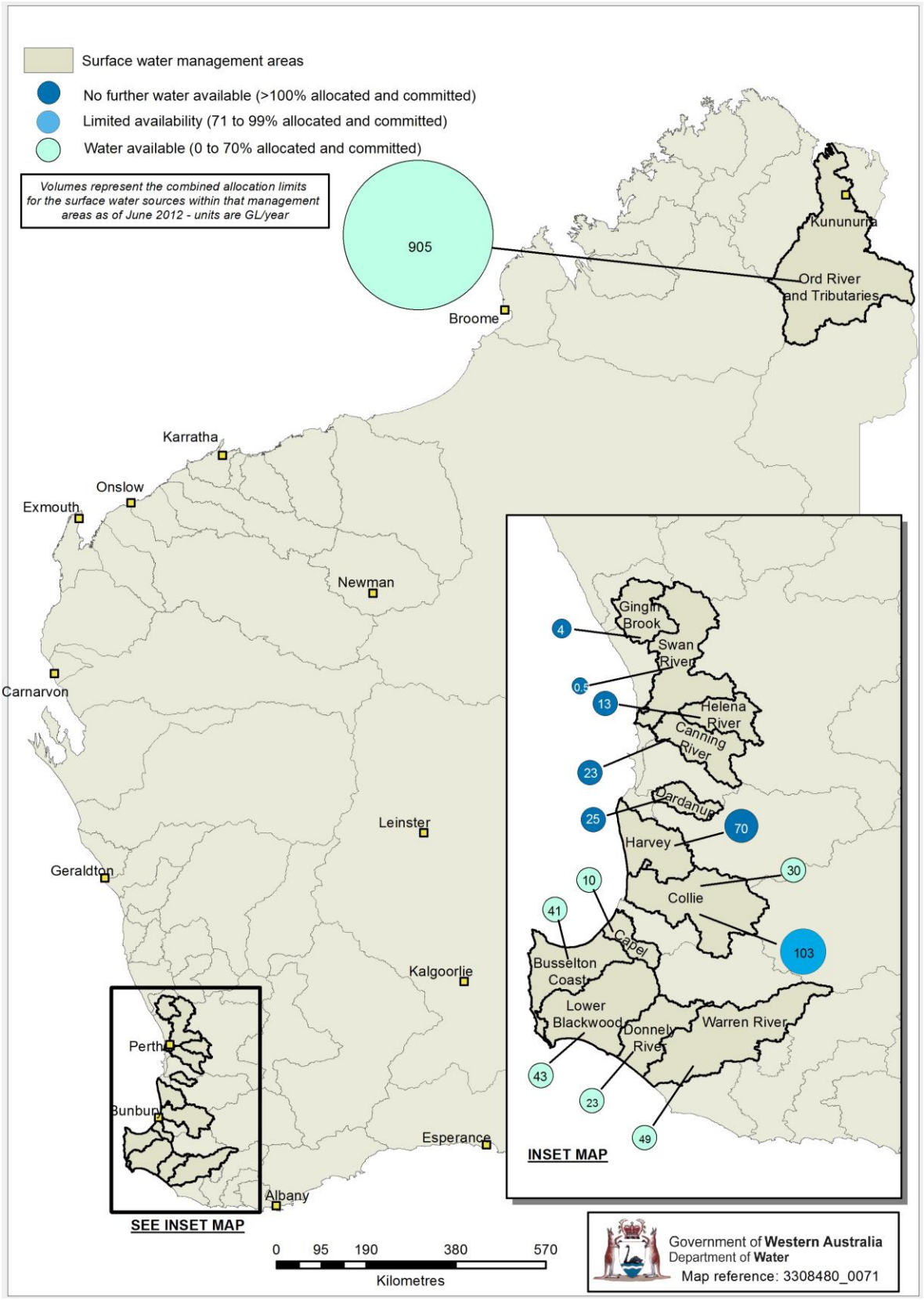

Figure 1 State-wide surface water resources and their availability status

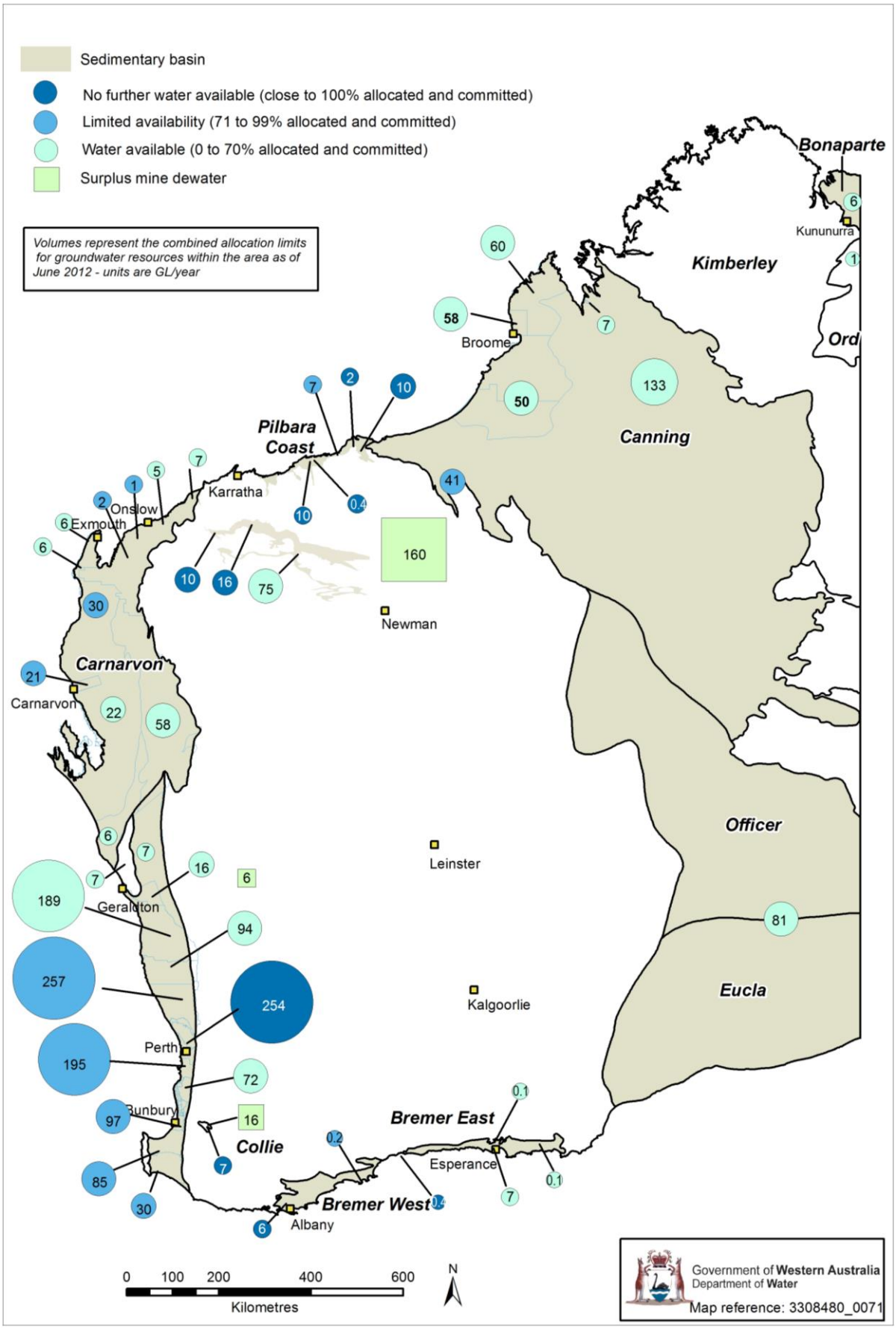

Figure 2 State-wide groundwater resources and their availability status

1.2 How to use this report

Water information in this report is presented for the 10 Department of Planning regions (see Figure 3). For each region, information for surface water and groundwater resources is organised into the water resource management areas and resources used by the Department of Water.

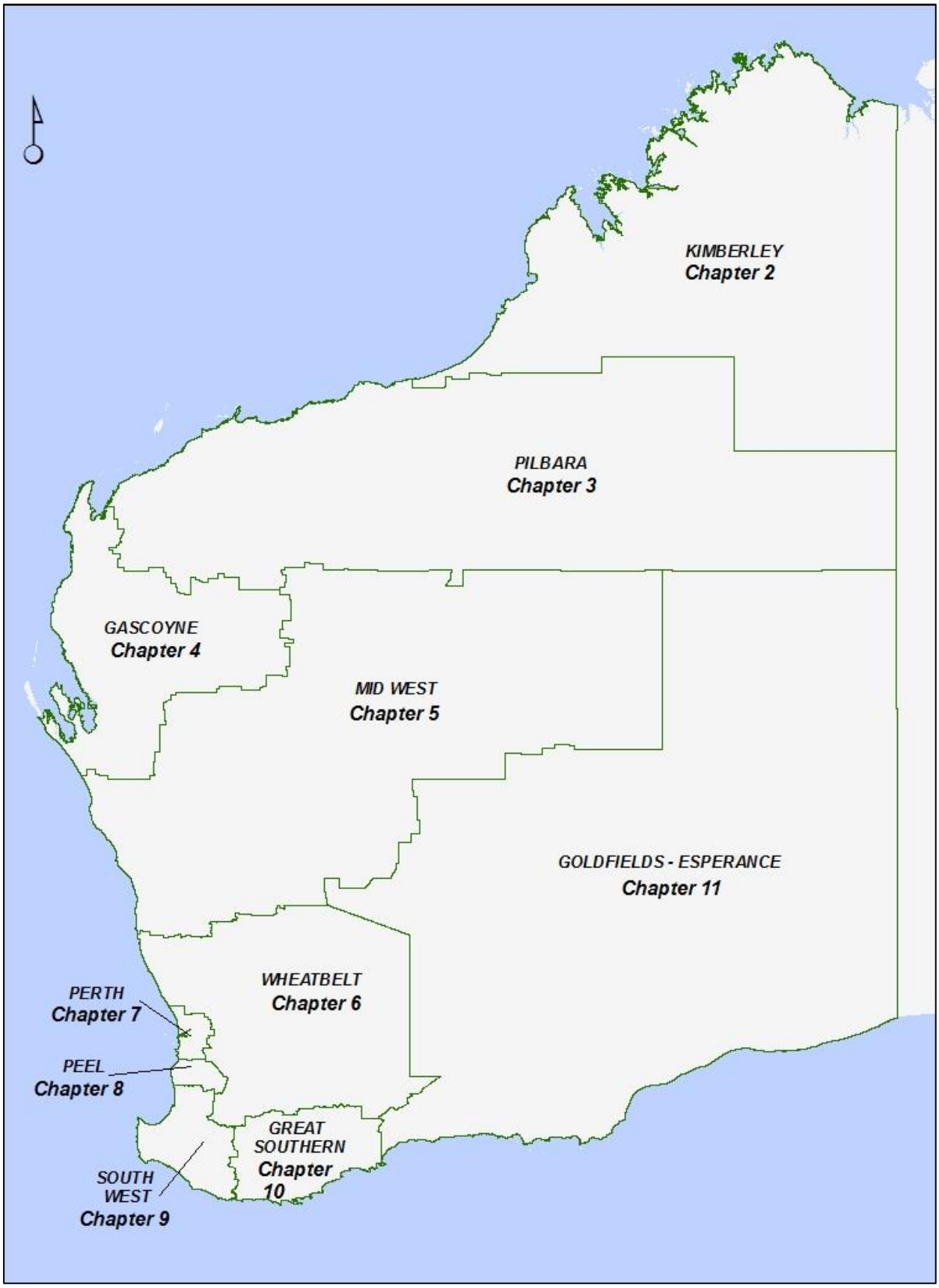

Figure 3 Department of Planning regions

Water quantity information is presented as tables showing surface water and groundwater resources. Water quality information is presented as maps showing average water quality for surface water and groundwater resources.

This report provides the following information about each water resource:

- The allocation limit and the volume of water still available for general licensing, as an indication of how much further water could be used for new or increased licensed use.
- The salinity range of the resource, as an indication of its likely water quality.
- The water level trend as an indicator of how the resource is responding to current climate and abstraction, and therefore how reliable it may be.
- The level of technical information available for each resource, as an indicator of the precision of assessments of quantity, quality and reliability of the water resource.
- An indication of aquifer depth (shallow, middle or deep) and hence the cost of obtaining water from them (white areas on the groundwater maps indicate where the aquifer is not present).

This report is a snapshot in time. The information provided was accurate as at June 2012, and more recently where it has been subsequently updated through an allocation planning process. Because water availability information can change with changes in licensing, we encourage you to contact the department's regional offices for up-to-date information:

<http://www.water.wa.gov.au/Water+regions/default.aspx>.

Alternatively please refer to the department's online water registry found at: <http://www.water.wa.gov.au/Business+with+water/Water+trading+and+register/default.aspx>.

1.3 Water quantity available for further use

This report shows the quantity of water available for further general licensing. This is the water that has not been allocated to existing licences, committed to conditional approvals and development commitments, reserved for future strategic uses or set aside to account for small-scale exempt use. The quantity of water available for further general licensing is the water available for development.

Allocation limits and further water available for development

The Department of Water sets allocation limits to manage the volume of water that can be abstracted or taken from a resource annually. To help us account for water use, the allocation limit includes water that can be taken or abstracted from a water resource for household, urban, irrigation, stock, mining and industrial water uses. It does not include water that is left in the resource for social, cultural or ecological purposes.

The allocation limit accounts for all types of water use including use that requires a licence and use that is exempt from licensing under the *Rights in Water and Irrigation Act 1914*. We divide the total allocation limit into components for accounting purposes. The components of an allocation limit are generally:

- General licensing component – the volume of water that can be issued as annual licence entitlements for general public licensing purposes, such as irrigation, mining, industrial and other commercial type uses.
- Public water supply licensing component – the volume of water that is issued as annual licence entitlements for public water supply through a water service provider.
- Exempt component – accounts for the volume of water that is exempt from licensing under the *Rights in Water and Irrigation Act 1914*, such as small-scale stock watering and domestic garden use.
- Reserve component – a volume of water that has been reserved for future public water supply.

What is water availability status?

In this report, water availability status refers to the volume of water available for future use and development from the general licensing component that has not yet been issued as individual licence entitlements.

Allocation limits and management units

Surface water systems across the state are divided into a hierarchy of 'management units'. The highest level is the 'drainage basin', then the 'surface water management area', then the 'surface water resource (subarea)' and at the lowest or most detailed level the actual 'surface water source'.

Surface water allocation limits and available water are presented as totals for each surface water management area. Where there is a major reservoir within the surface water management area, the reservoir has been listed separately.

Sedimentary groundwater resources across the state are also divided into a hierarchy of management units. These management units are a combination of administrative boundaries (proclaimed groundwater areas and groundwater subareas) and hydrogeology (basin and aquifer). Groundwater resources are named firstly by the 'proclaimed groundwater area' then the 'groundwater subarea' followed by the 'basin and aquifer'.

Allocation limits and available water for groundwater resources are reported at the most detailed level which is the 'basin and aquifer' level (referred to as a 'groundwater resource').

Where allocation limits do not apply

Allocation limits have not been set for all resources. This is usually for one, or a combination, of the following reasons:

- The resource is not proclaimed under the *Rights in Water and Irrigation Act 1914*, so licensing is not required.
- An annual allocation limit is not normally applied to fractured rock groundwater resources where water information is site specific and/or water abstraction is relatively isolated.
- Management of water use is in transition and allocation limits are yet to be developed.
- There is little to no demand for the water resource.
- There is little information about the resource.

When there is no allocation limit but there is some demand for a water resource, the department assesses each proposal to use water on a case-by-case basis.

1.4 Water quality

Many of the freshwater resources around the state are already well utilised. There are more saline resources which have potential to be developed for fit-for-purpose uses. The report groups salinity into five broad ranges to give an indication of average water quality for each resource.

General types of uses suitable for each salinity range are shown in Table 1.

Table 1 Water quality and use matrix

	Fresh 0–500 mg/L TDS	Marginal 500–1 000 mg/L TDS	Brackish 1 000–3 000 mg/L TDS	Saline 3 000–35 000 mg/L TDS	Hyper saline >35 000 mg/L TDS
Potable water – desirable					
Potable water – acceptable					
Irrigation					
Industry					

Innovative design and use of alternative technologies for industry, or sophisticated farming techniques and crop selections, can allow for the use of higher salinity water if these options are considered early enough in the development process.

Water quality can vary significantly across a water resource and salinities can change seasonally as well as from year to year. The values shown in the maps and tables in chapters 2 to 11 should be used as a resource scale guide, and not for site specific information.

For more local and site specific information about the water quality of a given resource, please contact one of the Department of Water's regional offices at <www.water.wa.gov.au/Water+regions/default.aspx>.

1.5 Water information

The level of technical information available for each resource is categorised as: 'initial', 'medium' or 'high', based on the:

- amount and quality of data
- scale of hydrological and hydrogeological investigations and assessment
- coverage, frequency and period of groundwater monitoring and streamflow gauging.

Climate

Our changing climate and how it is affecting water resource security is a critical factor to consider in the future development of our water resources. Water resources in the Perth, Peel and South West regions have been affected by reduced rainfall over the last three to four decades. This is clearly demonstrated by reduced flows into Perth's public water supply reservoirs and declines in groundwater levels across the Perth area.

Trends

Groundwater level and streamflow trends have been provided for most resources in chapters 2 to 11. The assessment of these trends have been based on existing historical data, generally from 1975 onwards. Resources have broadly been categorised as 'declining', 'stable' or 'increasing'. In some cases, such as in the Gascoyne and Pilbara regions, trends are difficult to assess due to the large seasonal and yearly variations in rainfall and recharge events. In these cases, the trend has been categorised as seasonal.

The trend assessment has used the best available information. Given the scale of the report, generalisations have been made. Where there is significant variation in trends within one resource, the assessment reflects the overall trend in that area. For some resources there is insufficient data on which to base a trend assessment.

The trend assessment does not include the rate or magnitude of the trend.

Cost of access

This report clearly shows that while there is considerable water available around the state, it is not always easily accessible. Groundwater resources have been simply categorised as shallow, middle or deep based on where they occur within their relevant geological unit. Generally the depth of the aquifer provides a guide to the cost of accessing the resource. The costs of accessing surface water is more related to the site conditions and where applicable, the size of the dam.

2 Kimberley water resources

Surface water

Most of Western Australia's surface water is in the Kimberley. The greatest volumes are carried by the two largest rivers – the Fitzroy River in the West Kimberley and the Ord River in the East Kimberley (Figure 4). As many as 20 significant rivers flow north and west, across the remote Kimberley plateau, to discharge dramatically into the Timor Sea.

Kimberley rivers are sub-tropical. The water is generally fresh, and flows vary widely from year to year. The rivers usually flood in the wet season and, apart from the lower Ord, recede to low or no flow and pools in the dry season. Despite above-average rainfall for more than a decade, no definitive climate trends have been identified and global climate modelling suggests the high natural variability from year to year will continue.

Both the Ord and Fitzroy rivers are a focus for development. Further planned irrigation expansion is being enabled through the *Ord surface water allocation plan* (DoW 2013b), which defines a highly reliable allocation limit of 865 000 ML/year downstream of the Ord River Dam. A total of 350 000 ML of annual water entitlements have been granted (mainly for irrigation) in Western Australia. Much of the remaining 515 000 ML/year is expected to be granted for irrigation expansion over the next five to ten years.

There is surface water available within the highly reliable allocation limit set for the Ord system. Water demands for existing and future irrigation and current obligations to hydropower generation mean that the water resources are essentially committed to meet state and Commonwealth governments' priority to provide reliable water supplies for irrigation expansion.

Depending on crop types, additional water may be needed to support irrigation expansion into the Northern Territory. The Lake Argyle spillway is relatively low compared to the level of the Ord River Dam, and potential for additional reliable water supply through raising the spillway is being investigated. Other options are also being investigated.

All the Kimberley rivers are rich in social, cultural and environmental values. The highly seasonal rivers to the north are not good prospects for irrigation, due to their remoteness and land tenure. The scale of flooding is a significant issue for the Fitzroy. While there are large volumes of water flow in the Fitzroy, its tributaries and the northern rivers, there has been only limited technical work done to consider competing values, development options, technical feasibility, potential allocations or management arrangements. Large scale development at Camballin in the 1960s was not successful due to uncontrolled flooding, and groundwater may be a more viable water source option for small to medium scale irrigation.

In the Kimberley Region, surface water abstraction is licensed under the proclaimed Ord River and tributaries, Fitzroy River and tributaries and Wyndham water supply

(Pentecost and King rivers) surface water areas. Town supply for Wyndham is sourced from the Moochalabra Dam. The approach to allocating and managing water in the Ord River is described in the *Ord River surface water allocation plan* (DoW 2013b).

Table 2 Kimberley Region surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend[2]	Level of technical information
Drysdale River	Rivers & tributaries	Not set	-	0–500	Increasing	Initial
King Edward River	Rivers & tributaries	Not set	-	0–500	Increasing	Initial
Prince Regent River	Rivers & tributaries	Not set	-	0–500	Increasing	Initial
Pentecost & King River	Rivers & tributaries	Not set	-	0–500	Increasing	Initial
Ord River and tributaries	Carlton-Mantinea	115 000	115 000	0–500	Increasing	High
	Tarrara-Carlton	0	0	0–500	Increasing	High
	Main Ord River (includes Lake Argyle and Lake Kununurra)	750 000	403 000	0–500	Increasing	High
	Dunham River	25 000	4 965	0–500	Increasing	High
	Upper Ord	15 000	6 065	0–500	Increasing	High
	Other tributaries	Not set	-	0–500	Increasing	Medium
Keep River	Rivers & tributaries	Not set	-	0–500	Increasing	Initial
Isdell River	Rivers & tributaries	Not set	-	0–500	Increasing	Initial
Lennard River	Rivers & tributaries	Not set	-	0–500	Increasing	Initial
Cape Leveque Coast	Rivers & tributaries	Not set	-	0–500	Increasing	Initial
Fitzroy River & tributaries	Rivers & tributaries	Not set	-	0–1 000	Increasing	Initial
Mackay Basin	Inland desert	Not set	-	No data	No data	Initial
Totals		**905 000**	**529 030**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The average streamflow trend is for the last decade, not a trend projected into the future.

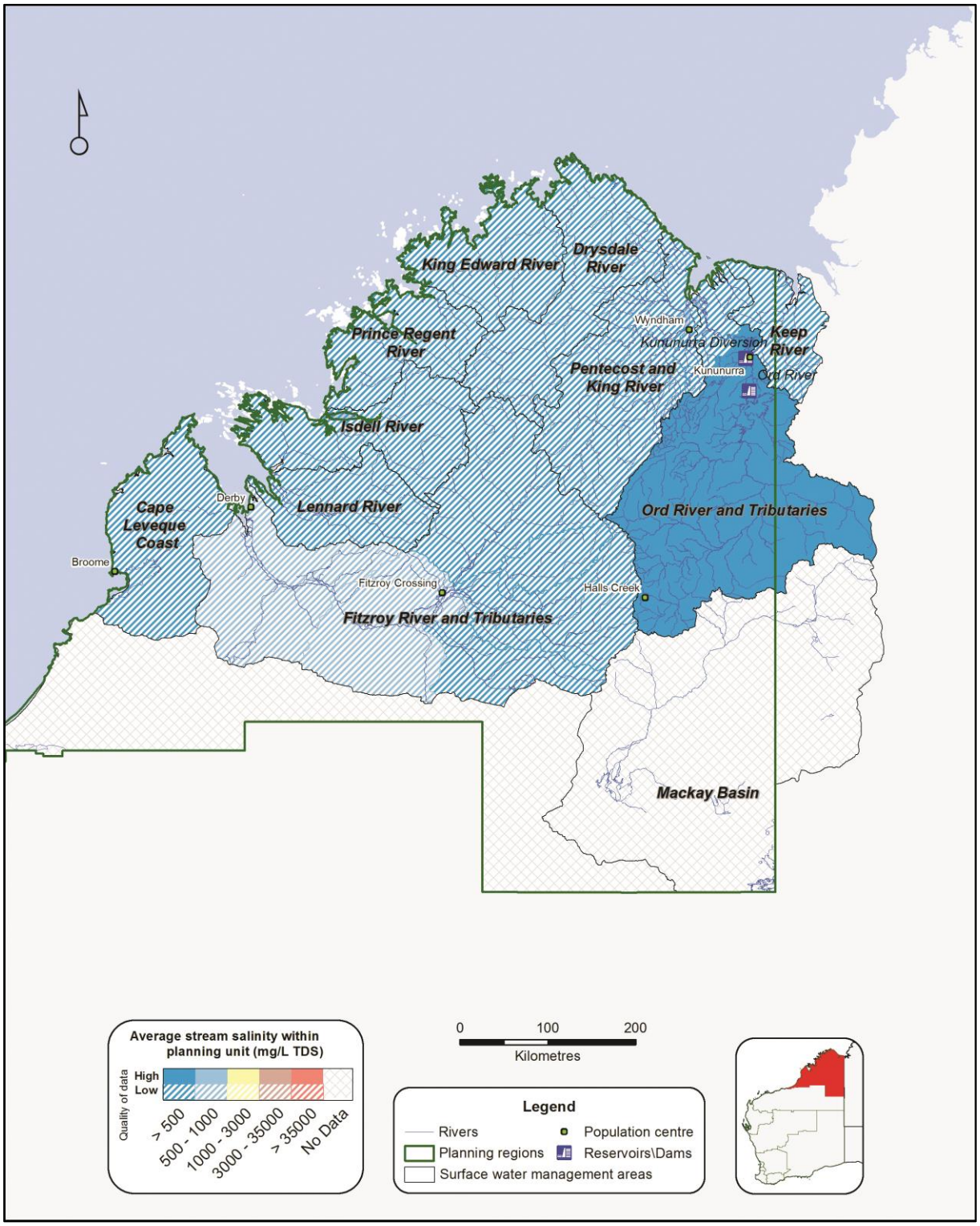

Figure 4 Kimberley Region surface water resources and water quality

Groundwater

The Kimberley Region's major groundwater resources occur in the sedimentary Canning Basin, with other resources in smaller sedimentary basins and more distributed alluvial and fractured rock aquifers.

The Canning Basin is an extensive aquifer system to the south and west of the Kimberley, extending into the Pilbara Region. Groundwater is recharged through cyclonic rainfall events and generally moves from east to west, discharging at the coast. Because rainfall is episodic and evaporation is high, groundwater recharge is low and spread across a very large area. The shallow Broome Sandstone aquifer of the Canning Basin is relatively fresh, though saltwater intrusion occurs near the coast at Broome in response to abstraction. Deeper aquifers, including the Canning-Wallal, are more brackish in some locations.

The Ord and Bonaparte basins form smaller sedimentary aquifers in the East Kimberley.

Groundwater in the Kimberley Region is abstracted for stock, households, horticulture, mining and public water supply. At present, most groundwater is used near Broome for town water supplies and horticulture, and for distributed horticulture developments in La Grange (south-west of Broome) and some limited use in the Fitzroy Valley.

Across the region there is over 270 000 ML/year of groundwater currently identified as available from the sedimentary aquifers for general purpose licensing. Additional water may also be available from these and other aquifers, and would need to be further assessed to determine the potential for development.

The level of knowledge of groundwater varies across the region, and is largely drawn from investigations completed to support urban and development pressures.

The Canning Basin has a high potential for future use and site specific investigations would help to determine volumes available and management needs at the local scale. There is reasonable groundwater resource potential in the alluvium of the Fitzroy River (recharged by flood flows along the Fitzroy River) and for the Cockatoo Sands within the Bonaparte Basin in the East Kimberley.

The saltwater interface, coastal wetlands and groundwater-dependent ecosystems are major considerations for development of the water resources of the Canning Basin, as are floods for Fitzroy Valley alluvial aquifers. The low annual average recharge, especially in the Canning Basin, means that the possible effects of water users' use on each other need to be carefully managed. The Department of Water is currently investigating the groundwater potential of the Canning-Broome aquifer of the Dampier Peninsula. The hydrogeological drilling, monitoring and assessment work is funded through the Royalties for Regions program.

In the Kimberley Region groundwater abstraction is managed under the proclaimed Canning-Kimberley, Derby, and Broome groundwater areas.

The approach to allocating and managing water from the La Grange subarea of the Canning Basin is described in the *La Grange groundwater allocation plan* (DoW 2010c).

Table 3 Kimberley Region shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Canning-Kimberley groundwater area							
1	Canning-Kimberley	Bonaparte – Alluvial	5 000	2 871	0–500	Declining	Initial
		Bonaparte – Limestone	1 000	1 000	0–500	No data	Initial
		Bonaparte – Superficial	100	0	0–500	No data	Initial
		Ord – Victoria	1 000	993	500–1 000	No data	Initial
		Officer – Surficial	1 000	1 000	No data	No data	Initial
		Canning – Limestone	5 458	3 342	500–1 000	No data	Initial
		Canning – Liveringa	10 000	9 322	1 000–3 000	No data	Initial
		Canning – Sandstone	1 000	930	1 000–3 000	No data	Initial
		Canning – Wallal	10 000	8 572	No data	No data	Initial
		Canning – Grant[2]	100 000	85 079	500–1 000	Stable	Medium
2	Canning – Pender	Canning – Broome	50 000	47 895	0–500	Stable	Initial
3	La Grange North	Canning – Broome	35 000	23 633	0–500	Stable	Initial
4	La Grange South	Canning – Broome	15 000	8 890	0–500	Stable	Initial
5	West Canning – Pardoo	Canning – Broome	10 000	9 998	1 000–3 000	No data	Initial
Derby groundwater area							
6	Derby Township	Canning – Wallal	770	525	1 000–3 000	Stable	Medium
7	Hamlet Grove	Canning – Wallal	382	220	0–500	Stable	Medium
8	Rural	Canning – Wallal	3 717	3 601	0–500	Stable	Medium
Broome groundwater area							
9	Roebuck	Canning – Broome	34 700	34 078	0–500	Stable	Initial
10	Coconut Wells	Canning – Broome	318	169	0–500	Stable	High
11	Skuthorpe	Canning – Broome	2 856	1 310	0–500	Stable	High
12	12 Mile	Canning – Broome	981	115	0–500	Stable	High
13	Town Water Reserve	Canning – Broome	10 628	5 221	0–500	Stable	High
14	Cable Beach	Canning – Broome	852	731	1 000–3 000	Stable	High
15	Townsite	Canning – Broome	939	639	1 000–3 000	Stable	High
Totals			**300 701**	**250 134**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The majority of the Canning-Grant aquifer is shown in the Pilbara Region in Figure 9.

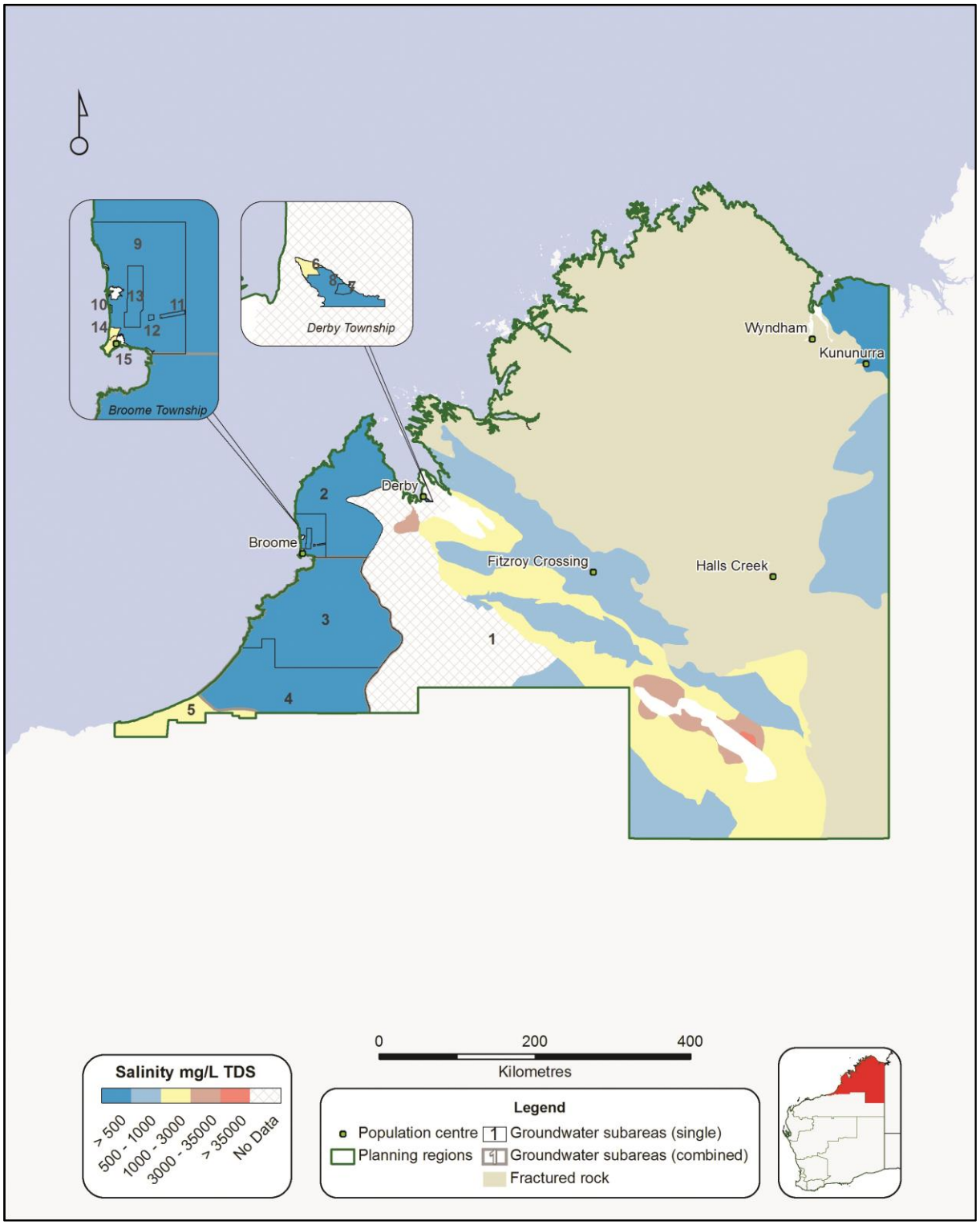

Figure 5 Kimberley Region shallow groundwater resources and water quality

Table 4 Kimberley Region middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Canning-Kimberley groundwater area							
1	Canning-Kimberley	Officer – Sedimentary	1000	1 000	No data	No data	Initial
		Canning – Erskine	5000	5 000	0–500	No data	Initial
		Canning – Erskine.	Not set	0	No data	No data	Initial
2	Canning – Pender	Canning – Wallal.	10 000	10 000	1 000–3 000	Stable	Initial
3	Canning – Lagrange	Canning – Wallal.	Not set	–	No data	No data	Initial
4	West Canning	Canning – Wallal.	30 000	2 475[3]	0–500	No data	Initial
Derby groundwater area							
5	Derby Township	Canning – Erskine.	800	0	0–500	Stable	Medium
6	Hamlet Grove	Canning – Erskine.	45	45	No data	Stable	Medium
7	Rural	Canning – Erskine.	1 166	357	0–500	Stable	Medium
Broome groundwater area							
8	Roebuck	Canning – Wallal.	1 000	1 000	1 000–3 000	Stable	Initial
9	Coconut Wells	Canning – Wallal.	1 000	1 000	1 000–3 000	Stable	Initial
10	Skuthorpe	Canning – Wallal.	1 000	1 000	1 000–3 000	Stable	Initial
11	12 Mile	Canning – Wallal.	1 000	1 000	1 000–3 000	Stable	Initial
12	Town Water Reserve	Canning – Wallal.	1 000	1 000	1 000–3 000	Stable	Initial
13	Cable Beach	Canning – Wallal.	1 000	865	1 000–3 000	Stable	Initial
14	Townsite	Canning – Wallal.	1 000	1 000	1 000–3 000	Stable	Initial
Totals			**55 011**	**25 742**			

[1] A full stop at the end of the aquifer name identifies that it is a confined resource.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[3] The West Canning – Canning-Wallal. aquifer is likely to become fully allocated soon, as the full amount has been applied for by various proponents.

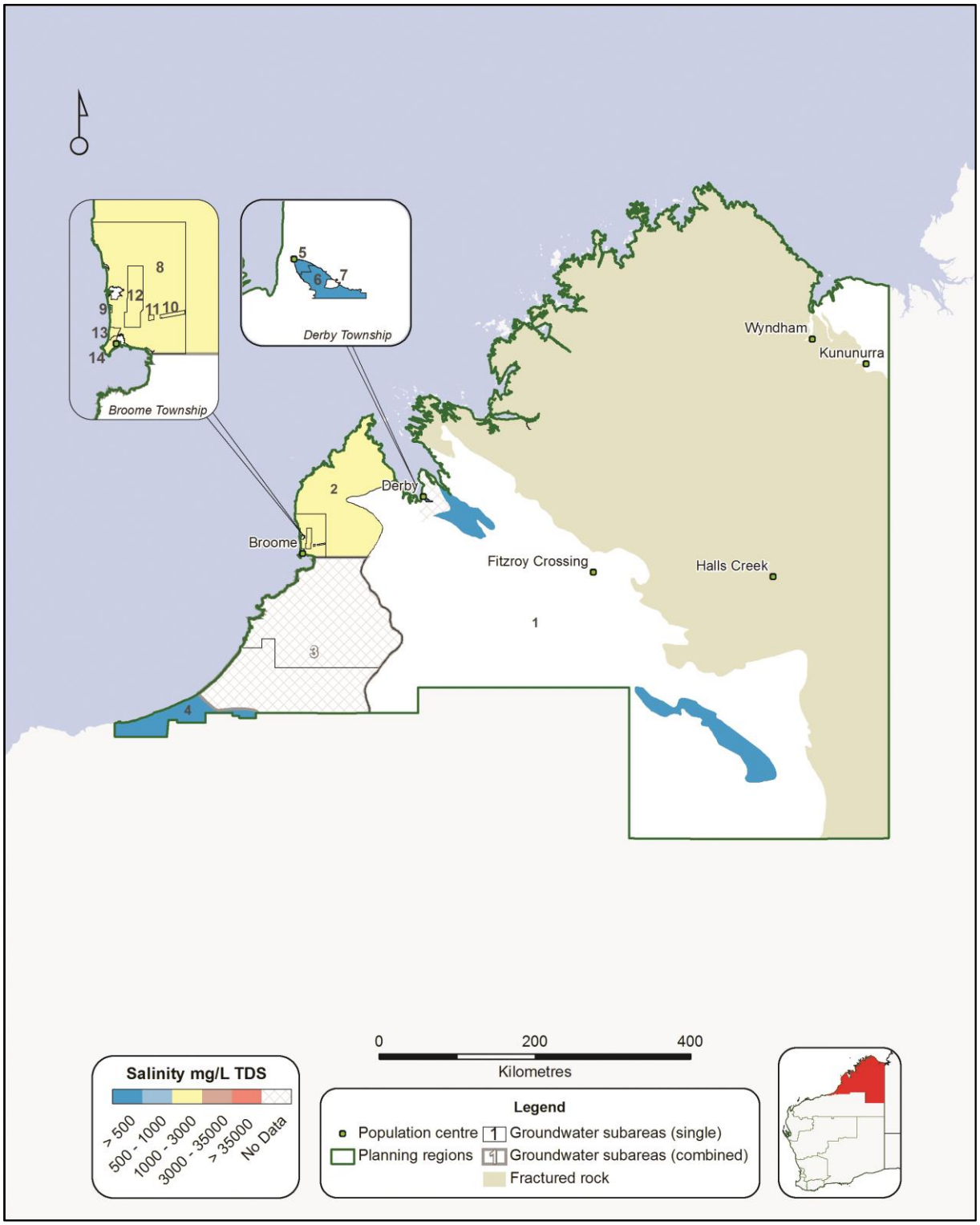

Figure 6 Kimberley Region middle groundwater resources and water quality

Table 5 Kimberley Region deep groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year	Salinity range mg/L TDS	Water level trend	Level of technical information
Canning-Kimberley groundwater area							
1	Canning – Pender	Canning – Grant	Not set	–	No data	No data	Initial
Broome groundwater area							
2	Roebuck	Canning – Grant	Not set	–	No data	Stable	Initial
Totals			**–**	**–**			

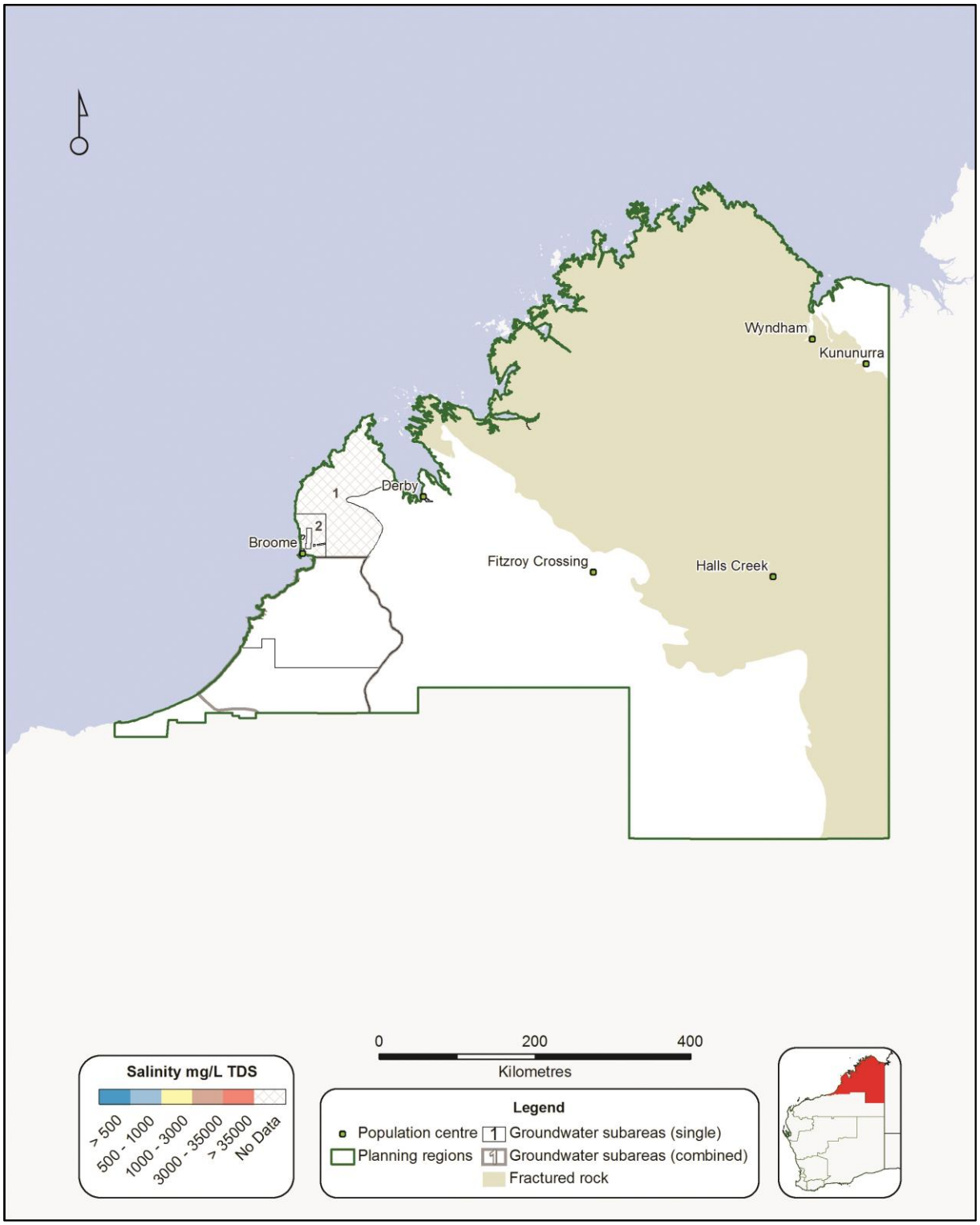

Figure 7 Kimberley Region deep groundwater resources and water quality

3 Pilbara water resources

Surface water

The Pilbara Region has an arid climate with highly variable rainfall. River systems flow roughly east to west.

The De Grey, north of Port Hedland, is the largest river system, with a catchment covering about a third of the Pilbara. The next largest rivers are the Fortescue River arising east of Newman and extending to the coast south of Karratha, and the Ashburton River reaching the coast south of Onslow. Between these large rivers there are numerous shorter coastal streams.

Streamflows are mostly a direct response to cyclonic and monsoonal rainfall and are therefore highly seasonal and highly variable, depending on which catchments receive rainfall. Rivers can quickly transform from dry sandy channels with disconnected pools to flooding torrents, or stay dry year after year. As availability of surface water is so variable and evaporation is so high, groundwater is the dominant economic water source for the high water demand in the region. Flood flows are essential for recharging the gravelly alluvial aquifers, which have formed where rivers discharge on coastal plains, and the dolomite aquifer at Millstream.

Surface water is generally fresh, although at this latitude poor reliability of river flow, high evaporation, and turbidity caused by diurnal temperature changes, limit the effectiveness of storing water for direct use. Rivers and associated sites all hold significant heritage values.

The Harding River was dammed in the 1980s to provide public water supply for the West Pilbara Water Supply Scheme. Water from the Harding Dam is used conjunctively with groundwater from the Millstream aquifer.

The shallow Ophthalmia Dam on the Fortescue River at Newman slows surface water enough to recharge groundwater, which is used to provide town water supplies.

Other surface water use is small and opportunistic.

In the Pilbara Region surface water abstraction is managed under the proclaimed Pilbara surface water area, and a licence is required to take surface water.

The approach to allocating and managing the water stored by the Harding Dam, in conjunction with groundwater from the Millstream aquifer, is described in the *Pilbara groundwater allocation plan* (DoW 2013c).

Table 6 Pilbara Region surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year	Further water available ML/year	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
DeGrey	Rivers & tributaries	Not set	–	500–1 000	Not assessed	Initial
Yule	Rivers & tributaries	Not set	–	0–500	Not assessed	Initial
Sherlock	Rivers & tributaries	Not set	–	0–500	Not assessed	Initial
Harding	Harding Reservoir	Not set	–	0–500	Not assessed	Initial
	Other tributaries	Not set	–	0–500	Not assessed	Initial
Karratha Coast	Rivers & tributaries	Not set	–	0–500	Not assessed	Initial
Lower Fortescue	Rivers & tributaries	Not set	–	1 000–3 000	Not assessed	Initial
Robe River	Rivers & tributaries	Not set	–	500–1 000	Not assessed	Initial
Cane River	Rivers & tributaries	Not set	–	500–1 000	Not assessed	Initial
Ashburton River	Rivers & tributaries	Not set	–	1 000–3 000	Not assessed	Initial
Yannarie	Rivers & tributaries	Not set	–	0–500	Not assessed	Initial
Upper Fortescue	Rivers & tributaries	Not set	–	500–1 000	Not assessed	Initial
Sandy Desert Basin	Inland desert	Not set	–	No data	Not assessed	Initial
Totals		**Not set**	**–**			

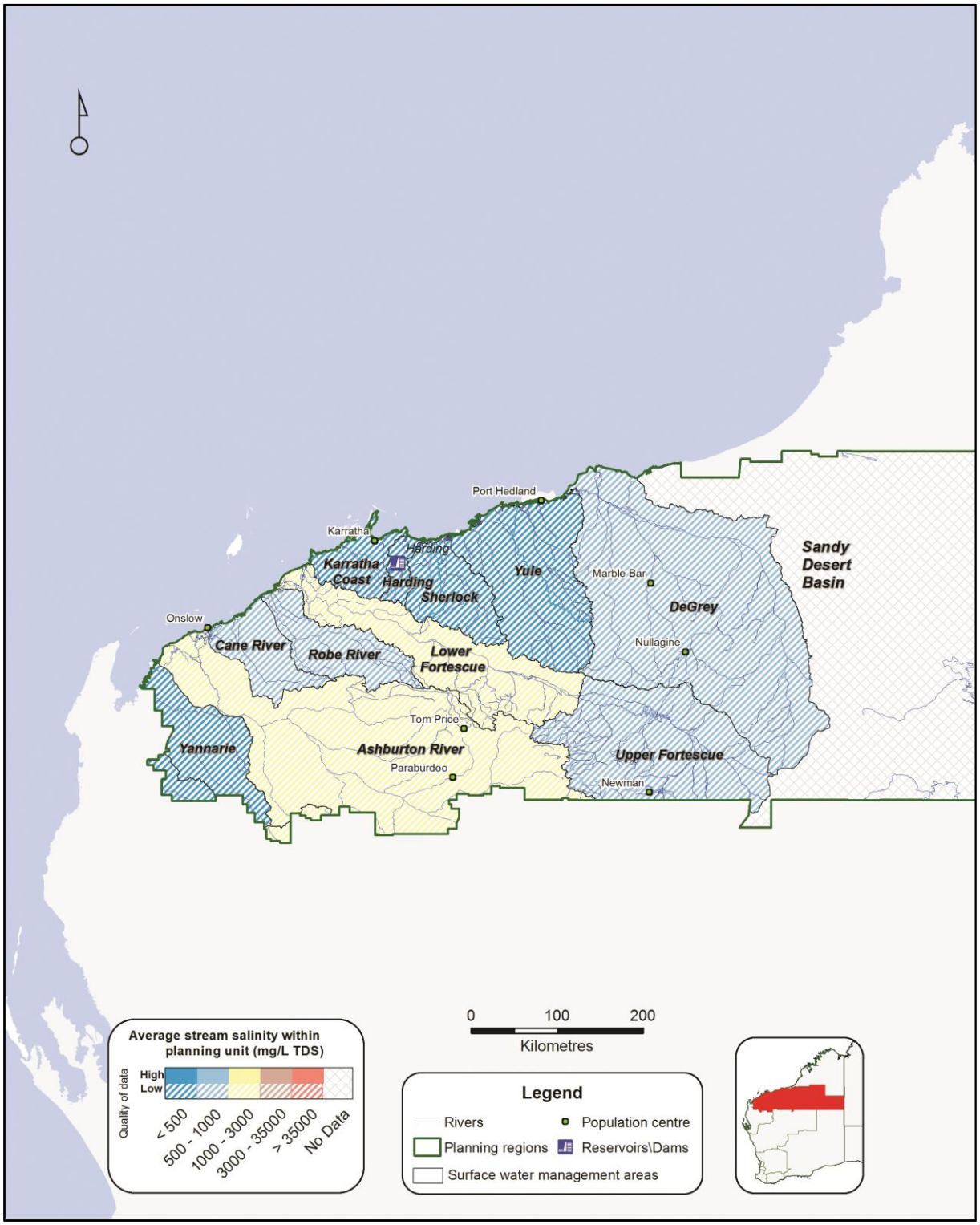

Figure 8 Pilbara Region surface water resources and water quality

Groundwater

Alluvial aquifers which lie underneath the rivers as they near the coast, and the dolomite aquifer at Millstream, are the most important water sources in the Pilbara. Less utilised sedimentary aquifers fringe the region – to the north is the western part of the extensive Canning Basin and to the south-west is the northern tip of the Carnarvon Basin. Water stored in irregular fractures and fissures in the hard rock across most of the region also provides significant groundwater, particularly in the central Pilbara.

The shallow alluvium of the lower De Grey River and lower Yule River is pumped to provide water for the Port Hedland Water Supply Scheme. The shallow alluvium of the lower Cane River provides a small supply for Onslow. The lower Fortescue alluvium is used to supply water for local mining and industrial purposes. The lower Robe has potential to provide a supply, but is remote from demand centres, and the alluvium of the lower Ashburton is slightly brackish and has not yet been developed. The Millstream aquifer is essential for the West Pilbara Water Supply Scheme, and the smaller old alluvial aquifers in the central Pilbara – the Hamersley-Fortescue and Wittenoom – are used for local towns.

Water level trends in alluvial aquifers generally reflect the seasonal cyclonic cycle and can vary significantly both monthly and yearly. Recharge events are hard to predict. In the coastal alluvial aquifers, fresh groundwater is limited to a few kilometres along the river beds and is only replenished by flood flows. Water use in these coastal alluvial aquifers is managed carefully to prevent saltwater moving into the fresh part of the aquifer.

Fractured rock is tapped to provide much of the water abstracted for mining activities and facilities in the inland Pilbara. When mining intersects fractures and fissures, or goes below the watertable, the water that needs to be removed is used locally to maintain groundwater-dependent environments and supplement water supplies. There is often too much water for local needs and surplus water may be relocated and used for other purposes, reinjected to the aquifer or released, depending on local circumstances.

The West Canning Basin will become increasingly important as a water source. It is one of the most viable options for providing future town and industrial water supplies to Port Hedland, and is already used to support mining and for pastoral diversification into irrigated pasture production. Through the Royalties for Regions program the Department of Water is conducting a regional-scale groundwater investigation in the West Canning Basin. This aims to assess how much fresh water could be supplied on a long-term basis to provide public water supplies for Port Hedland. The Water Corporation, with industry partners, is investigating potential future supplies to support industrial growth.

At the regional scale, there is additional groundwater available for general purpose licensing within the allocation limits for the sedimentary basins and river alluvial aquifers (39 000 ML/year). However, groundwater of the appropriate quantity and quality is now in short supply near high demand areas, particularly the regional

centres of Karratha and Port Hedland, with the reliable annual allocation already fully utilised. Additional groundwater is available from inland areas but this is hundreds of kilometres from the demand centres.

Over the past 10 years the Department of Water has invested significantly into improving our understanding of Pilbara groundwater. We now have good information which has been used to assess the yield of critical public water supply aquifers including Millstream, the lower Cane, lower Yule, and lower De Grey, as well as the lower Fortescue and lower Robe.

This work shows that short to medium term demand for the Port Hedland scheme can be met by developing additional groundwater from the Yule and De Grey aquifers.

Groundwater from the Bungaroo Valley in the Hamersley Range is being developed to supplement water supply to the West Pilbara ports. Other valleys to the south of the Hamersley Range may also hold potential groundwater resources.

Additional groundwater is also likely to be available from fractured rock aquifers across the whole region, but the potential yield of these resources is difficult to assess and is managed on a case-by-case basis.

In 2012, the Department of Water estimated that there was approximately 160 000 ML/year of surplus mine dewater across the region (DoW 2013d). At sites where dewatering of mines generates a net water surplus there is scope to consider using dewater to develop short to medium term agricultural initiatives. Groundwater abstraction in the Pilbara Region is managed under the proclaimed Pilbara groundwater area and a licence is required to take groundwater.

The approach to allocating and managing groundwater is described in the *Pilbara groundwater allocation plan* (DoW 2013c).

Table 7 Pilbara Region shallow level groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Pilbara groundwater area							
1	East Pilbara	Canning – Wallal	1 000	955	1 000–3 000	Seasonal	Initial
2	Ashburton	Pilbara – Lower De Grey Alluvial	10 150	0	0–500	Seasonal	Medium
3	Ashburton	Lower Turner Alluvial	420	0	1 000–3 000	Seasonal	Medium
4	Ashburton	Pilbara – Coastal Saline	2 000	0	3 000–35 000	Seasonal	Medium
5	Ashburton	Pilbara – Lower Yule Alluvial	10 560	0	0–500	Seasonal	Medium
6	Ashburton	Lower Fortescue Alluvial	6 600	4 942[2]	0–500	Seasonal	Initial
7	Ashburton	Lower Cane Alluvial	1 000	93	0–500	Seasonal	Medium
8	East Pilbara	Hamersley – Fortescue	1 000	1 000	0–1 000	Seasonal	Initial
9	Ashburton	Hamersley – Fortescue	Not set	–	0–500	Seasonal	Medium
10	Ashburton	Millstream	15 682[3]	0	0–500	Seasonal	High
11	Ashburton	Lower Bungaroo Valley	10 000	0	0–500	Seasonal	Medium
12	East Pilbara	Wittenoom – Wittenoom	50 000	8 323	0–500	Seasonal	Initial
13	Ashburton	Wittenoom – Wittenoom	20 000	18 183	500–1 000	Seasonal	Initial
14	Ashburton	Pilbara – Alluvial	7 000	1 799	No data	Seasonal	Initial
15	Ashburton	Carnarvon – Lower Robe Alluvial	5 090	2 910	500–1 000	Seasonal	Medium
16	Ashburton	Carnarvon – Superficial	2 000	355	No data	Seasonal	Initial
17	Ashburton	Carnarvon – Cape Range Limestone	Not set	–	3 000–35 000	Seasonal	Initial
18	Ashburton	Carnarvon – Birdrong	100	100	No data	Seasonal	Initial
Totals			**142 602**	**38 660**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The staged development in the lower Fortescue is likely to take up the current allocation limit. We will use new information from the development to review the allocation limit.

[3] 15 000 ML/year is the maximum amount provided management conditions are met and the Harding Dam cannot be used. The long-term reliable allocation for the Millstream aquifer as a standalone source is 6 000 ML/yr.

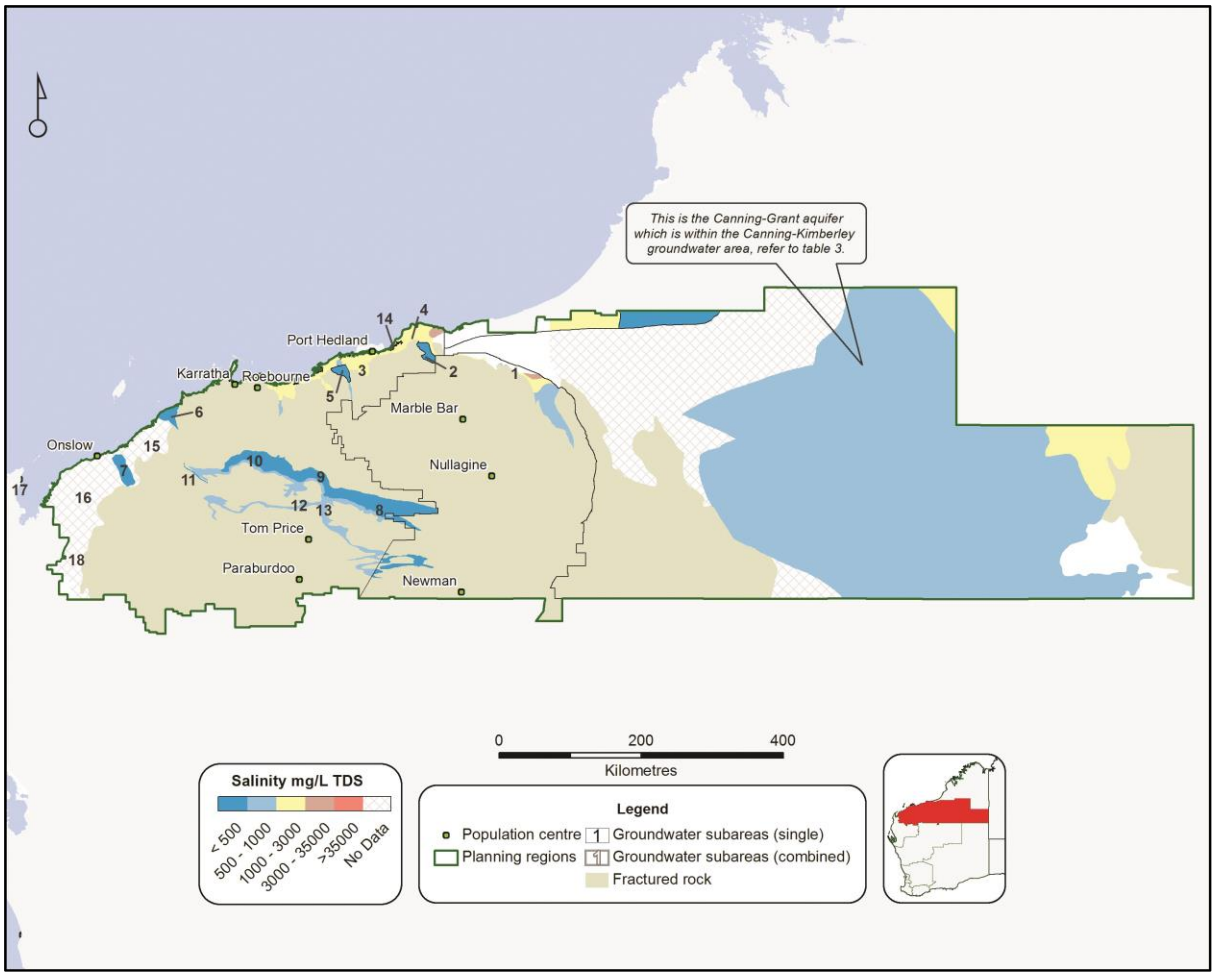

Figure 9 Pilbara Region shallow groundwater resources and water quality

Table 8 Pilbara Region middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Pilbara groundwater area							
1	Ashburton	Canning – Wallal.	Not set	–	0–500	Seasonal	Initial
2	Ashburton	Carnarvon – Birdrong.	300	0	3 000–35 000	Seasonal	Initial
Totals			**300**	**0**			

1 A full stop at the end of the aquifer name identifies that it is a confined resource.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

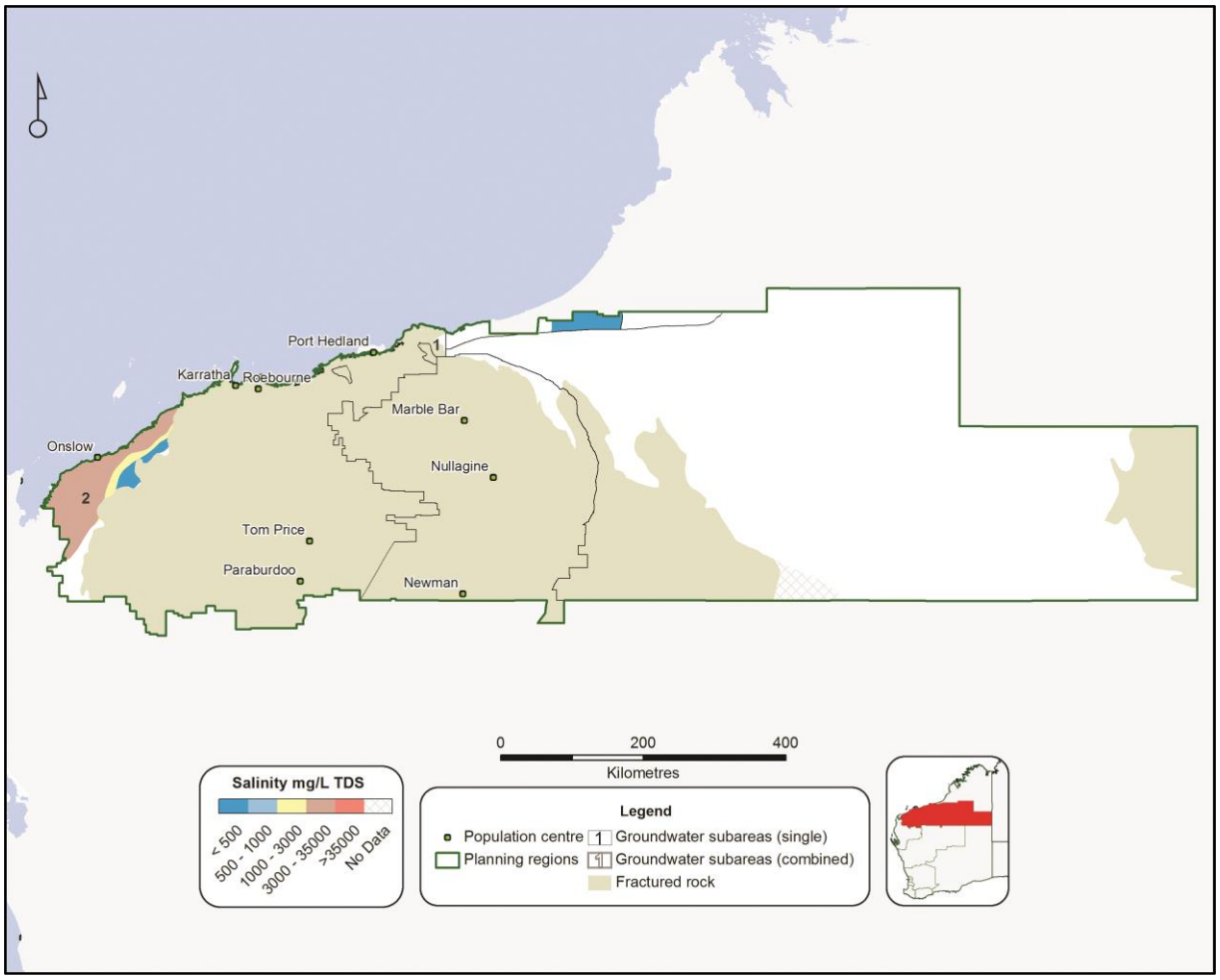

Figure 10 Pilbara Region middle groundwater resources and water quality

4 Gascoyne water resources

Surface water

When the Gascoyne River is in flood, licensees in the Carnarvon Irrigation District can pump surface water directly. Since floods provide an irregular, opportunistic supply, they are much more important for recharging groundwater aquifers, which provide more reliable supplies for irrigated horticulture and the town of Carnarvon.

Fresh surface water is scarce in this semi-arid region. Streamflows are generally a direct response to rainfall and are highly seasonal and variable. Water quality varies – an extensive flood flow across parts of the catchment can mobilise salts and deliver quite saline water to the lower Gascoyne.

Other surface water use across the region is very low, and development of surface water is limited to very small-scale and opportunistic access.

The Carnarvon Irrigation District is proclaimed under the *Rights in Water and Irrigation Act 1914* for licensing.

Table 9 Gascoyne Region surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year	Further water available ML/year	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
North West Cape	Rivers & tributaries	Not set	–	0–500	Not assessed	Initial
McLeod	Rivers & tributaries	Not set	–	0–1000	Not assessed	Initial
Gascoyne River & tributaries	Rivers & tributaries	Not set	–	1 000–3 000	Not assessed	High
Carnarvon	Rivers & tributaries	Not set	–	0–500	Not assessed	High
Wooramel River	Rivers & tributaries	Not set	–	0–500	Not assessed	Initial
Totals		**Not set**	**–**			

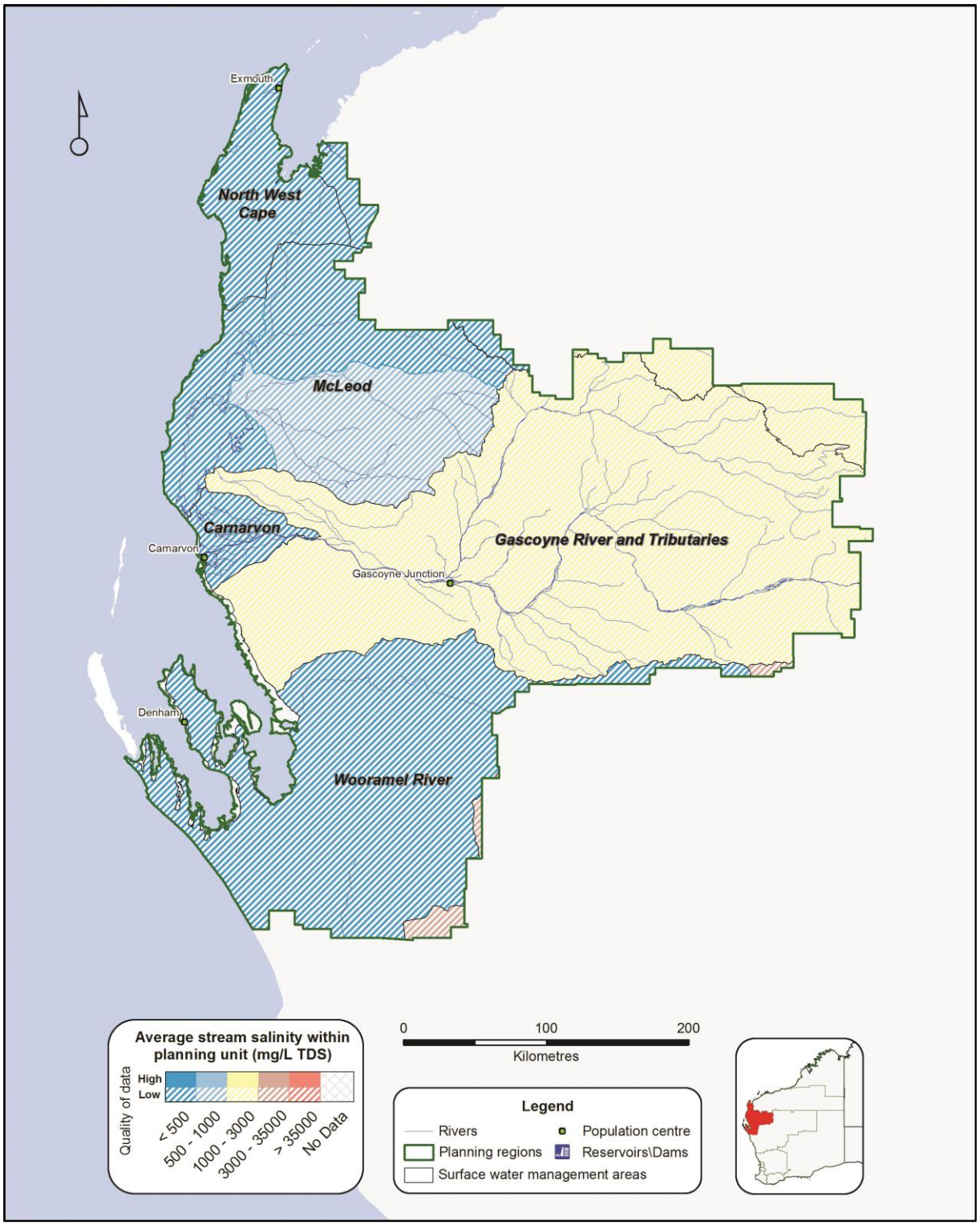

Figure 11 Gascoyne Region surface water resources and water quality

Groundwater

The Gascoyne Region contains the complex and multi-layered sedimentary aquifers of the Carnarvon Basin, the alluvial aquifers along the Gascoyne River and some fractured rock resources in the east of the region.

Fresh groundwater is limited across the region. The most significant groundwater resources are located within the sand deposits in the channel and banks of the Gascoyne River, the Lower Gascoyne alluvial aquifer, and the artesian Carnarvon–Birdrong aquifer.

The Lower Gascoyne alluvial aquifer supports the valuable horticultural industry of the Carnarvon Irrigation District. The volume of fresh groundwater that can be pumped is constrained by the intrusion of saline water, so managing the rate and the distribution of pumping is essential to maintaining the quality of the resource. The Department of Water is adjusting the total volume of water entitlements so that it matches a reliable annual allocation of fresh groundwater.

The Carnarvon–Birdrong aquifer is brackish to saline and has historically been developed for pastoral use. The aquifer is up to 1500 m deep in parts, with water temperatures reaching up to 80°C.

Sedimentary aquifers along the Exmouth peninsula are used to provide public water supply. The volume of fresh water that can be abstracted is managed carefully to limit the risk of saline intrusion of sea water and saline up-coning of the saltier aquifers beneath.

Across the region there is more than 60 000 ML/year of water available for general purpose licensing from the sedimentary aquifers. As the water is generally brackish to saline, it is not suitable for all types of use. 1800 ML/year of fresh groundwater from subarea B-L of the Lower Gascoyne alluvial aquifer is reserved for future public water supply for the town of Carnarvon, and there is currently more than 3000 ML/year of fresh water available for future horticulture development. Water from fractured rock aquifers is used for stock and domestic purposes where it is accessible and of suitable quality.

We have detailed information on the alluvial aquifers of the lower Gascoyne, and management is supported by up-to-date monitoring and modelling. Across the rest of the region, where groundwater use is much less intense, information is more limited and management is site specific. In the Carnarvon–Birdrong aquifer the objective is to maintain pressure heads sufficiently to allow pastoral users to operate efficient distribution systems.

Groundwater abstraction in the Gascoyne Region is managed under the proclaimed Gascoyne groundwater area. The following documents describe how water is allocated and managed in the area:

- *Lower Gascoyne water allocation plan* (DoW 2011c)
- *Carnarvon Artesian Basin water management plan* (DoW 2007a)
- *Groundwater allocation plan: Exmouth groundwater subarea* (WRC 1999).

Table 10 Gascoyne Region shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend[2]	Level of technical information
Gascoyne groundwater area[3]							
1	Exmouth North	Carnarvon – Cape Range Limestone	200	0	1 000–3 000	Seasonal	High
2	Exmouth Town	Carnarvon – Cape Range Limestone	300	36	1 000–3 000	Seasonal	High
3	Exmouth Central	Carnarvon – Cape Range Limestone	1 000	134	1 000–3 000	Seasonal	High
4	Exmouth West	Carnarvon – Cape Range Limestone	50	31	1 000–3 000	Seasonal	High
5	Exmouth South	Carnarvon – Cape Range Limestone	4 700	4 478	1 000–3 000	Seasonal	High
6	Zuytdorp/Ningaloo	Carnarvon – Sedimentary	5 000	5 000	3 000–35 000	Seasonal	Initial
		Carnarvon – Alluvium	12 200	12 200	3 000–35 000	Stable	Initial
		Carnarvon – Superficial	5 000	4 292	3 000–35 000	Stable	Initial
7	Talisker/Mia Mia	Carnarvon – Alluvium	5 000	5 000	No data	No data	Initial
		Carnarvon – Surficial	5 000	4 899	3 000–35 000	Stable	Initial
		Carnarvon – Sedimentary	10 000	9 937	3 000–35 000	Seasonal	Initial
8	Area B-L	Lower Gascoyne Alluvial	15 500	5 100	500–1 000	Seasonal	High
9	Area A	Lower Gascoyne Alluvial	6 100	0	500–1 000	Seasonal	High
10	Yandoo	Carnarvon – Surficial	100	100	1 000–3 000	Seasonal	Initial
		Lower Gascoyne Alluvial	Not set	Not set	1 000–3 000	Seasonal	Initial
Totals			**70 150**	**51 207**			

1 Water available for general purpose licensing from the general allocation limit component as of June 2012.

2 Water levels of the shallow groundwater resources respond to recharge events on a seasonal and episodic basis, such as after cyclonic events.

3 The Gascoyne groundwater area extends south and into the Mid West Region. Refer to the Mid West Region for the remaining shallow groundwater resources of the Gascoyne groundwater area.

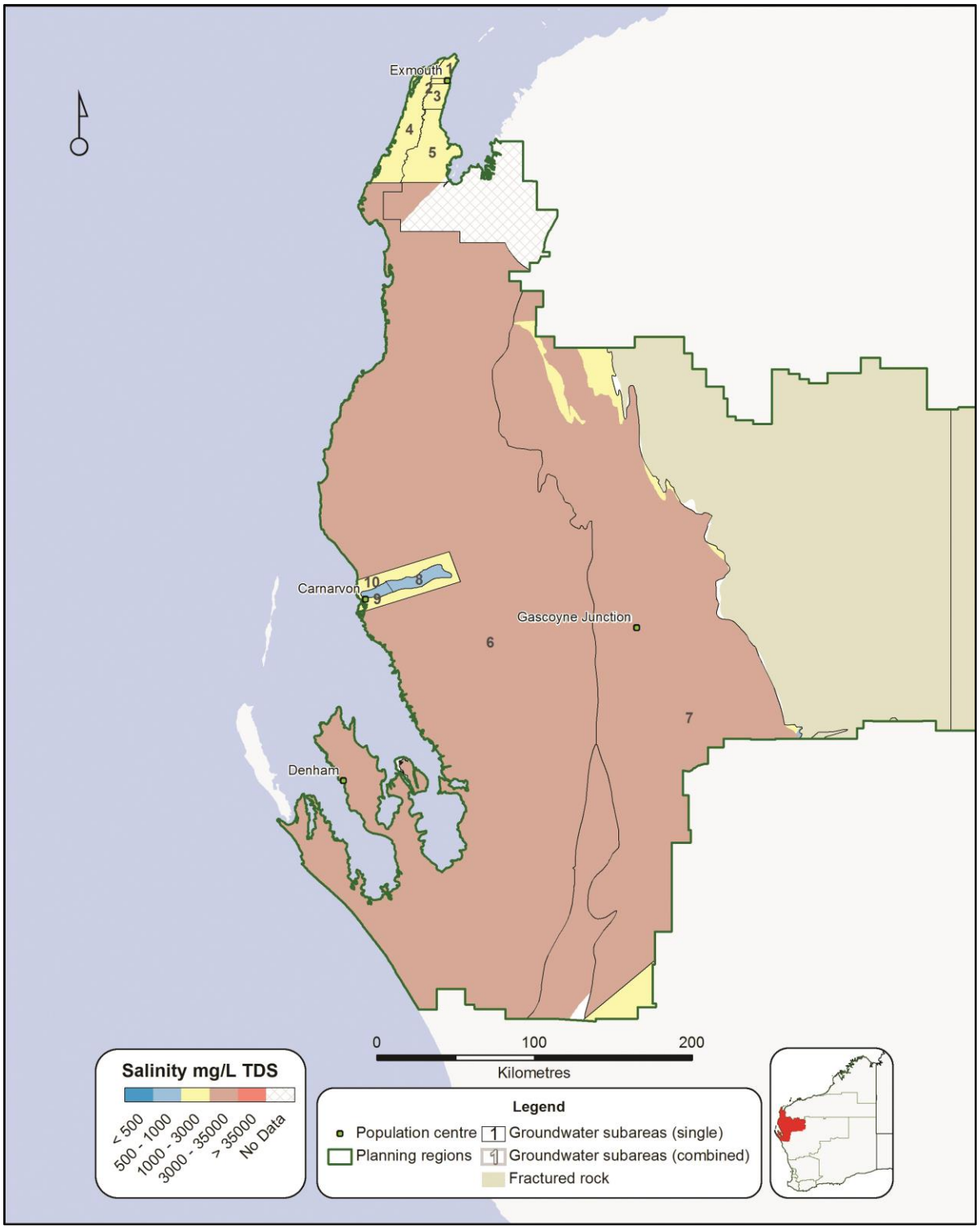

Figure 12 Gascoyne Region shallow groundwater resources and water quality

Table 11 Gascoyne Region middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Gascoyne groundwater area[3]							
1	Exmouth North	Saline resource	500	468	3 000–35 000	Stable	Initial
2	Exmouth Town	Saline resource	50	50	3 000–35 000	Stable	Initial
3	Exmouth Central	Saline resource	4 000	3 250	3 000–35 000	Stable	Initial
4	Exmouth West	Saline resource	1 000	1 000	3 000–35 000	Stable	Initial
5	Exmouth South	Saline resource	500	470	3 000–35 000	Stable	Initial
6	Zuytdorp/Ningaloo	Carnarvon – Birdrong.	30 000	2 746	3 000–35 000	Stable	Initial–medium
		Carnarvon – Windalia	Not set	-	3 000–35 000	Stable	Initial
7	Talisker/Mia Mia	Keogh-Ballythanna	37 120	0	No data	No data	Initial
Totals			**73 170**	**7 984**			

1 A full stop at the end of the aquifer name identifies that it is a confined resource.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

3 The Gascoyne groundwater area extends south and into the Mid West Region. Refer to the Mid West Region for the remaining middle level groundwater resources of the Gascoyne groundwater area.

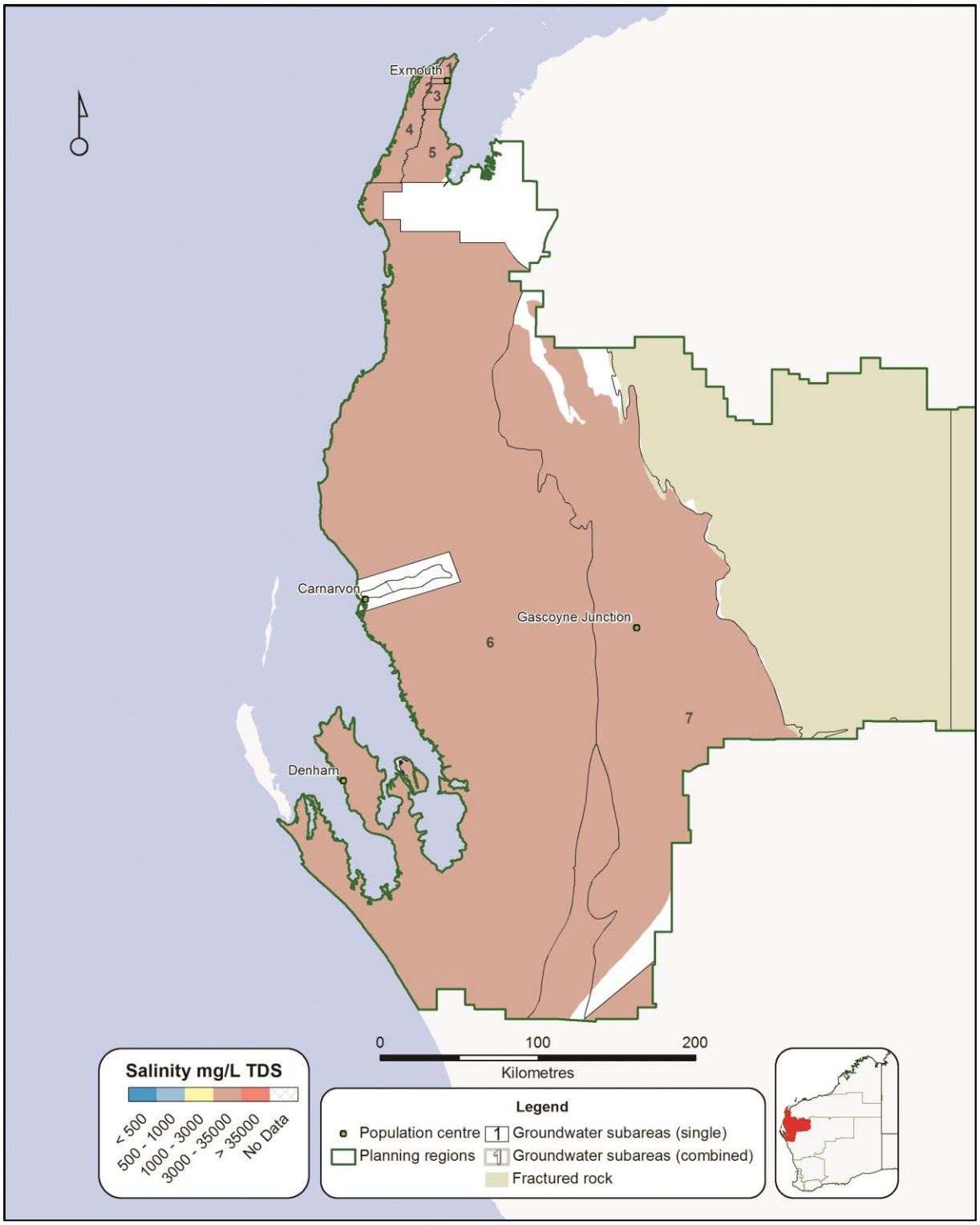

Figure 13 Gascoyne Region middle groundwater resources and water quality

Table 12 Gascoyne Region deep groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Gascoyne groundwater area[2]							
1	Zuytdorp/Ningaloo	Carnarvon – Tumblagooda	Not set	–	1 000–3 000	Stable	Initial
2	Talisker/Mia Mia	Carnarvon – Tumblagooda	1 000	1 000	3 000–35 000	Stable	Initial
Totals			**1 000**	**1 000**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The Gascoyne groundwater area extends south and into the Mid West Region. Refer to the Mid West Region for the remaining deep groundwater resources of the Gascoyne groundwater area.

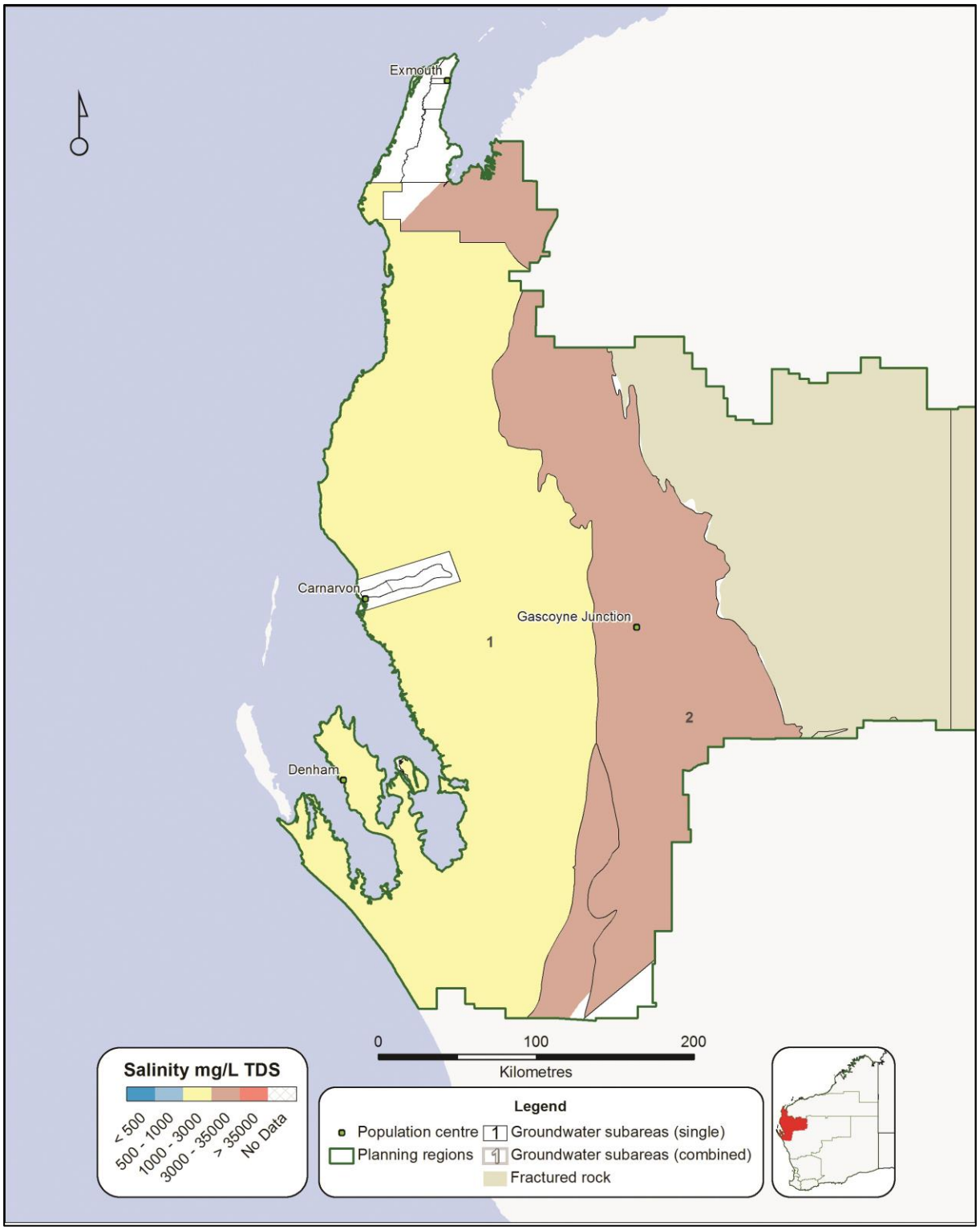

Figure 14 Gascoyne Region deep groundwater resources and water quality

5 Mid West water resources

Surface water

The Murchison River is the largest surface water system in the Mid West Region, and flows through the impressive gorges of the Kalbarri National Park as it nears the coast. The west-flowing Greenough, Irwin and Arrowsmith rivers are significant landscape features.

Rivers in the Mid West Region flow only intermittently, so fresh surface water for reliable use is limited. Water users rely on groundwater for a regular supply.

The Hill, Greenough and Eneabba surface water areas are the main areas proclaimed for water licensing, and water is used mostly for stock. A small volume of surface water is licensed for road construction and dust suppression.

Table 13 Mid West Region surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year	Further water available ML/year	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
Murchison River	Rivers & tributaries	Not set	–	3 000–35 000	Not assessed	Initial
Northampton Coast	Rivers & tributaries	Not set		1 000–35 000	Not assessed	Initial
Greenough River & tributaries	Rivers & tributaries	Not set	–	3 000–35 000	Not assessed	Initial
Yarra Yarra	Rivers & tributaries	Not set	–	>35 000	Not assessed	Initial
Irwin River	Rivers & tributaries	Not set	–	3 000–35 000	Not assessed	Initial
Arrowsmith River	Rivers & tributaries	Not set	–	3 000–35 000	Not assessed	Initial
Eneabba Coastal tributaries	Rivers & tributaries	Not set	–	1 000–3 000	Not assessed	Initial
Hill River & tributaries	Rivers & tributaries	Not set	–	1 000–3 000	Not assessed	Initial
Coonderoo/Marchagee	Rivers & tributaries	Not set	–	3 000–35 000	Not assessed	Initial
Ninghan	Rivers & tributaries	Not set	–	>35 000	Not assessed	Initial
Totals		**–**	**–**			

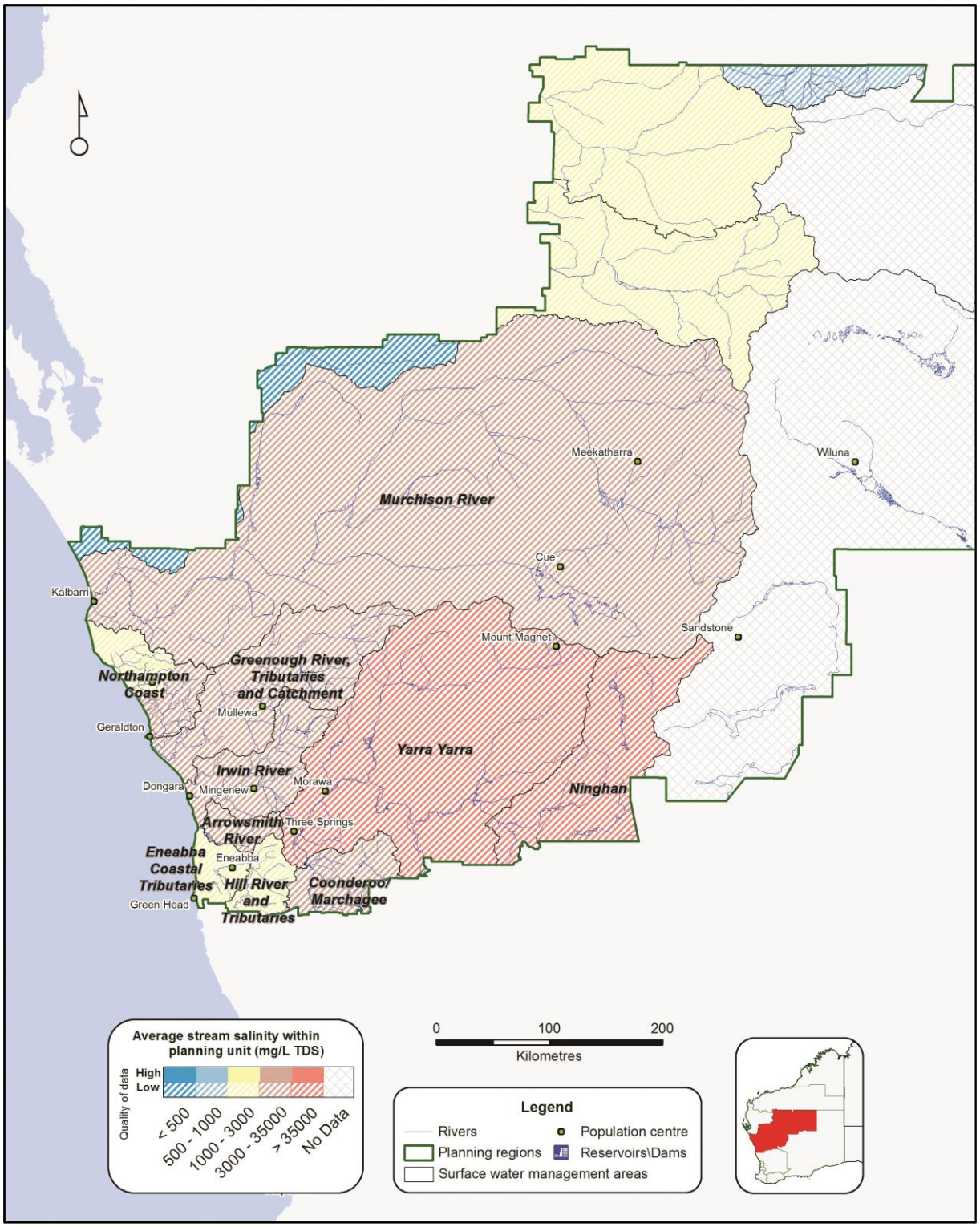

Figure 15 Mid West Region surface water resources and water quality

Groundwater

The Mid West Region contains the complex and multi-layered sedimentary aquifers of the Carnarvon and Northern Perth basins. It also contains large areas of fractured rock aquifers.

The most significant sedimentary aquifers are the Superficial, Parmelia, Yarragadee and Lesueur Sandstone aquifers within the Northern Perth basin. Groundwater is mainly used for mining, agriculture and public water supply.

Large volumes of groundwater are available for further licensing throughout the region (141 000 ML/year), but useful volumes at a local scale will vary depending on the naturally variable water quality and the aquifer distribution and complexity. Additional water could also be available from fractured rock aquifers.

Water level trends across the region are highly variable due to the spatial variation in climate and land use changes. Some groundwater levels are increasing, possibly as a response to catchment clearing. Most groundwater levels are declining, particularly towards the south-west of the region. In the north of the region many resources are stable, or respond with seasonal variations during cyclonic recharge events. Monitoring data across the region is patchy, reflecting the relatively low levels of use.

In general, we have basic level information on the groundwater resources in the north of the region where water use is relatively low. We have more detailed information on the groundwater resources in the Arrowsmith groundwater area. This comes from departmental investigations supplemented by information such as hydrogeological reports, monitoring information and bore log details, provided by licensed water users. Over the last three years the department's investigations into groundwater-dependent ecosystems in the Mid West is adding to the information available for licence assessments.

With investment from the Department of Regional Development and Lands under the Royalties for Regions project, the Department of Water is conducting a groundwater investigation in the East Murchison River catchment. The project aims to locate ancient aquifers that may have formed in ancient river channels (palaeochannels). Fresh water identified by this and subsequent investigations may support future magnetite mining in inland areas distant from the coastal sedimentary aquifers. The department is developing a Mid West water supply strategy, which will identify medium- to long-term water demand projections and likely water supply options.

Groundwater abstraction in the Mid West Region is managed under the proclaimed Gascoyne, East Murchison and Arrowsmith groundwater areas. The *Arrowsmith groundwater allocation plan* (DoW 2010a) describes how water is allocated and managed.

Table 14 Mid West Region shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Gascoyne groundwater area[2]							
1	Kalbarri/Eurardy	Carnarvon – Surficial	100	16	3 000–35 000	Stable	Initial
2	Yuna/Eradu	Perth – Surficial (North)	500	411	1 000–3 000	Seasonal	Initial
		Perth – Permian Sandstone	5 000	4 910	1 000–3 000	Seasonal	Initial
3	Northampton/Gelena	Northampton – Sedimentary	2 000	1 342	1 000–3 000	Seasonal	Initial
		Northampton – Surficial	5 000	4 494	1 000–3 000	Declining	Initial
		Perth – Superficial Swan	200	200	3 000–35 000	Stable	Initial
4	Casuarinas	Perth – Surficial (North)	100	100	1 000–3 000	Increasing	Initial
		Perth – Superficial Swan	100	64	1 000–3 000	Stable	Medium
		Perth – Permian Sandstone	500	290	1 000–3 000	Seasonal	Initial
East Murchison groundwater area[3]							
5	Officer	Officer – Surficial	10 000	10 000	500–35 000	No data	Initial
		Canning – Grant	10 000	10 000	1 000–3 000	No data	Initial
Arrowsmith groundwater area							
6	Dongara	Perth – Superficial Swan	8 000	3 198	500–35 000	No data	Medium
7	Eneabba Plains	Perth – Superficial Swan	14 600	14 136	500–35 000	Declining	Medium
8	Twin Hills	Perth – Surficial	600	489	500–1 000	No data	Initial
9	Darling	Perth – Surficial	2 500	2 150	3 000–35 000	No data	Initial
Totals			**59 200**	**51 800**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The Gascoyne groundwater area extends north into the Gascoyne Region. Refer to the Gascoyne Region for the remaining shallow groundwater resources of the Gascoyne groundwater area.

[3] The East Murchison groundwater area is located along the eastern border of the Mid West Region. It has not been displayed in the accompanying map due to the large spatial coverage of the area. The East Murchison groundwater area is partly displayed in the adjoining Goldfields-Esperance Region.

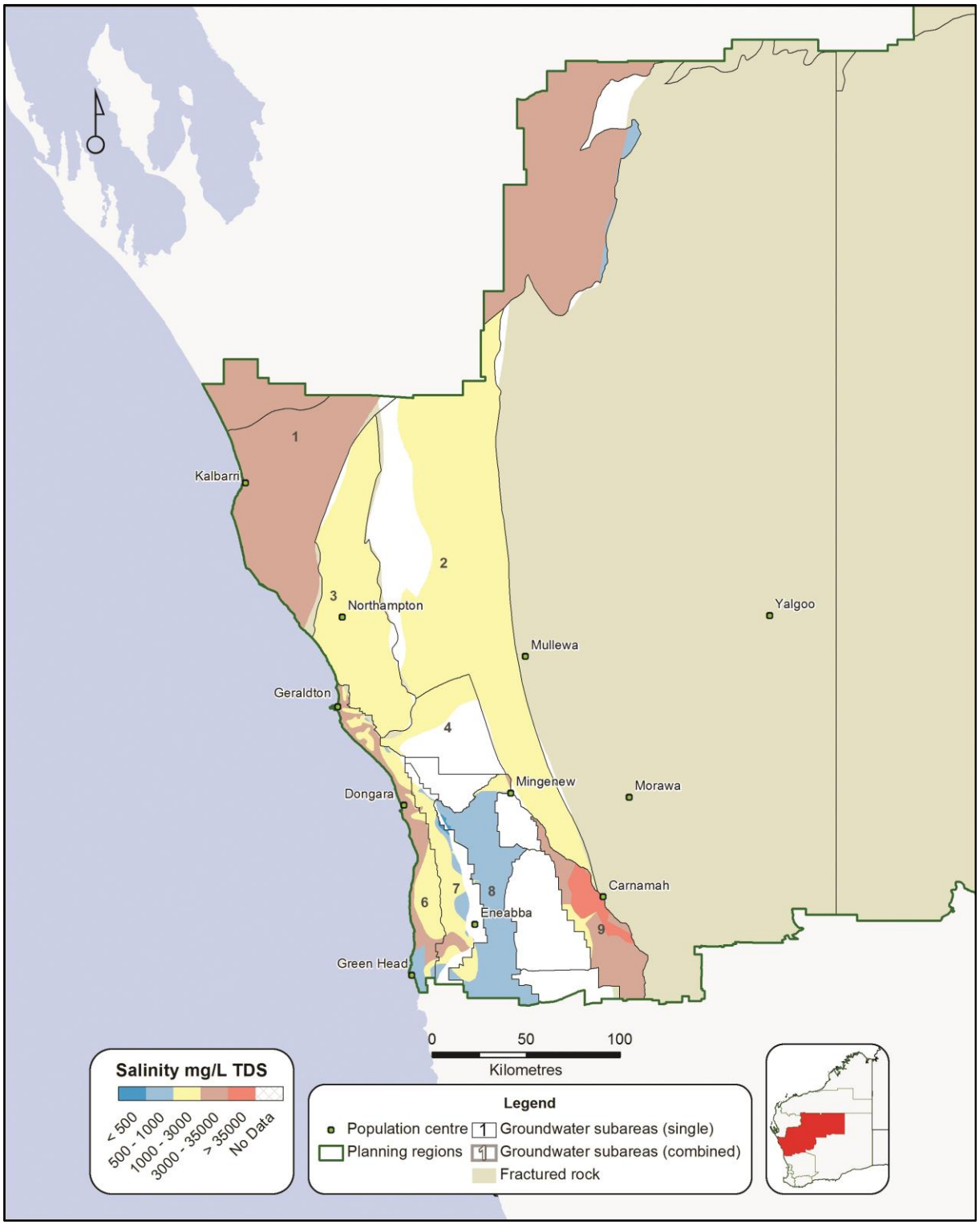

Figure 16 Mid West Region shallow groundwater resources and water quality

Table 15 Mid West Region middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Gascoyne groundwater area[3]							
1	Mullewa/Byro	Keogh-Ballythanna	Not set	–	No data	No data	Initial
2	Kalbarri/Eurardy	Carnarvon – Sandstone	1 000	939	1 000–35 000	Stable	Initial
3	Yuna/Eradu	Perth – Parmelia	200	200	500–1 000	Seasonal	Initial
		Perth – Sedimentary	1 000	965	3 000–35 000	Seasonal	Initial
East Murchison groundwater area[4]							
4	Officer	Officer – Sedimentary	10 000	10 000	No data	No data	Initial
Arrowsmith groundwater area							
5	Twin Hills	Perth – Parmelia	3 400	3 354	500–1 000	No data	Initial
6	Mingenew	Perth – Parmelia	8 200	440	1 000–3 000	Increasing	Medium
7	Darling	Perth – Parmelia	100	100	No data	No data	Initial
8	Tathra	Perth – Parmelia	33 400	11 370	500–3 000	No data	Initial
9	Morrison	Perth – Parmelia	4 000	3 440	1 000–3 000	No data	Initial
Totals			**61 300**	**30 808**			

1 A full stop at the end of the aquifer name identifies that it is a confined resource.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

3 The Gascoyne groundwater area extends north into the Gascoyne Region. Refer to the Gascoyne Region for the remaining middle groundwater resources of the Gascoyne groundwater area.

4 The East Murchison groundwater area is located along the eastern border of the Mid West Region. It has not been displayed due to spatial coverage of the accompanying map. The East Murchison groundwater area is partly displayed in the adjoining Goldfields-Esperance Region.

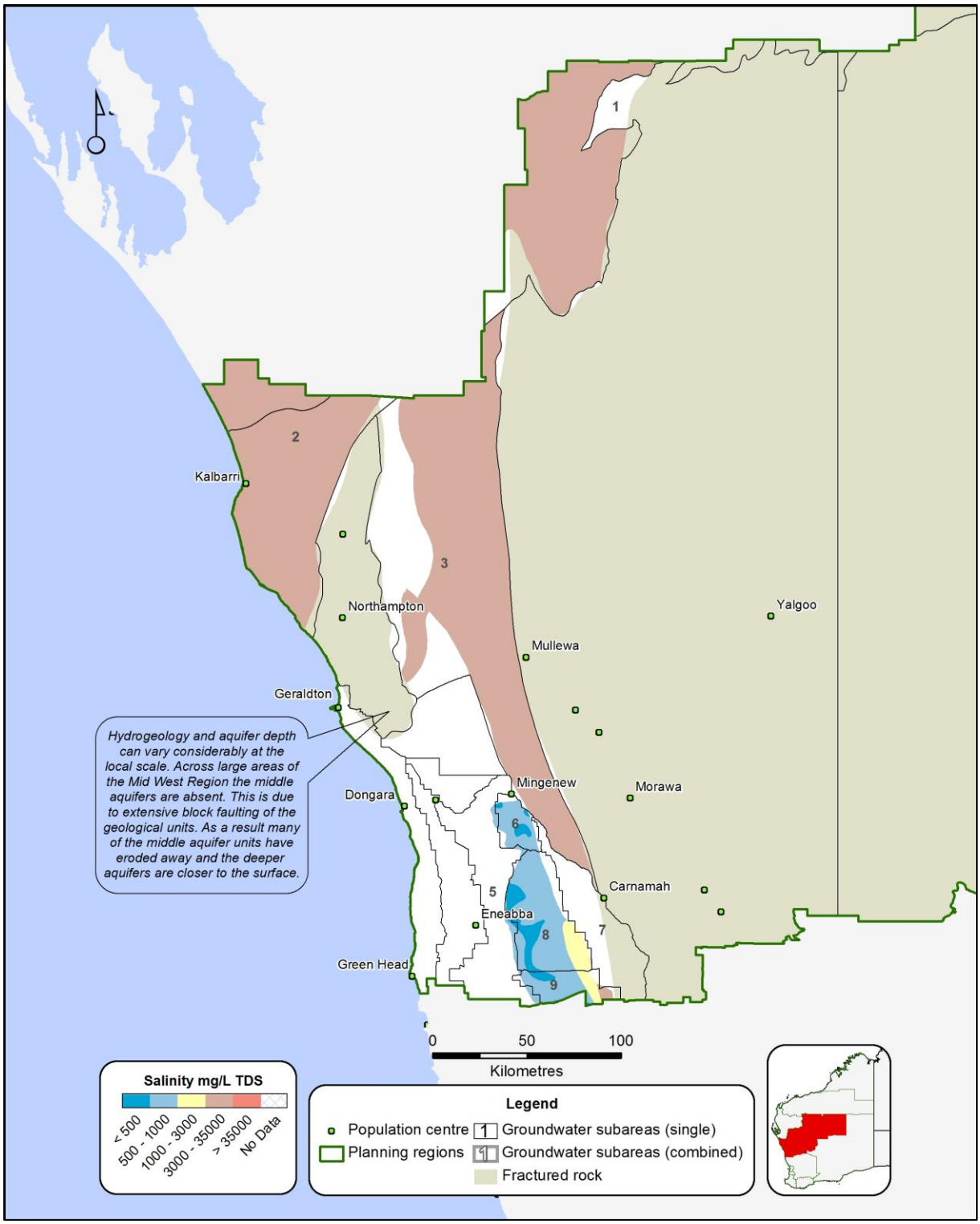

Figure 17 Mid West Region middle groundwater resources and water quality

Table 16 Mid West Region deep groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Gascoyne groundwater area[3]							
1	Kalbarri/ Eurardy	Carnarvon – Tumblagooda	5 000	2 026	3 000–35 000	Stable	Initial
2	Yuna/ Eradu	Perth – Tumblagooda	Not set	0	1 000–3 000	Stable	Initial
3	Northampton/ Gelena	Carnarvon – Tumblagooda	100	100	3 000–35 000	Stable	Initial
4	Casuarinas	Perth – Yarragadee North.	10 000	4 332	500–1 000	Increasing	Medium
		Perth – Cockleshell Gully	5 000	3 973	3 000–35 000	Stable	Initial
Arrowsmith groundwater area							
5	Dongara	Perth – Cattamarra Coal Measures North.	200	195	3 000–35 000	No data	Initial
		Perth – Yarragadee North.	4 500	3 253	3 000–35 000	No data	Initial
6	Allanooka	Perth – Yarragadee North.	28 800	8 434	0–1000	Increasing	Medium
7	Twin Hills	Perth – Eneabba.	400	400	3 000–35 000	No data	Initial
		Perth – Yarragadee North.	48 800	24 579	0–1000	No data	Initial
		Perth – Cattamarra Coal Measures North.	500	500	3 000–35 000	Increasing	Initial
		Perth – Lesueur Sandstone North.	200	200	3 000–35 000	No data	Initial
8	Eneabba Plains	Perth – Eneabba.	2 000	600	500–3 000	Declining	Medium
		Perth – Yarragadee North.	22 500	5 007	500–3 000	Declining	Medium
		Perth – Cattamarra Coal Measures.	100	100	500–3 000	Stable	Medium
		Perth – Lesueur Sandstone North.	1 800	1 330	500–3 000	No data	Initial
9	Tathra	Perth – Eneabba.	100	100	1 000–3 000	No data	Initial
		Perth – Lesueur Sandstone North.	100	100	1 000–3 000	No data	Initial
		Perth – Yarragadee North.	700	700	500–3 000	No data	Initial
		Perth – Cattamarra Coal Measures.	50	50	1 000–3 000	No data	Initial
10	Darling	Perth – Cattamarra Coal Measures.	400	400	1 000–3 000	No data	Initial
		Perth – Lesueur Sandstone North.	1 400	1 400	1 000–35 000	No data	Initial
		Perth – Yarragadee North.	200	200	500–3 000	No data	Initial
		Perth – Eneabba.	400	400	1 000–35 000	No data	Initial
11	Morrison	Perth – Yarragadee North.	1 000	1 000	1 000–3 000	No data	Initial
Totals			**134 250**	**59 379**			

1 A full stop at the end of the aquifer name identifies that it is a confined resource.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

3 The Gascoyne groundwater area extends north into the Gascoyne Region. Refer to the Gascoyne Region for the remaining deep groundwater resources on the Gascoyne groundwater area

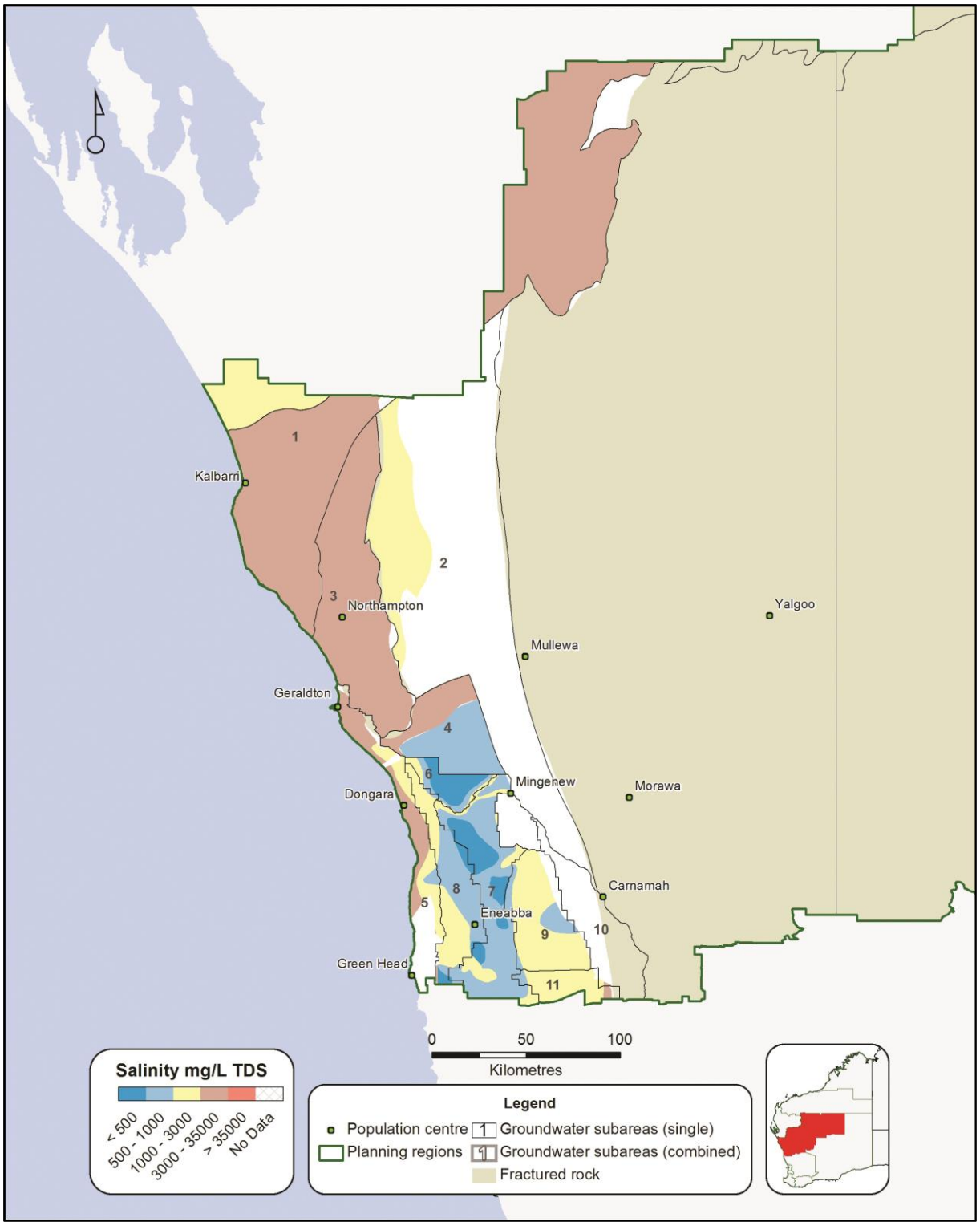

Figure 18 Mid West Region deep groundwater resources and water quality

6 Wheatbelt water resources

Surface water

The Avon River and the upper parts of the Blackwood River are the largest surface water systems in the Wheatbelt Region. Both systems are seasonal, depending on winter rains for significant flow. They recede to pools in summer.

The Avon River gains the most flow once it reaches the higher rainfall areas near the Darling Scarp, only occasionally receiving inflow from its outer catchments. The Blackwood River gains the most flow once it leaves the Wheatbelt and enters the higher rainfall, forested areas of the South West. In summer it relies on groundwater discharge from the Yarragadee aquifer near Nannup. Both systems are saline in the Wheatbelt. The smaller Gingin Brook and Moore River that arise closer to the coast are also dependent on groundwater discharge in summer.

Surface water use in the Wheatbelt Region is very low. Most rivers are saline and all are seasonal. Some surface water is pumped from streams in the Gingin Brook catchment at the western edge of the region, where the water is generally fresh. Water users pump small volumes directly from streams during the summer months, for irrigated agriculture and horticulture.

Where water is fresh, streamflows are less reliable than when irrigation began some decades ago. Flows in the Gingin Brook and other small coastal rivers have declined over the last 30 years due to a drying climate, and are now less viable as water sources for irrigation. Many water users are more frequently experiencing years where there is insufficient water for them to take their full licensed entitlement during the irrigation period.

Additional surface water might possibly be harvested from high flows in wetter years, if it could be stored for use over the irrigation period. However, traditional dams are less suitable on the coastal plain so this may not be an option.

Surface water abstraction in the Wheatbelt Region is licensed in the Gingin Brook and tributaries, Moore River and certain tributaries, and Avon river system surface water areas, which are proclaimed under the *Rights in Water and Irrigation Act 1914*. The *Gingin surface water allocation plan* (DoW 2011a) describes how water is allocated and managed.

Table 17 Wheatbelt Region surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
Avon River Catchment	River & tributaries	Not set	–	3 000–35 000	Not assessed	Medium
Avon River System	Rivers & tributaries	Not set	–	3 000–35 000	Not assessed	Medium
Gingin Brook & tributaries	Gingin, Lennard, Moondah, Mungala, Quin & Wallering brooks	3 572	0	0–3000	Declining	Medium
Lower Moore	River & tributaries	Not set	–	3 000–35 000	Not assessed	Medium
Middle Moore	River & tributaries	Not set	–	3 000–35 000	Not assessed	Medium
Nambung/Cataby Coastal tributaries	River & tributaries	Not set	–	1 000–3 000	Not assessed	Initial
Outer Avon Management Area	Rivers & tributaries	Not set	–	3 000–35 000	Not assessed	Initial
Upper Blackwood	Rivers & tributaries	Not set	–	3 000–35 000	Not assessed	Medium
Totals		**3 572**	**0**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

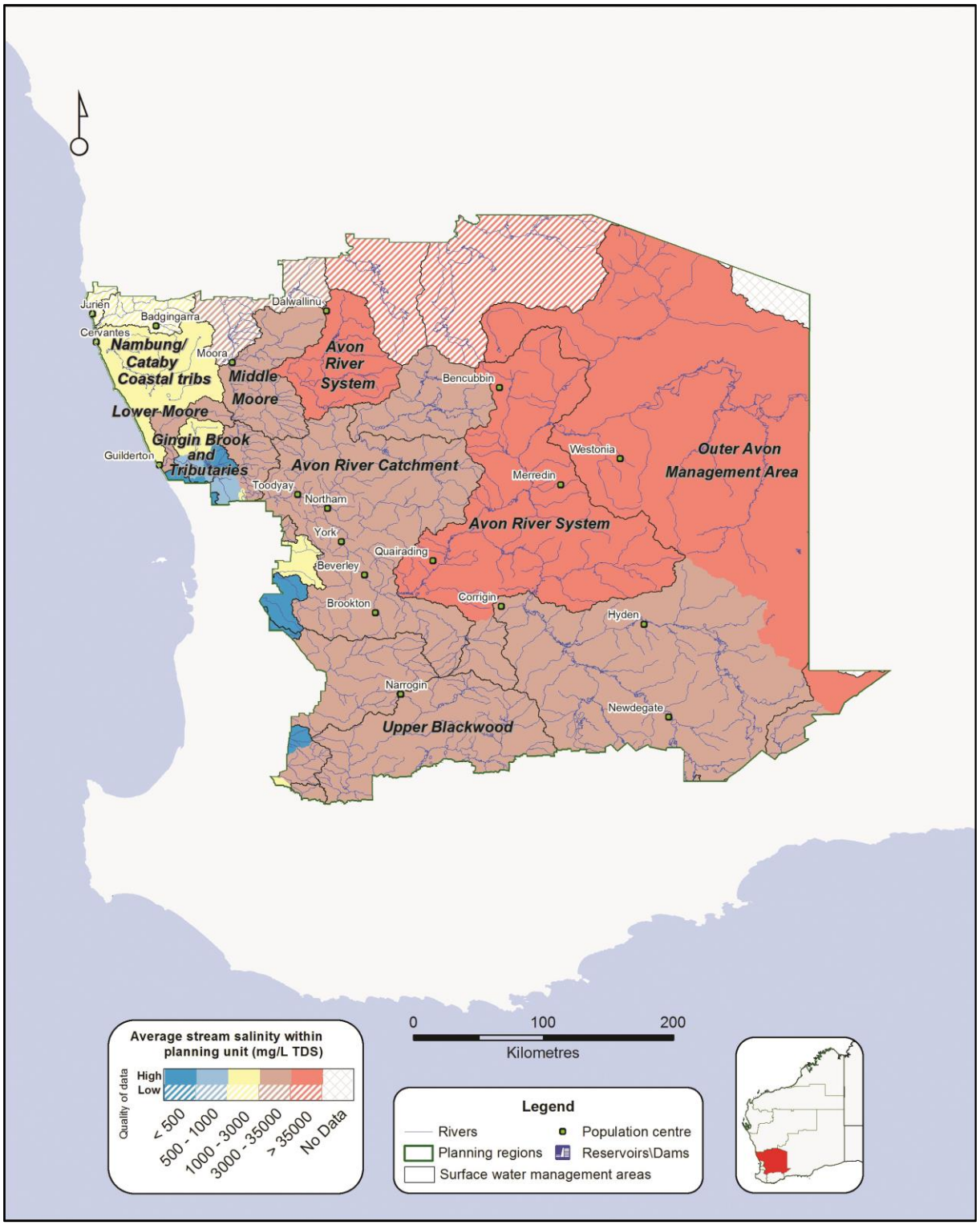

Figure 19 Wheatbelt Region surface water resources and water quality

Groundwater

Significant groundwater only occurs in the coastal areas of the Wheatbelt Region, stored in a thick succession of sedimentary aquifers of the Northern Perth Basin. The central and eastern part of the region is made up of much older hard rock containing variably distributed fractured rock aquifers and palaeochannels. Seasonal water is stored in weathered soil profiles where vegetation has been cleared.

The largest fresh groundwater resources of the Northern Perth Basin are contained within the Superficial, Leederville, Leederville–Parmelia and Yarragadee aquifers. The Yarragadee aquifer is the largest regional aquifer containing low salinity groundwater, with depths in excess of 1200 m in parts. Other fresh groundwater resources are contained in the Mirrabooka, Cattamarra, Leederville–Parmelia, Eneabba and Lesueur aquifers.

Brackish to saline groundwater is contained within portions of all of the aquifers, particularly the Superficial aquifer north of Green Head, the Yarragadee aquifer at depth and the Cattamarra aquifer.

The majority of groundwater in the Northern Perth Basin is abstracted for agriculture, public water supply and mining. In the central, eastern and southern parts of the Wheatbelt region, small volumes of groundwater are important for watering stock.

Across the region there are large volumes of groundwater available for further general purpose licensing (more than 130 000 ML/year), mostly from the Jurien groundwater area. The water resources across the Gingin groundwater area are largely allocated.

Actual volumes available for site-specific abstraction from the Northern Perth Basin depend on localised hydrogeology and water quality. Additional water could also be available from fractured rock aquifers subject to site-specific assessment.

Water level trends across the region are highly variable in response to seasonal climate variation, land use change and localised hydrogeology and topography. In some areas, including the north-eastern parts of the Jurien and Gingin groundwater areas, soil water levels are rising where land has been cleared. In the southern part of the Gingin groundwater area groundwater levels have fallen by 1 to 2 m on average since 2002. This is partly due to higher levels of abstraction and decreased average rainfall since the 1980s.

There is significant information available on the groundwater resources in the Gingin groundwater area, largely from the department's groundwater investigations and from hydrogeological reports, monitoring information and bore log details provided by licensed water users.

Through the Department of Water's State Groundwater Investigation Program, a groundwater investigation of north Gingin will improve monitoring bore coverage and our understanding of the Leederville and Yarragadee aquifers between Gingin and Moora on the Swan Coastal Plain. Exploratory drilling and construction of monitoring bores is nearing completion. The Mirrabooka aquifer to the north of Gingin has also been noted as an investigation prospect.

Groundwater abstraction from the sedimentary aquifers of the Northern Perth Basin is managed under the proclaimed Gingin and Jurien groundwater areas. The *Gingin groundwater allocation plan: plan for public comment* (DoW 2013a) and the *Jurien groundwater allocation plan* (DoW 2010b) describe how water is allocated and managed.

The Wheatbelt water quality maps (figures 20–22) cover the coastal area where these sedimentary aquifers occur.

Table 18 Wheatbelt Region shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Jurien groundwater area							
1	Cervantes	Perth – Superficial Swan	30 000	23 399	500–3 000	Stable	Initial
2	Nambung	Perth – Superficial Swan	4 000	930	500–35 000	Stable	Initial
3	Badgingarra	Perth – Surficial	Not set	-	500–1 000	No data	Initial
4	Dinner Hill	Perth – Surficial	1 000	394	500–35 000	No data	Initial
5	Watheroo	Perth – Surficial	300	210	3 000–35 000	No data	Initial
Gingin groundwater area							
6	Moora	Perth – Surficial	800	640	3 000–35 000	No data	Initial
7	Wedge Island	Perth – Superficial Swan	58 500	27 215	0–3 000	Stable	High
		Perth – Surficial	3 000	2 719	0–3 000	No data	Initial
8	Victoria Plains	Perth – Surficial	4 400	3 526	1 000–35 000	No data	Initial
9	Lancelin	Perth – Superficial Swan	21 000	0	0–1 000	Stable	Medium
10	Namming Lake	Perth – Superficial Swan	10 500	8 910	0–3 000	Declining	Medium
		Perth – Surficial	300	300	0–3 000	No data	Initial
11	Karakin Lakes	Perth – Superficial Swan	17 000	5 263	500–3 000	Declining	High
12	North Moore River Park	Perth – Superficial Swan	12 900	3 578	0–1 000	Stable	Medium
13	Red Gully	Perth – Surficial	5 600	4 560	1 000–35 000	No data	Initial
		Perth – Superficial Swan	750	0	1 000–35 000	No data	Initial
14	Seabird	Perth – Superficial Swan	17 000	0	500–1 000	Stable	High
15	South Moore River Park	Perth – Superficial Swan	7 500	1 857	0–1 000	Stable	Initial
16	Guilderton North	Perth – Superficial Swan	6 500	0	0–1 000	Declining	Medium
17	Beermullah Plain North	Perth – Superficial Swan	6 500	603	0–3 000	Declining	Medium
18	Guilderton South	Perth – Superficial Swan	9 924	0	0–1 000	Declining	Medium
19	Beermullah Plain South	Perth – Superficial Swan	2 700	0	0–1 000	Declining	Medium
21	Gingin Townsite	Perth – Surficial	5 000	2 406	1 000–35 000	No data	Initial
		Perth – Superficial Swan	920	384	1 000–35 000	No data	Initial
22	Deepwater Lagoon South	Perth – Superficial Swan	3 500	27	0–1 000	Declining	Medium
23	Bindoon	Perth – Surficial	2 400	282	3 000–35 000	No data	Initial
24	Eclipse Hill	Perth – Superficial Swan	1 050	0	1 000–3 000	Declining	Medium
		Perth – Surficial	3 000	1 744	1 000–3 000	No data	Initial
25	Lake Mungala	Perth – Superficial Swan	3 164	0	0—1 000	Declining	Initial
Totals			**239 208**	**88 947**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

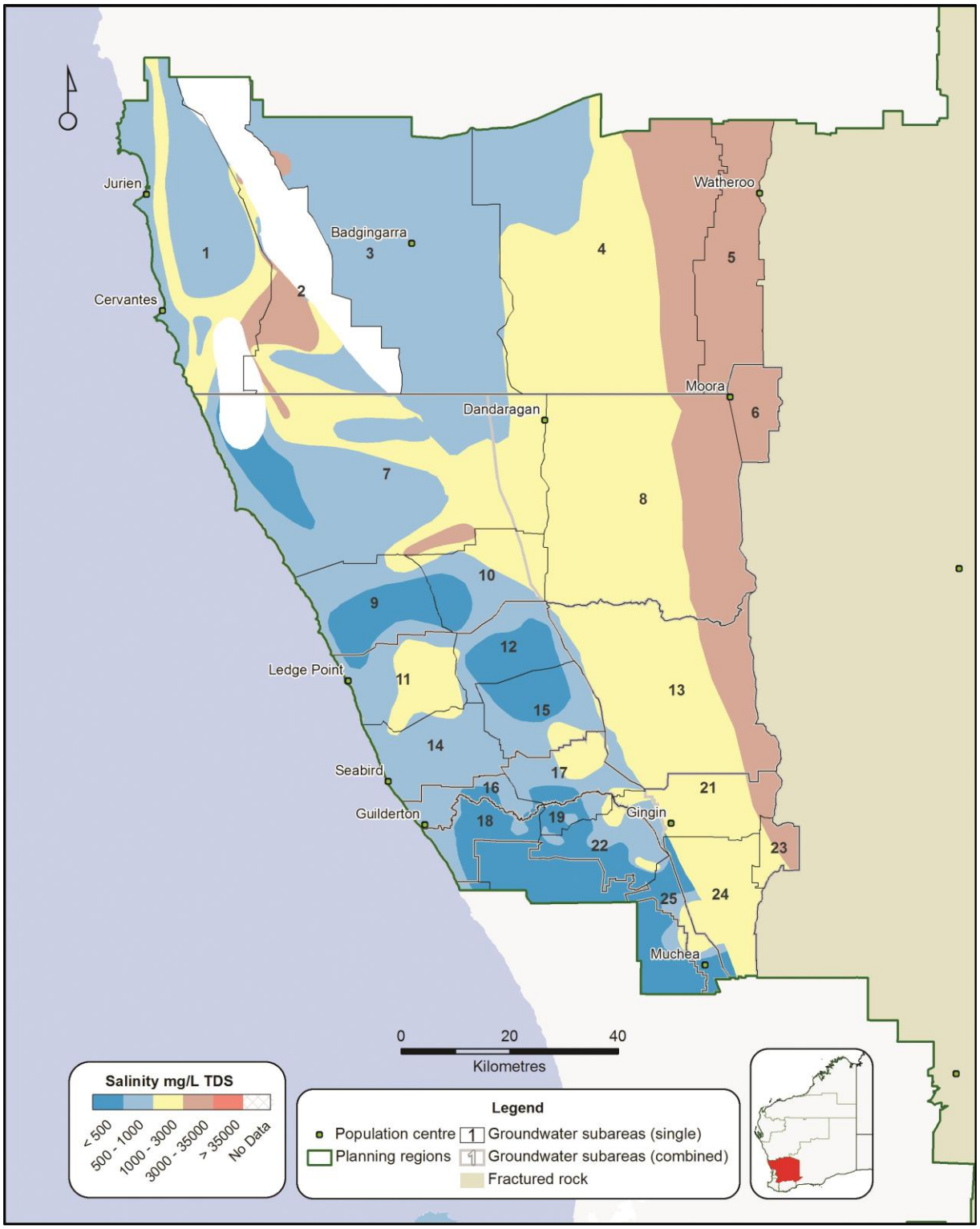

Figure 20 Wheatbelt Region shallow groundwater resources and water quality

Table 19 Wheatbelt Region middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Jurien groundwater area							
1	Badgingarra	Perth – Leederville – Parmelia.	300	300	500–1 000	No data	Initial
2	Dinner Hill	Perth – Mirrabooka	500	500	0–35 000	No data	Initial
2	Dinner Hill	Perth – Leederville – Parmelia.	12 600	1 162	0–35 000	Increasing	Medium
3	Watheroo	Perth – Leederville – Parmelia.	100	10	3 000–35 000	No data	Initial
Gingin groundwater area							
4	Cowalla Confined	Perth – Leederville – Parmelia.	19 000	0	0–35 000	No data	Initial
5	Northern Coastal Semi-confined	Perth – Leederville.	4 100	432	500–1 000	Declining	Initial
6	Central Coastal Semi-confined	Perth – Leederville.	2 800	0	500–1 000	Declining	Initial
7	Southern Coastal Semi-confined	Perth – Leederville.	1 000	286	0–1 000	No data	Initial
8	Northern Scarp Semi-confined	Perth – Mirrabooka	3 700	3 070	0–35 000	No data	Initial
9	Central Scarp Semi-confined	Perth – Mirrabooka	1 500	601	0–3 000	No data	Initial
10	Southern Scarp Semi-confined	Perth – Mirrabooka	800	0	0–3 000	Declining	Initial
11	Lake Mungala	Perth – Mirrabooka	100	100	3 000–35 000	No data	Initial
12	SA 3 South	Perth – Leederville.	2 600	0	1 000—3 000	Declining	High
Totals			**49 100**	**6 461**			

[1] A full stop at the end of the aquifer name identifies that it is a confined resource.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

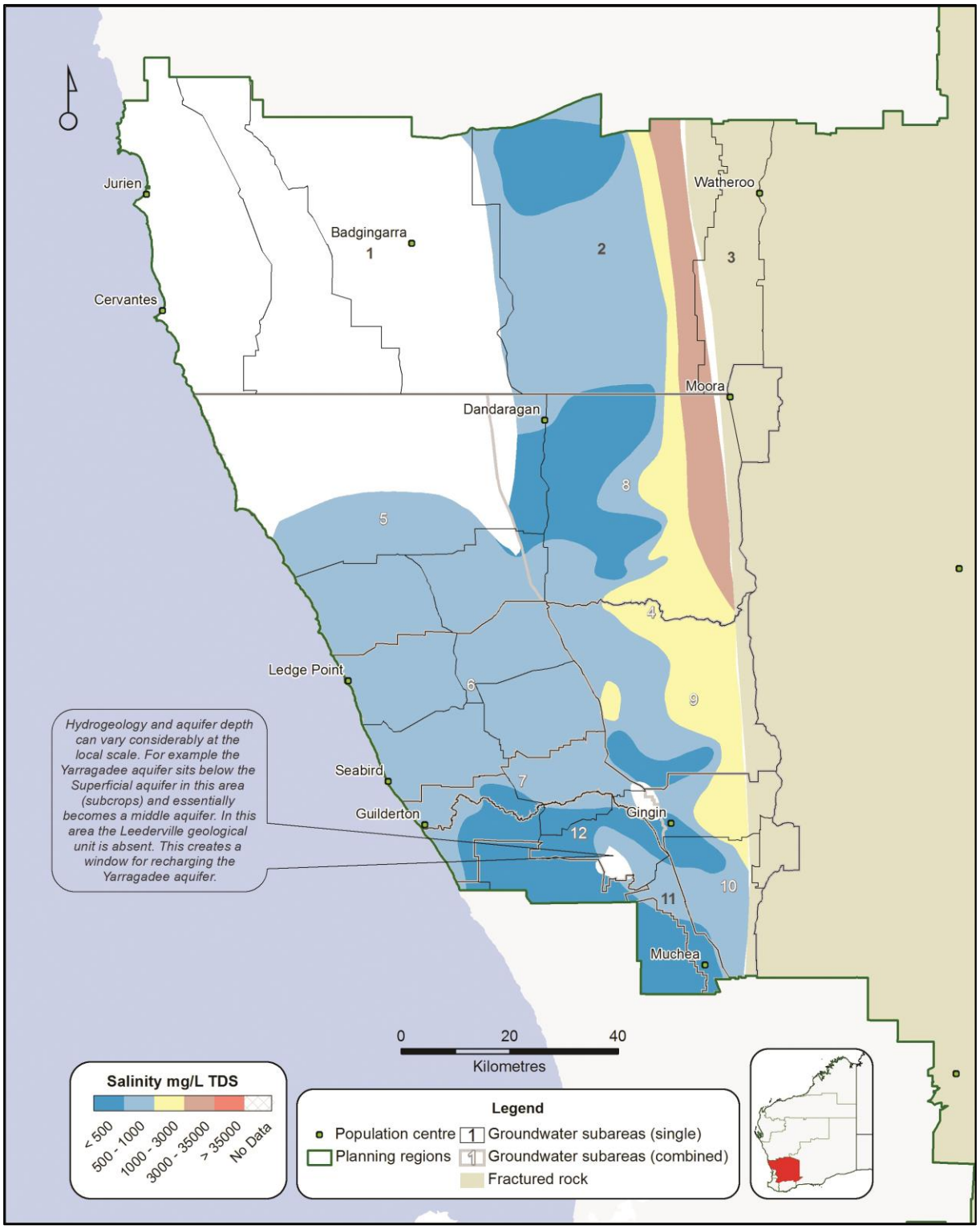

Figure 21 Wheatbelt Region middle groundwater resources and water quality

Table 20 Wheatbelt Region deep groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Jurien groundwater area							
1	Cervantes	Perth – Eneabba.	600	600	0–35 000	Declining	Initial
		Perth – Lesueur Sandstone North.	3 000	0	0–35 000	Declining	Initial
		Perth – Cattamarra Coal Measures North.	100	100	0–35 000	No data	Initial
2	Nambung	Perth – Cattamarra Coal Measures North.	1 600	1 600	0–3 000	No data	Initial
		Perth – Lesueur Sandstone North.	2 700	2 700	0–3 000	No data	Initial
		Perth – Eneabba.	300	300	0–3 000	No data	Initial
		Perth – Yarragadee North.	8 800	6 300	0–3 000	Increasing	Initial
3	Badgingarra	Perth – Cattamarra Coal Measures North.	400	245	0–3 000	No data	Initial
		Perth – Yarragadee North.	27 500	25 176	0–3 000	No data	Initial
Gingin groundwater area							
4	Cataby Confined	Perth – Yarragadee North.	13 000	23	0–3 000	Declining	Initial
5	Northern Coastal Semi-confined	Perth – Cattamarra Coal Measures North.	250	250	0–1 000	No data	Initial
		Perth – Lesueur Sandstone North.	1 700	0	0–1 000	No data	Initial
6	Wannamal Confined	Perth – Yarragadee North.	1 300	0	500–1 000	Declining	Initial
7	Chandala Confined	Perth – Yarragadee North.	850	200	3 000–35 000	Declining	Initial
8	SA 3 South	Perth – Yarragadee North.	0	0	0–1 000	Declining	Medium
Totals			**62 100**	**37 494**			

[1] A full stop at the end of the aquifer name identifies that it is a confined resource.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

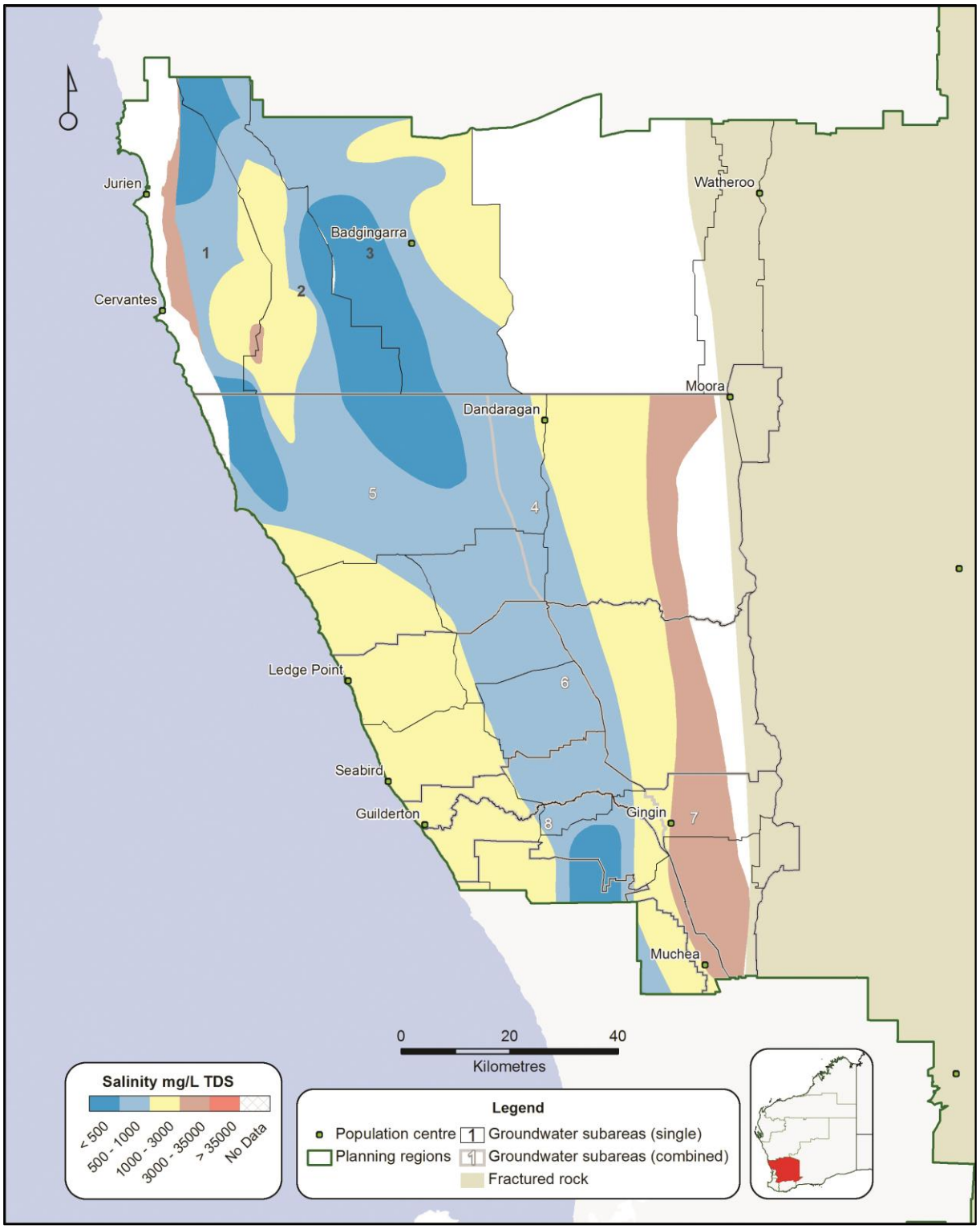

Figure 22 Wheatbelt Region deep groundwater resources and water quality

7 Perth water resources

The Perth Region is described as two subregions – Perth North (north of the Swan River) and Perth South (south of the Swan River) to provide a more detailed view.

7.1 Perth North subregion water resources

Surface water

Surface water within the Perth North subregion comprises tributaries of the Swan River. The most significant fresh surface water resources are the Mundaring Reservoir and the Lower Helena pumpback.

The reservoir and pumpback supply some of the water for Perth's integrated water supply scheme as well as the Goldfields and northern Wheatbelt schemes. Inflows have diminished as rainfall has declined over the last forty years, and groundwater and desalinated water now provide most of the water for these schemes.

Despite the drying climate, the storages continue to be important. Rainfall is variable from year to year, and by contributing more surface water in wetter years, the storages provide opportunities to reduce groundwater pumping and enable some recovery of groundwater levels.

Small volumes of surface water are also abstracted along the tributaries of the Helena and Swan rivers for private, self-supply for irrigation and domestic gardens. Water is either pumped directly from the tributaries or from small on-stream dams.

The Helena and Swan rivers are proclaimed under the *Rights in Water and Irrigation Act 1914*.

Table 21 Perth North subregion surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year[1]	Further water available ML/year[2]	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
Swan Coastal	Minor tributaries	Not set	–	0–500	Not assessed	Medium
Swan River & tributaries	Rivers & tributaries	Not set	–	500–35 000	Declining	High
	Brockman River	482	0	3 000–35 000	Declining	High
	Marbling Brook	72	0	1 000–3 000	Declining	High
Helena River	Mundaring Reservoir	(8 180)	0	0–500	Declining	High
	Lower Helena pumpback	(4 838)	0	0–500	Declining	High
	Rivers & tributaries	Not set		0–3 000	Declining	High
Totals		**(13 572)**	**0**			

1 Allocation limits shown in brackets have not been formally set but are an indication of the total volume of water available. These volumes are based on the average inflows to the reservoirs from 2006 to 2011.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

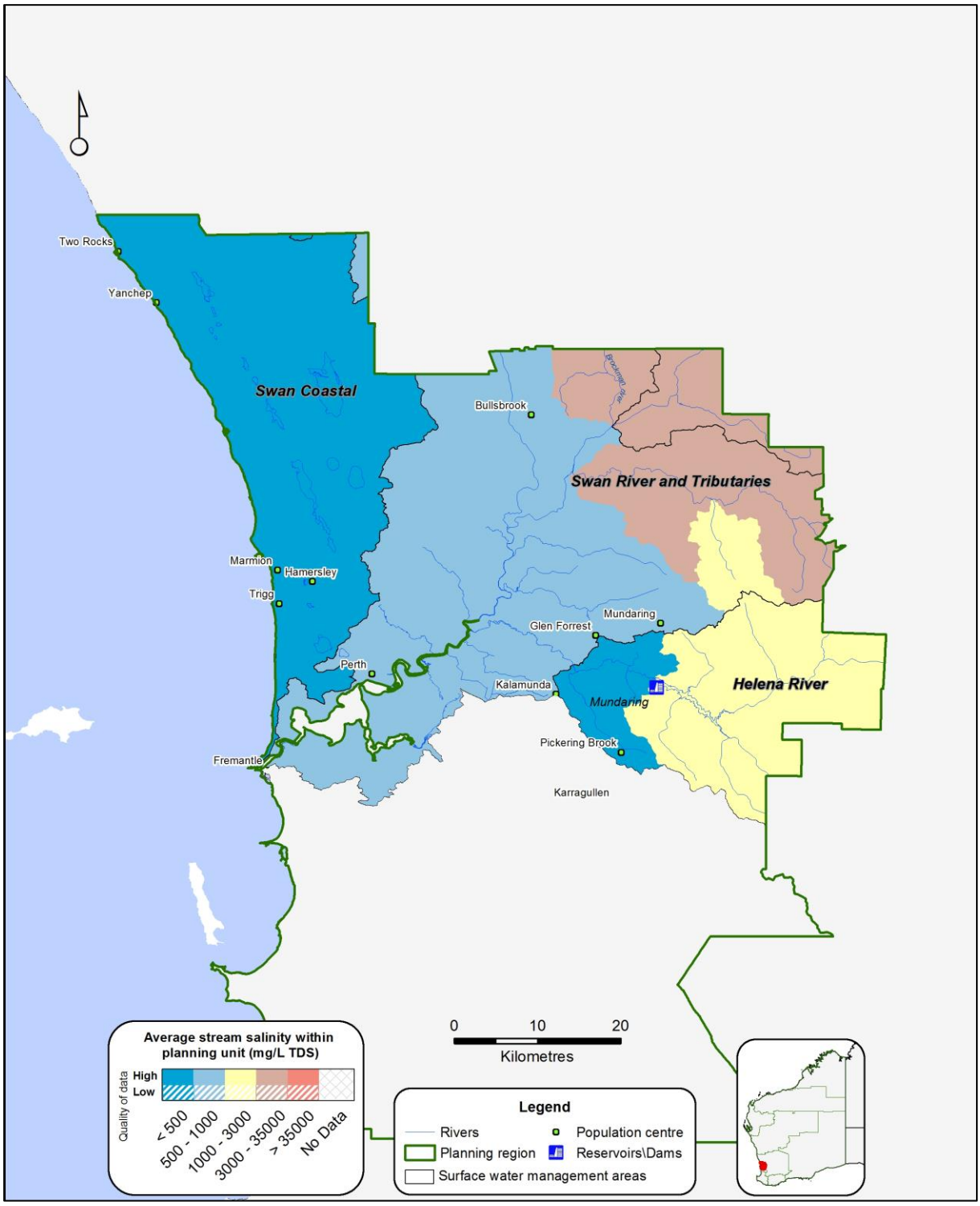

Figure 23 Perth North subregion surface water resources and water quality

Groundwater

One of the most strategically important fresh groundwater resources in the state – the Gnangara groundwater system – is in the Perth North subregion. The Gnangara system is the major source of Perth's public water supply and supports an extensive horticultural industry, urban parks, recreational areas and grounds, some industry and thousands of garden bores.

The Gnangara groundwater system comprises multiple sedimentary aquifers – the shallow Superficial aquifer; the deeper, partly confined Leederville aquifer; and the deep, mostly confined Yarragadee aquifer. Other aquifers, including the Mirrabooka and minor fractured rock aquifers, also occur in the region but are less significant.

Generally, groundwater from the Superficial aquifer is fully allocated. In most areas, water use is now being reduced to rebalance abstraction with changing rainfall. In a few lower lying locations, there is limited groundwater available for further general purpose licensing. Water from the deeper Leederville and Yarragadee aquifers is largely used for public water supply and pumping is limited in locations where these aquifers are highly connected with the Superficial aquifer.

In the sedimentary aquifer resources, groundwater levels have declined significantly over the past 30 years. This is a result of a combination of factors including increased water abstraction from all aquifers, changes in land use and declining rainfall.

This subregion (and across the Perth–Peel regions) is experiencing increased urban growth. As climate-dependent water resources are in short supply, urban development processes are considering the limitations on water resources and planning accordingly.

While future groundwater availability across the region is generally limited, managed aquifer recharge with treated wastewater will be increasingly used to offset additional take for public water supply. Urban design that maximises water conservation and efficiency is now essential. Depending on location, increased recharge to groundwater from urbanisation may offset efficient, small-scale garden bore use.

The Department of Water has extensive information on the Gnangara groundwater system, resulting from decades of groundwater monitoring, investigations, assessments and modelling. Because of the demand pressure on the resource, management focuses on:

- assessing how pumping affects the seawater interface
- assessing how pumping affects the movement between aquifer systems
- the capacity of wetlands to adapt to a drier climate.

The department is currently further investigating the capacity of the Leederville and Yarragadee aquifers to support future aquifer recharge, and for additional groundwater abstraction.

Groundwater abstraction in the Perth North subregion is managed under the proclaimed Gnangara, Gwelup, Mirrabooka, Perth, Swan, Wanneroo and Yanchep groundwater areas. These areas are collectively referred to as the Gnangara

groundwater system. Groundwater is allocated in accordance with the *Gnangara groundwater areas groundwater allocation plan* (DoW 2009a).

Table 22 Perth North subregion shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Gnangara groundwater area							
1	Reserve	Perth – Superficial Swan	8 830	310	0–500	Declining	High
2	Wanneroo Wellfield	Perth – Superficial Swan	11 850	0	0–500	Declining	High
Yanchep groundwater area							
3	Yanchep	Perth – Superficial Swan	[2]12 000	2 000	0–1 000	Declining	High
Wanneroo groundwater area							
4	Carabooda	Perth – Superficial Swan	5 764	0	0–500	Declining	High
5	Nowergup	Perth – Superficial Swan	1 802	0	0–500	Declining	High
6	Pinjar	Perth – Superficial Swan	452	0	0–500	Declining	High
7	Neerabup	Perth – Superficial Swan	2 386	0	0–500	Declining	High
8	Carramar	Perth – Superficial Swan	1 546	0	0–500	Declining	High
9	Adams	Perth – Superficial Swan	906	0	0–500	Declining	High
10	Mariginiup	Perth – Superficial Swan	3 614	0	0–500	Declining	High
11	Joondalup	Perth – Superficial Swan	1 354	448	0–500	Declining	High
12	Jandabup	Perth – Superficial Swan	183	0	0–1 000	Declining	High
13	Lake Gnangara	Perth – Superficial Swan	7 500	0	0–500	Declining	High
Swan groundwater area							
14	Bandy Spring	Perth – Superficial Swan	350	0	500–3 000	No data	Medium
15	Cockman Bluff	Perth – Superficial Swan	1 351	181	0–3 000	Declining	High
16	Radar	Perth – Superficial Swan	1 801	0	0-500	Declining	High
17	Neaves	Perth – Superficial Swan	1 800	0	0–500	Declining	High
18	North Swan	Perth – Superficial Swan	1 826	0	0–1 000	Declining	High
19	East Swan	Perth – Superficial Swan	681	0	500–1 000	Stable	High
20	Central Swan	Perth – Superficial Swan	920	0	500–1 000	Declining	High
21	South Swan	Perth – Superficial Swan	3 622	0	0–1 000	Declining	High
Mirrabooka groundwater area							
22	State Forest	Perth – Superficial Swan	900	0	0–500	Declining	High
23	Plantation	Perth – Superficial Swan	600	65	500–1 000	Declining	High
24	Henley Brook	Perth – Superficial Swan	1 572	0	0–500	No data	Medium
25	Landsdale	Perth – Superficial Swan	1 400	270	0–500	Declining	High
26	Improvement Plan 8	Perth – Superficial Swan	5 484	0	0–500	Declining	High
27	Whiteman Park	Perth – Superficial Swan	987	0	0–500	Declining	High
28	Ballajura	Perth – Superficial Swan	5 902	0	0–500	No data	Medium
29	Beechboro	Perth – Superficial Swan	901	621	0–500	Declining	High
Gwelup groundwater area							
30	Gwelup	Perth – Superficial Swan	7 850	0	0–500	Declining	High

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] Allocation limits and further water available are being reviewed as part of the Northwest urban growth corridor licensing schedule. Water will be allocated for urban development and public water supply.

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
[2]Perth groundwater area							
31	Eglinton	Perth – Superficial Swan	[3]3 500	700	0–1 000	Declining	High
32	Quinns	Perth – Superficial Swan	[4]14 846	0	0–1 000	Declining	High
33	Whitfords	Perth – Superficial Swan	21 537	0	0–1 000	Declining	High
34	City of Stirling	Perth – Superficial Swan	11 150	0	0–1 000	Declining	High
35	Shire of Swan North	Perth – Superficial Swan	900	290	0–500	Declining	High
36	Town of Bassendean	Perth – Superficial Swan	450	76	0–1 000	Declining	High
37	City of Bayswater	Perth – Superficial Swan	2 300	623	0–1 000	Declining	High
38	Town of Vincent	Perth – Superficial Swan	1 000	0	500–1 000	Declining	High
39	Town of Cambridge	Perth – Superficial Swan	3 500	1 068	500–1 000	Declining	High
40	City of Subiaco	Perth – Superficial Swan	1 000	0	500–3 000	Declining	High
41	City of Perth	Perth – Superficial Swan	1 500	0	500–1 000	No data	Medium
42	City of Nedlands	Perth – Superficial Swan	2 300	0	500–3 000	Declining	High
43	Town of Claremont	Perth – Superficial Swan	700	0	1 000–3 000	Declining	High
44	Shire of Peppermint Grove	Perth – Superficial Swan	100	16	500–3 000	Stable	High
45	Town of Cottesloe	Perth – Superficial Swan	300	52	500–1 000	Stable	High
46	Town of Mosman Park	Perth – Superficial Swan	500	18	500–1 000	Declining	High
47	City of Fremantle North	Perth – Superficial Swan	700	656	500–1 000	No data	Medium
Rottnest Island groundwater area							
48	Rottnest Island	Perth – Rottnest Superficial	250	130	500–35 000	No data	Medium
Totals			**162 667**	**7 524**			

1 Water available for general purpose licensing from the general allocation limit component as of June 2012.

2 The Perth groundwater area extends south of the Swan River. Refer to the Perth South subregion for the remaining shallow groundwater resources of the Perth groundwater area.

3 Allocation limits and further water available are being reviewed as part of the Northwest urban growth corridor licensing schedule. Water will be allocated for urban development and public water supply.

4 Allocation limits and further water available are being reviewed as part of the Northwest urban growth corridor licensing schedule. Water will be allocated for urban development and public water supply.

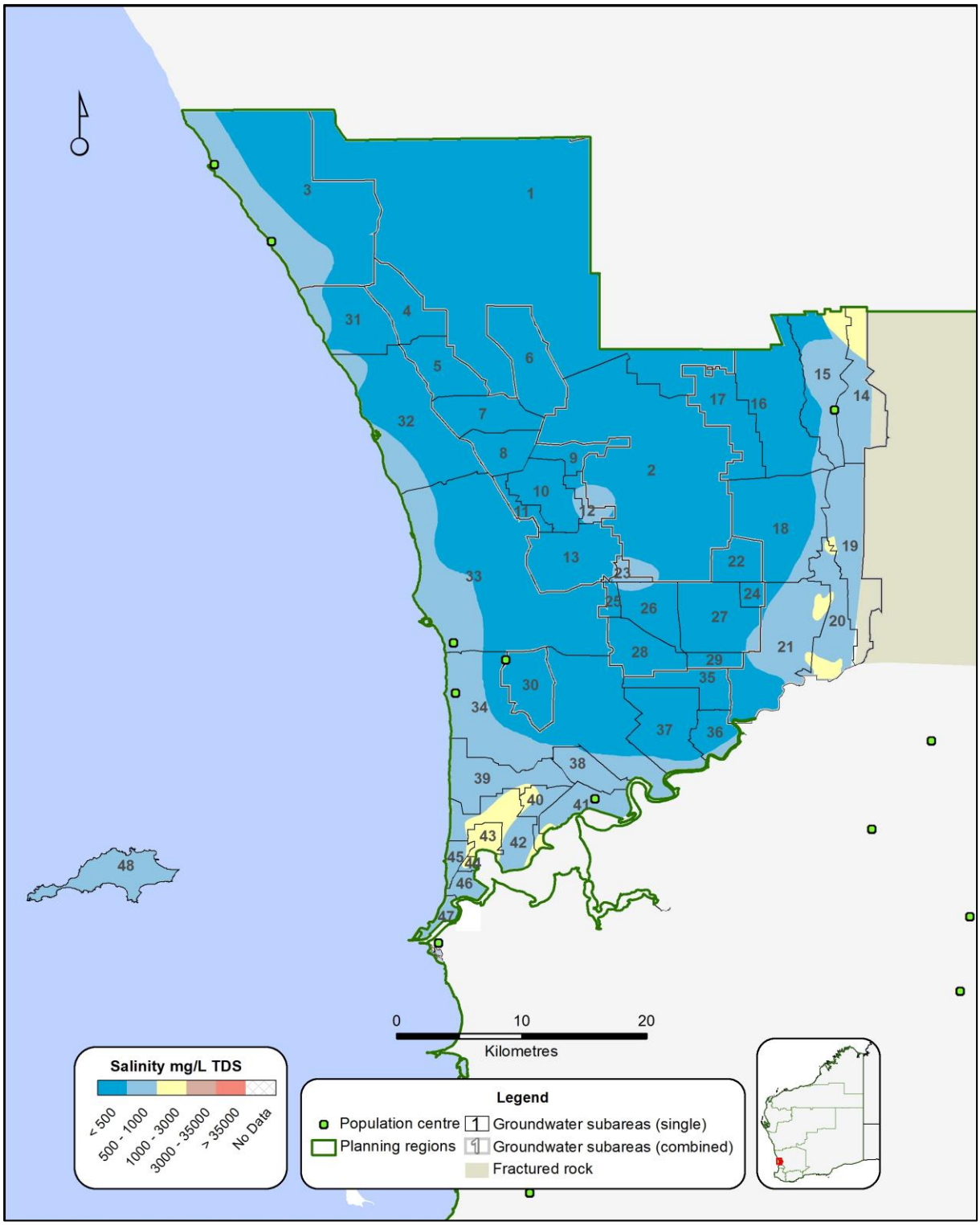

Figure 24 Perth North subregion shallow groundwater resources and water quality

Table 23 Perth North subregion middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Gnangara groundwater area							
1	Gnangara Confined	Perth – Leederville.	15 100	0	0–500	Declining	High
Yanchep groundwater area							
2	Yanchep Confined	Perth – Leederville.	360	40	0–500	Declining	Medium
Wanneroo groundwater area							
3	Wanneroo Confined	Perth – Leederville.	1 250	0	0–500	Declining	High
Swan groundwater area							
4	Swan Confined	Perth – Leederville.	5 000	0	0–3 000	Declining	High
5	Radar	Perth – Mirrabooka	200	2	0–1 000	Declining	Medium
6	North Swan	Perth – Mirrabooka	300	8	0–3 000	Declining	High
7	South Swan	Perth – Mirrabooka	1 600	45	0–3 000	Declining	High
Mirrabooka groundwater area							
8	State Forest	Perth – Mirrabooka	200	50	0–500	Declining	High
9	Henley Brook	Perth – Mirrabooka	360	0	0–500	Declining	Medium
10	Whiteman Park	Perth – Mirrabooka	400	0	0–1 000	Declining	High
11	Mirrabooka Confined	Perth – Leederville.	6 000	0	0–1 000	Declining	High
Gwelup groundwater area							
12	Gwelup	Perth – Mirrabooka	3 600	0	500–1 000	No data	Medium
13	Gwelup Confined	Perth – Leederville.	5 300	0	500–1 000	Declining	Medium
Perth groundwater area[3]							
14	Perth North Confined	Perth – Leederville.	10 700	0	0–1 000	Declining	High
15	Shire of Swan North	Perth – Mirrabooka	230	70	0–1 000	Declining	High
16	City of Bayswater	Perth – Mirrabooka	50	50	0–1 000	Declining	Medium
Totals			**50 650**	**265**			

[1] A full stop at the end of the aquifer name identifies that it is a confined resource.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[3] The Perth groundwater area extends south of the Swan River. Refer to the Perth South subregion for the remaining middle groundwater resources of the Perth groundwater area.

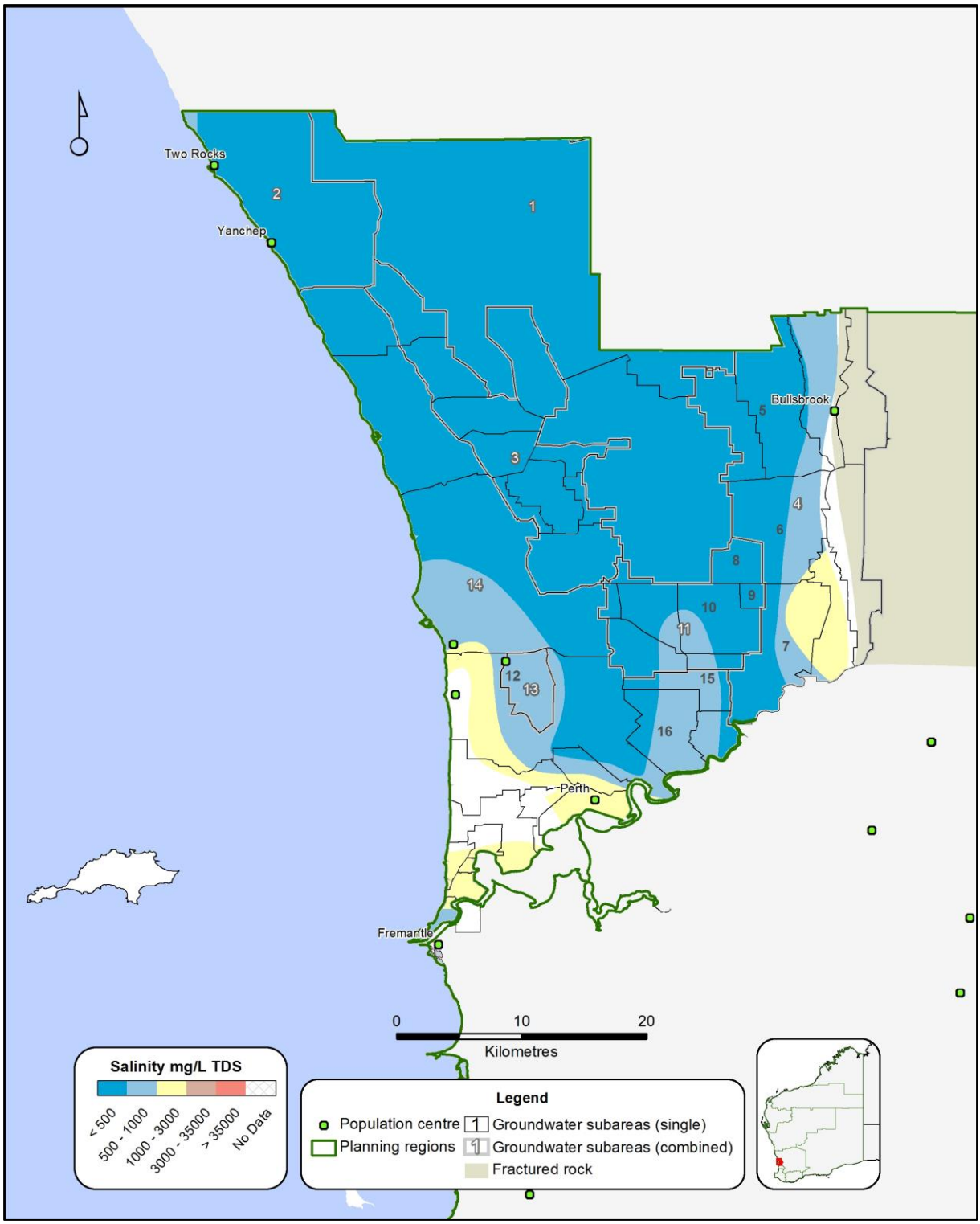

Figure 25 Perth North subregion middle groundwater resources and water quality

Table 24 Perth North subregion deep groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Gnangara groundwater area							
1	Gnangara Confined	Perth – Yarragadee North.	5 150	0	0–3 000	Declining	Medium
Yanchep groundwater area							
2	Yanchep Confined	Perth – Yarragadee North.	390	0	1 000–3 000	Declining	Medium
Wanneroo groundwater area							
3	Wanneroo Confined	Perth – Yarragadee North.	5 000	0	0–1 000	Declining	Medium
Swan groundwater area							
4	Swan Confined	Perth – Yarragadee North.	500	0	1 000–35 000	Declining	Medium
Mirrabooka groundwater area							
5	Mirrabooka Confined	Perth – Yarragadee North.	1 580	0	500–35 000	Declining	Medium
Gwelup groundwater area							
6	Gwelup Confined	Perth – Yarragadee North.	7 500	0	0–500	Declining	Medium
Perth groundwater area[3]							
7	Perth North Confined	Perth – Yarragadee North.	21 000	167	0–500	Declining	Medium
Totals			**41 120**	**167**			

1 A full stop at the end of the aquifer name identifies that it is a confined resource.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

3 The Perth groundwater area extends south of the Swan River. Refer to the Perth South subregion for the remaining deep groundwater resources of the Perth groundwater area.

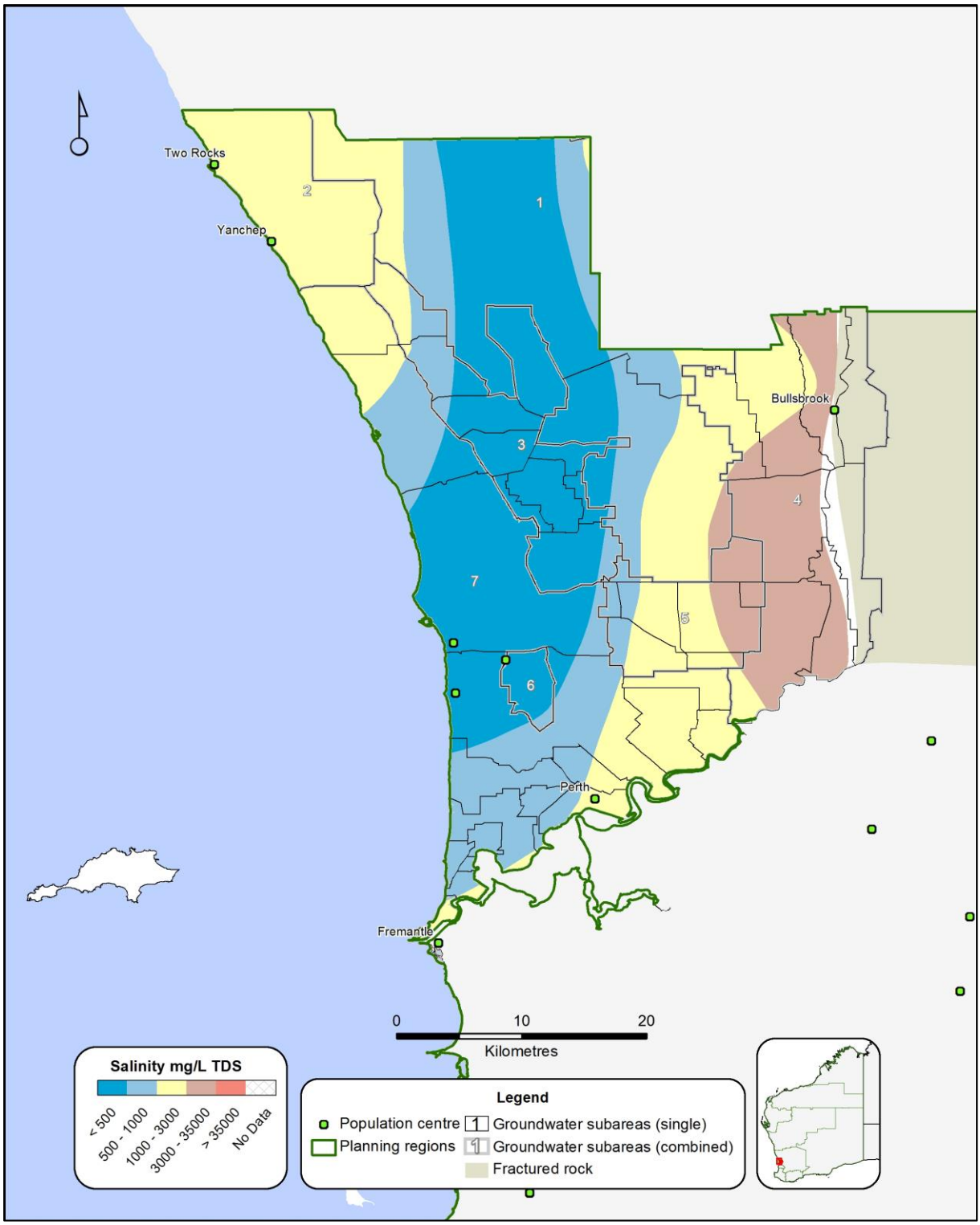

Figure 26 Perth North subregion deep groundwater resources and water quality

7.2 Perth South subregion water resources

Surface water

The Canning River and tributaries are the main source of surface water in the Perth South subregion. Reservoirs store water that feeds into the integrated water supply scheme supplying the Perth area.

Streams flowing into these reservoirs arise in the Darling Scarp water supply catchments and water is fresh.

Inflows into these reservoirs have declined under our drying climate and this trend is projected to continue into the future. Despite the drying climate, these storages are important sources of scheme water in wetter years.

A small volume of surface water is also abstracted from the fresh tributaries for private self-supply. Water is pumped for irrigation and domestic gardens. With increasing urbanisation these streams are becoming more important for their ecological and social values than as water supply.

There is no additional water for use from the Canning system, and existing use is gradually being reduced. Licensed water users on the lower Serpentine River rely on releases from the dam for their water supply, and there is no scope to increase water use.

Surface water abstraction is licensed in the Canning, Serpentine, Victoria Dam, Churchman's Brook, Wungong Dam and Canning Dam surface water areas that are proclaimed under the *Rights in Water and Irrigation Act 1914.* The *Middle Canning River surface water allocation plan* (DoW 2012a) describes how water is allocated and managed.

Table 25 Perth South subregion surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year[1]	Further water available ML/year[2]	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
Canning River	New Victoria Reservoir	(1 214)	0	0–500	Declining	High
	Canning Pipehead	(821)	0	0–500	Declining	High
	Churchmans Brook Reservoir	(1 288)	0	500–1 000	Declining	High
	Middle Canning River	650	0	500–1 000	Declining	High
	Canning Reservoir	(11 951)	0	0–500	Declining	High
	Wungong Reservoir	(6 950)	0	0–500	Declining	High
	Rivers & tributaries	Not set	–	0–500	Declining	High
Cockburn/Kwinana Coastal	Minor tributaries	Not set	–	1 000–3 000	Not assessed	High
Serpentine River Catchment	Serpentine Dirk/Karnet & Nambeelup rivers	Not set	–	0–500	Declining	High
Totals		**(22 874)**	**0**			

1 Allocation limits shown in brackets have not been formally set but are an indication of the total volume of water available. These volumes are based on the average inflows to the reservoirs from 2006 to 2011.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

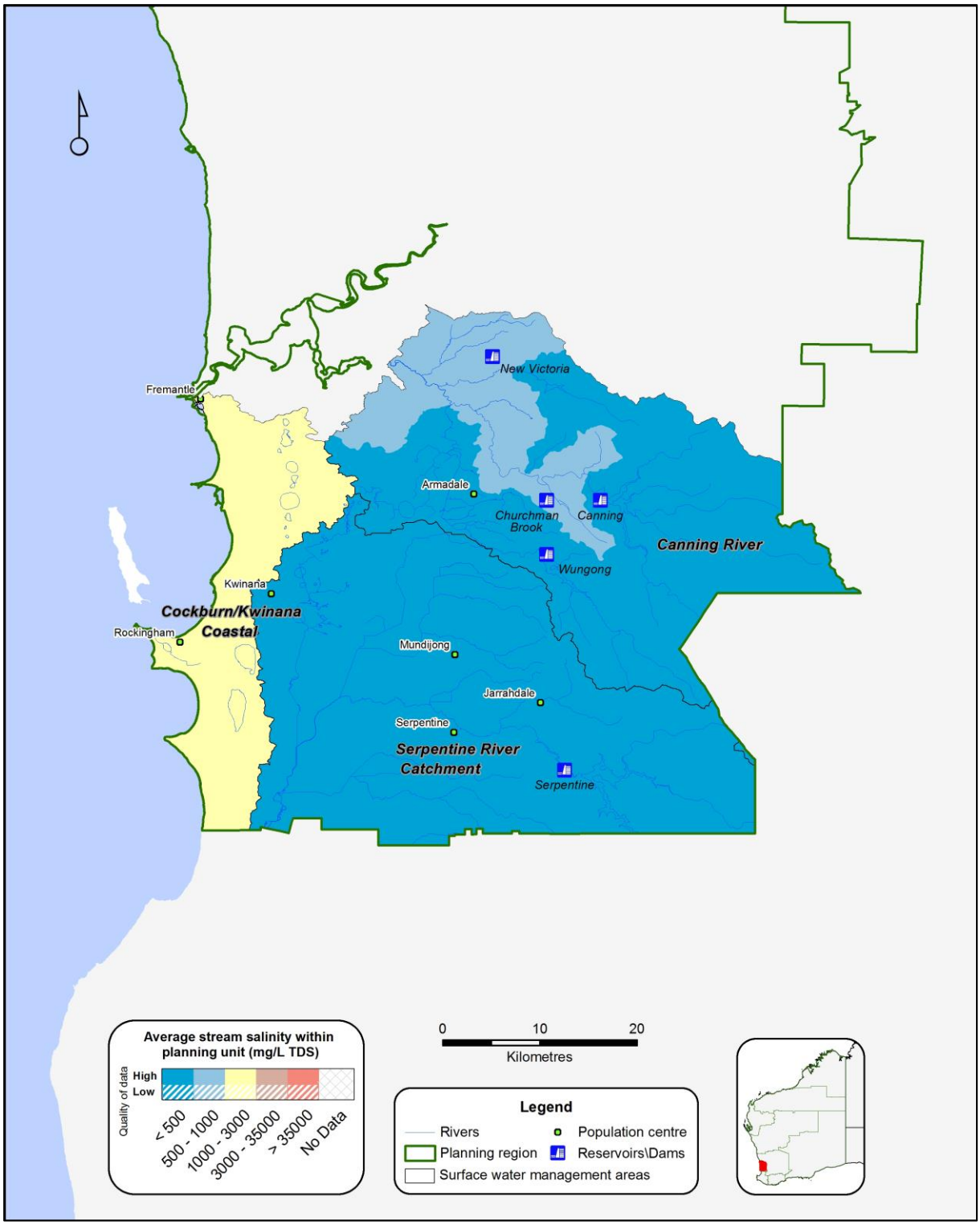

Figure 27 Perth South subregion surface water resources and water quality

Groundwater

The sedimentary Perth Basin extends south of the Swan River, and provides an important source of groundwater in the Perth South subregion. Groundwater is abstracted from the Jandakot groundwater system for public water supply (though much less than from the Gnangara system). Groundwater is also abstracted for industry, agricultural production, commercial activities, urban parks and recreational areas and for domestic gardens. Minor fractured rock aquifers occur in the east of the region but their use is minimal.

Across the subregion, additional water (just over 61 000 ML/year) is available for general purpose licensing. There is no further groundwater available for licensing from some resources subject to high demand .

The water that is available is generally more difficult to abstract than in the Perth North subregion, and water quality is generally not as good. The ability to abstract large volumes of water is constrained in some areas due to the high clay content of soils, which results in low bore yields.

Water level trends across the subregion are generally in decline. This is a result of regional abstraction (from the Perth North subregion) and reduced recharge from rainfall.

The Department of Water has detailed technical information on the Superficial and Leederville aquifers in the Perth South subregion. As there are only a small number of deep monitoring bores, information on the Yarragadee aquifer is less comprehensive than in the Perth North subregion.

Groundwater abstraction in the Perth South subregion is licensed in the Cockburn, Jandakot, Rockingham, Serpentine and Stakehill groundwater areas that are proclaimed under the *Rights in Water and irrigation Act 1914*. The way in which groundwater is allocated and managed is described in the *Cockburn groundwater allocation plan* (DoW 2007b) and the *Rockingham and Stakehill groundwater allocation plan* (DoW 2008a).

Table 26 Perth South subregion shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Perth groundwater area[2]							
1	Shire of Swan South	Perth – Superficial Swan	400	0	0–1 000	Declining	High
2	Shire of Mundaring	Perth – Superficial Swan	200	128	0–1 000	No data	Medium
3	Town of East Fremantle	Perth – Superficial Swan	100	0	500–1 000	No data	Medium
4	City of Fremantle South	Perth – Superficial Swan	1 900	212	500–1 000	No data	Medium
5	City of Cockburn	Perth – Superficial Swan	1 000	518	0–1 000	Declining	High
6	City of Melville	Perth – Superficial Swan	5 500	1 318	0–1 000	Declining	High
7	City of South Perth	Perth – Superficial Swan	3 000	512	0–1 000	Declining	High
8	Town of Victoria Park	Perth – Superficial Swan	2 500	353	0–1 000	Declining	High
9	City of Belmont	Perth – Superficial Swan	2 000	199	0–1 000	Declining	High
10	Shire of Kalamunda	Perth – Superficial Swan	3 000	402	0–500	No data	Medium
11	City of Canning	Perth – Superficial Swan	3 500	1 240	0–1 000	Declining	High
12	City of Gosnells	Perth – Superficial Swan	5 500	2 260	0–35 000	Stable	High
13	City of Armadale	Perth – Superficial Swan	4 000	915	0–3 000	Declining	High
14	Jarrahdale	Perth – Superficial Swan	1 600	218	0–3 000	Declining	High
Jandakot groundwater area							
15	South Lakes	Perth – Superficial Swan	1 250	663	0–500	Stable	Medium
16	Airport	Perth – Superficial Swan	4 290	790	0–500	Declining	Medium
17	Canning Vale	Perth – Superficial Swan	1 350	385	0–500	Declining	Medium
18	Wright	Perth – Superficial Swan	960	132	0–1 000	Declining	Medium
19	Success	Perth – Superficial Swan	4 300	1 023	0–500	Stable	Medium
20	Banjup	Perth – Superficial Swan	3 610	839	0–500	Stable	Medium
21	Forrestdale	Perth – Superficial Swan	2 010	585	0–500	Declining	Medium
22	Mandogalup	Perth – Superficial Swan	3 000	1 110	0–500	Declining	Medium
23	Wandi	Perth – Superficial Swan	1 200	544	0–500	Declining	Medium
24	Oakford	Perth – Superficial Swan	1 370	1 008	0–500	Declining	Medium
Cockburn groundwater area							
25	Kogalup	Perth – Superficial Swan	11 460	1 531	500–3 000	Declining	Medium
26	Thompsons	Perth – Superficial Swan	8 700	2 984	0–1 000	Declining	Medium
27	Valley	Perth – Superficial Swan	7 700	1 079	0–1 000	Stable	Medium
28	Wellard	Perth – Rockingham Sand	0	0	500–35 000	Declining	Medium
28	Wellard	Perth – Superficial Swan	10 320	4 108	500–35 000	Declining	Medium
Serpentine groundwater area							
29	Jandakot Mound 1	Perth – Superficial Swan	5 130	1 212	0–1 000	Declining	Medium
30	Jandakot Mound 2	Perth – Superficial Swan	1 930	172	0–3 000	Stable	Medium
31	Byford 2	Perth – Superficial Swan	8 130	7 565	0–3 000	Declining	Medium
32	Byford 3	Perth – Superficial Swan	13 630	12 310	500–35 000	Declining	Medium
33	Serpentine 1	Perth – Superficial Swan	1 370	1 186	500–3 000	Stable	Medium
34	Serpentine 2	Perth – Superficial Swan	2 760	1 301	500–3 000	Stable	Medium

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The Perth groundwater area extends north of the Swan River. Refer to the Perth North subregion for the remaining shallow groundwater resources of the Perth groundwater area.

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
35	Serpentine 3	Perth – Superficial Swan	2 380	1 846	0–3 000	Declining	Medium
36	Keysbrook 1	Perth – Superficial Swan	2 000	421	0–3 000	Stable	Medium
37	Keysbrook 2	Perth – Superficial Swan	2 600	2 326	0–1 000	Declining	Medium
Stakehill groundwater area							
38	Tamworth Swamp	Perth – Superficial Swan	3 485	344	1 000–3 000	Stable	Medium
39	Maramanup	Perth – Superficial Swan	1 956	214	500–35 000	Declining	Medium
40	Outridge	Perth – Superficial Swan	2 456	0	500–3 000	Declining	Medium
41	Churcher East	Perth – Superficial Swan and Rockingham Sand	3 672	447	500–3 000	Declining	Medium
42	Karnup East	Perth – Superficial Swan and Rockingham Sand	1 636	116	500–1 000	Declining	Medium
43	Keysbrook	Perth – Superficial Swan and Rockingham Sand	720	720	0–1 000	Stable	Medium
Rockingham groundwater							
44	Cooloongup	Perth – Superficial Swan and Rockingham Sand	272	0	1 000–3 000	Stable	Medium
45	Warnbro	Perth – Superficial Swan and Rockingham Sand	7 800	2 616	500–3 000	Declining	Medium
46	Churcher West	Perth – Superficial Swan and Rockingham Sand	1 849	648	500–3 000	Declining	Medium
47	Karnup West	Perth – Superficial Swan and Rockingham Sand	1 200	0	500–3 000	Declining	Medium
Totals			**160 696**	**58 500**			

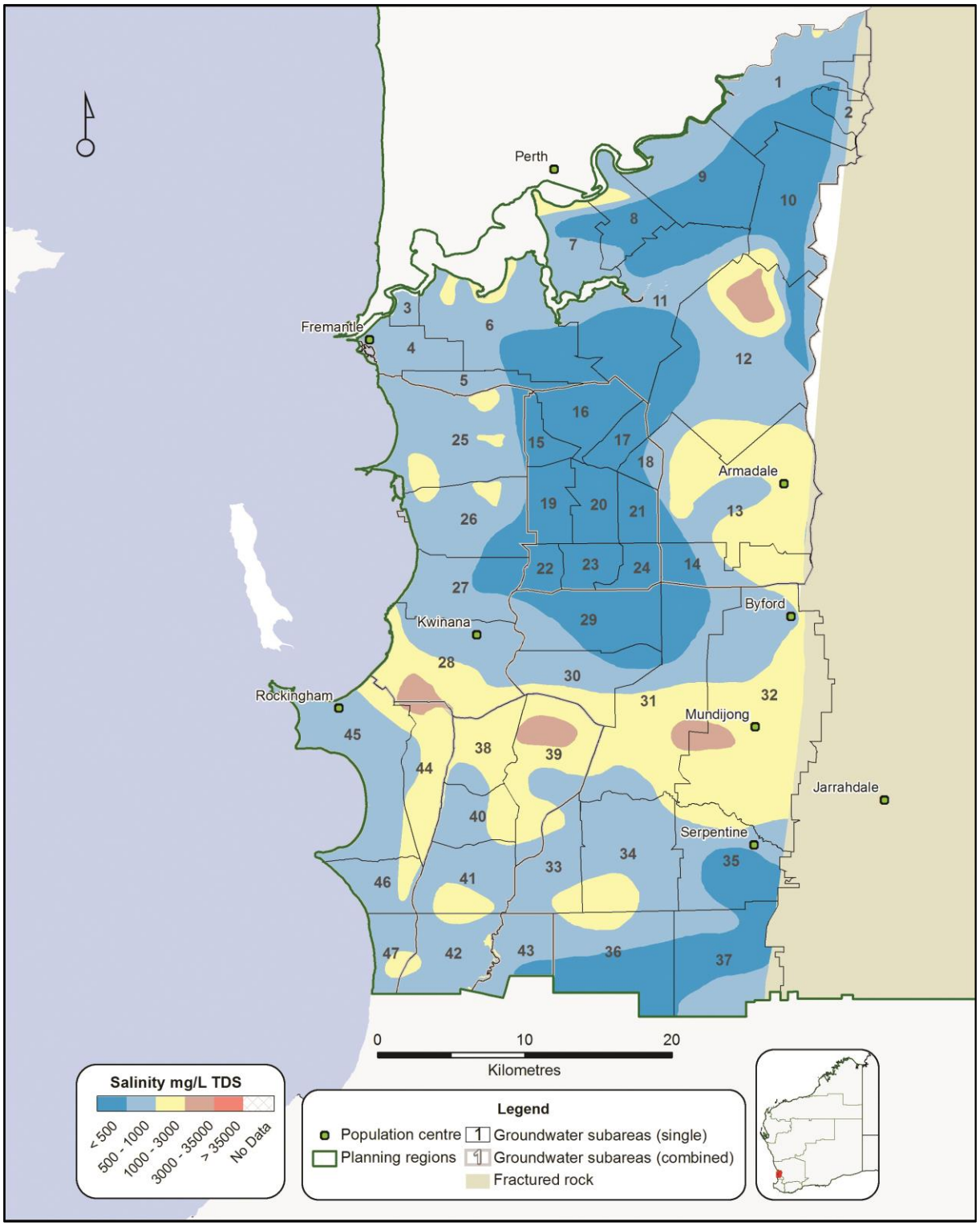

Figure 28 Perth South subregion shallow groundwater resources and water quality

Table 27 Perth South subregion middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Perth groundwater area[3]							
1	Perth South Confined	Perth – Leederville.	4 500	0	0–3 000	Declining	High
2	Shire of Swan South	Perth – Mirrabooka	20	4	0–1 000	Declining	High
Jandakot groundwater area							
3	Jandakot Confined	Perth – Leederville.	1 750	0	0–3 000	Declining	Medium
Cockburn groundwater area							
4	Cockburn Confined	Perth – Leederville.	1 350	0	500–3 000	Declining	Medium
Serpentine groundwater area							
5	Jandakot Mound 1	Perth – Leederville.	Not set	Not set	500–3 000	Declining	Medium
6	Jandakot Mound 2	Perth – Leederville.	Not set	Not set	500–1 000	Declining	Medium
7	Byford 2	Perth – Leederville.	1 350	687	0–3 000	Declining	Medium
8	Byford 3	Perth – Leederville.	2 270	430	0–3 000	Declining	Medium
9	Serpentine 1	Perth – Leederville.	450	0	1 000–3 000	Declining	Medium
10	Serpentine 2	Perth – Leederville.	920	248	0–1 000	Declining	Medium
11	Serpentine 3	Perth – Leederville.	790	29	0–1 000	Declining	Medium
12	Keysbrook 1	Perth – Leederville.	750	0	500–1 000	Declining	Medium
13	Keysbrook 2	Perth – Leederville.	860	412	0–1 000	Declining	Medium
Rockingham groundwater							
14	Rockingham Confined	Perth – Leederville.	430	29	500–35 000	Declining	Medium
Stakehill groundwater area							
15	Stakehill – Keysbrook Confined	Perth – Leederville.	150	150	500–1 000	Declining	Medium
16	Stakehill Confined	Perth – Leederville.	390	0	500–1 000	Declining	Medium
Totals			**15 980**	**1 989**			

[1] A full stop at the end of the aquifer name identifies that it is a confined resource.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[3] The Perth groundwater area extends north of the Swan River. Refer to the Perth North subregion for the remaining shallow groundwater resources of the Perth groundwater area.

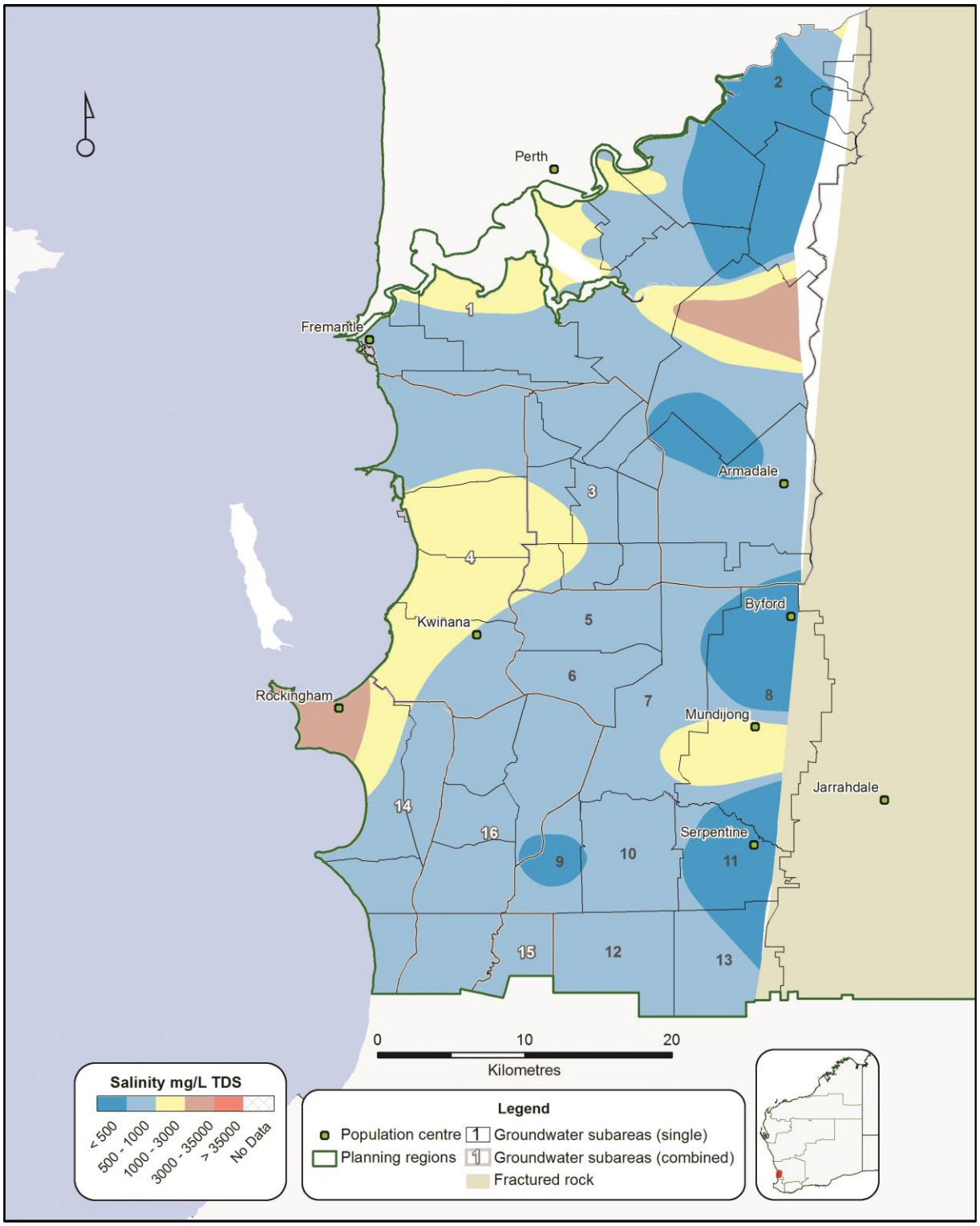

Figure 29 Perth South subregion middle groundwater resources and water quality

Table 28 Perth South subregion deep groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Perth groundwater area[3]							
1	Perth South Confined	Perth – Yarragadee North.	1 500	0	1 000–35 000	Declining	High
Jandakot groundwater area							
2	Jandakot Confined	Perth – Yarragadee North.	10 000	0	1 000–3 000	Declining	Medium
Cockburn groundwater area							
3	Cockburn Confined	Perth – Yarragadee North.	5 150	0	1 000–3 000	Declining	Medium
Serpentine groundwater area							
4	Jandakot Mound 1	Perth – Yarragadee North.	Not set	–	1 000–3 000	Declining	Initial
5	Jandakot Mound 2	Perth – Yarragadee North.	Not set	–	1 000–3 000	Declining	Initial
6	Byford 2	Perth – Cattamarra Coal Measures.	Not set	–	500–3 000	Declining	Initial
		Perth – Yarragadee North.	Not set	–	500–3 000	Declining	Initial
7	Byford 3	Perth – Cattamarra Coal Measures.	1 130	341	0–1 000	Declining	Medium
		Perth – Yarragadee North.	Not set	–	0–1 000	Declining	Initial
8	Serpentine 1	Perth – Yarragadee North.	Not set	–	1 000–3 000	Declining	Initial
9	Serpentine 2	Perth – Yarragadee North.	100	100	0–3 000	Declining	Initial
10	Serpentine 3	Perth – Cattamarra Coal Measures.	390	98	0–1 000	Declining	Initial
		Perth – Yarragadee North.	Not set	–	0–1 000	Declining	Initial
11	Keysbrook 1	Perth – Yarragadee North.	Not set	–	0–3 000	Declining	Initial
12	Keysbrook 2	Perth – Yarragadee North.	Not set	–	0–500	Declining	Initial
		Perth – Cattamarra Coal Measures.	Not set	–	0–500	Declining	Initial
Rockingham groundwater							
13	Rockingham Confined	Perth – Cattamarra Coal Measures.	Not set	–	1 000–3 000	Declining	Initial
		Perth – Yarragadee North.	Not set	–	1 000–3 000	Declining	Medium
Stakehill groundwater area							
14	Stakehill – Keysbrook Confined	Perth – Cattamarra Coal Measures.	450	450	1 000–3 000	Declining	Initial
		Perth – Yarragadee North.	Not set	–	1 000–3 000	Declining	Initial
15	Stakehill Confined	Perth – Cattamarra Coal Measures.	Not set	–	1 000–3 000	Declining	Initial
		Perth – Yarragadee North.	Not set	–	1 000–3 000	Declining	Initial
Totals			**18 720**	**989**			

[1] A full stop at the end of the aquifer name identifies that it is a confined resource.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[3] The Perth groundwater area extends north of the Swan River. Refer to the Perth North subregion for the remaining shallow groundwater resources of the Perth groundwater area.

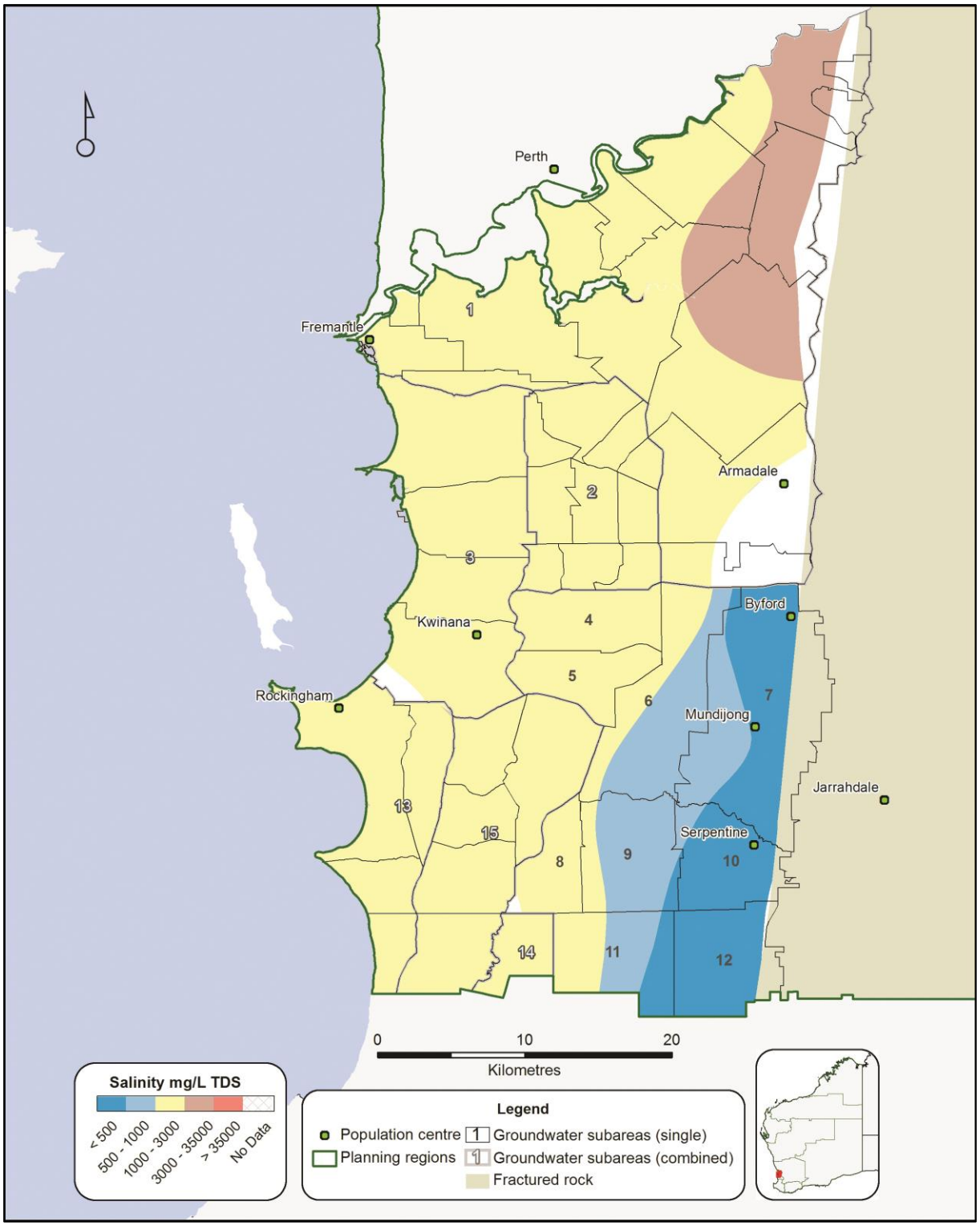

Figure 30 Perth South subregion deep groundwater resources and water quality

8 Peel water resources

Surface water

Short streams arising on the Darling Scarp and flowing through to the Peel Harvey Estuary are important sources of fresh surface water.

The main uses of surface water in the Peel Region are public water supply, industry and irrigation. Major reservoirs on the Dandalup River and tributaries supply water to Perth's integrated water supply scheme. Reservoirs on the Harvey River system supply the Waroona and Harvey Irrigation Districts. Surface water is also used for mining activities (bauxite and gold) and there is some direct pumping for irrigation, stock and gardens.

Inflows to reservoirs have declined under our drying climate. The public water supply reservoirs provide an important component of supply in wetter years. Water is distributed across the irrigation districts so that water can be effectively shared between all of Harvey Water Irrigation Cooperative's shareholders.

As the declining rainfall trend is projected to continue into the future, there is no further water available for licensing from these reservoirs. Water use efficiency, water sharing and alternative sources will continue to be essential to increase reliability and enable expansion.

Surface water abstraction is licensed in the Dandalup River system, Harvey Irrigation District and Murray River system areas that are proclaimed under the *Rights in Water and Irrigation Act 1914*.

Table 29 Peel Region surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year[1]	Further water available ML/year[2]	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
Dandalup River System	North Dandalup Reservoir	(8 968)	0	0–500	Declining	High
	South Dandalup Reservoir	(10 250)	0	0–500	Declining	High
	South Dandalup Pumpback	(3 179)	0	0–500	Declining	High
	Conjurunup Creek Pipehead	(2 627)	0	0–500	Declining	High
Kwinana Peel Coastal	Minor tributaries	Not set	–	500–1 000	Not assessed	High
Harvey[3]	Waroona Reservoir	Not set	0	0–500	Declining	High
	Drakes Brook Reservoir	Not set	0	0–500	Declining	High
	Samson Brook Reservoir	(9 692)	0	0–500	Declining	High
	Samson Brook Pipehead	(1 636)	0	0–500	Declining	High
	Rivers & tributaries	Not set	–	0–500	Declining	High
Murray River & tribs	Rivers & tributaries	Not set	–	500–35 000	Variable	High
Totals		**(36 352)**	**0**			

1 Allocation limits shown in brackets have not been formally set but are an indication of the total volume of water available. These volumes are based on the average inflows to the reservoirs from 2006 to 2011.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

3 The Harvey surface water management area extends south into the South West Region. Refer to the South West Region for the remaining surface water resources of the Harvey surface water management area.

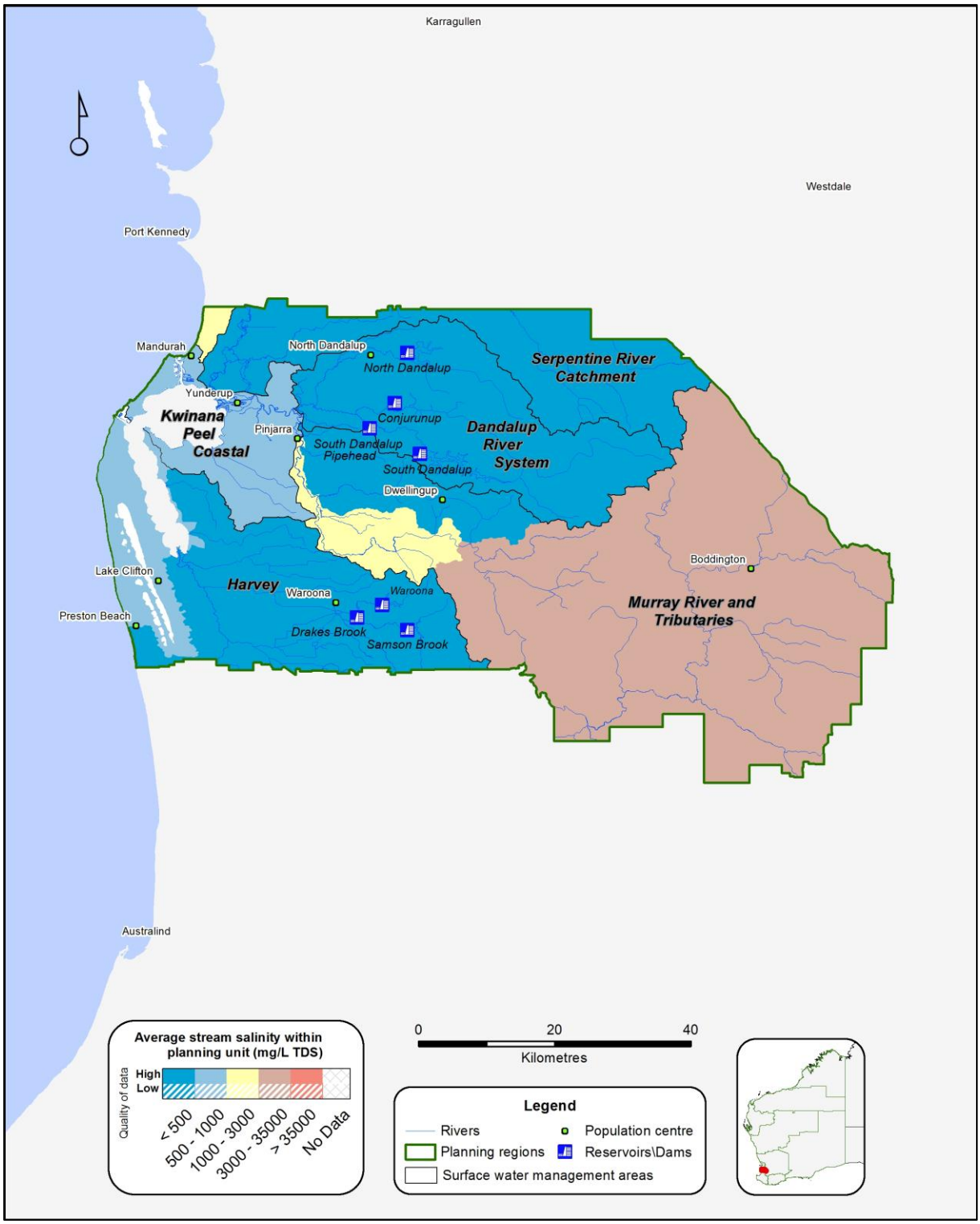

Figure 31 Peel Region surface water resources and water quality

Groundwater

High watertables are a characteristic of the Peel Region, especially in winter, though reliable groundwater supplies are not always easily accessible or of a suitable quality.

Across the Peel Region there are significant groundwater resources stored in a thick succession of sedimentary aquifers of the southern Perth Basin. The main fresh water aquifers are the Superficial and Leederville. The Cattamarra aquifer is also present but is generally deep, becoming shallower towards the east (along the Darling scarp). It provides an important source of water for local industries.

Groundwater in the Peel Region mainly supports industry, mining, agricultural production, urban parks and recreational areas. Minor fractured rock aquifers are present but their use is minimal.

There is further water available (just over 42 000 ML/year) for general purpose licensing across the region, mainly from the Superficial aquifer. Distributed, small-scale abstraction is viable, but abstraction of large volumes is not always practical.

In the South West Coastal groundwater area abstraction is constrained by the risks of seawater intrusion, saline up-coning from the more saline aquifers below the fresh water, and salt recycling. To manage these risks, only a small volume per bore can be allocated to licences, and bores must be widely distributed.

In the Murray groundwater area, abstraction of large volumes from the Superficial aquifer is affected by the high clay content of soils, which reduces bore yields. The current and future use of this resource is suited to widely distributed and small-scale use. More intensive future use is likely to be possible with extensive infrastructure.

Water level trends across the region are variable. As the shallow aquifer water levels can be highly seasonal, managed aquifer recharge is a promising option to capitalise on storing winter rainfall in the Leederville aquifer for reuse at other times.

There are significant declines in the potentiometric heads of the Leederville and Yarragadee aquifers. The declining head in the Yarragadee aquifer has been recorded on a broad scale and is largely attributed to abstraction outside the Peel Region, in the Perth Region.

The Department of Water has detailed information on the Superficial aquifer. Information on the Leederville and Yarragadee aquifers is more localised. We are currently investigating and assessing the groundwater resources of the confined Leederville and Cattamarra aquifers in the Murray and South West Coastal groundwater areas through the State Groundwater Investigation Program.

Groundwater abstraction in the Peel Region is licensed under the South West Coastal and Murray groundwater areas that are proclaimed under the *Rights in Water and Irrigation Act 1914.* The *Murray groundwater area allocation plan* (DoW 2012b) and the *South West Coastal groundwater allocation plan: for public comment* (DoW in prep.) describe how water is allocated and managed.

Table 30 Peel Region shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
South West Coastal groundwater area[2]							
1	Mandurah	Perth – Superficial Swan	4 519	0	500–3 000	Declining	Medium
2	Falcon	Perth – Superficial Swan	2 326	425	500–1 000	No data	Medium
3	Whitehills	Perth – Superficial Swan	331	3	500–1 000	Stable	Medium
4	Coastal	Perth – Superficial Swan	193	0	500–1 000	Declining	Medium
5	Island Point	Perth – Superficial Swan	575	51	0–1 000	Stable	Medium
6	Lake Clifton	Perth – Superficial Swan	657	0	0–1 000	Declining	Medium
7	Colburra Downs	Perth – Superficial Swan	70	0	0–1 000	Declining	Medium
Murray groundwater area							
8	Nambeelup	Perth – Superficial Swan	13 500	9 848	0–3 000	Stable	High
9	Coolup	Perth – Superficial Swan	17 000	14 208	0–3 000	Declining	High
10	Pinjarra	Perth – Superficial Swan	1 700	729	0–3 000	Declining	High
11	Waroona	Perth – Superficial Swan	8 000	4 916	0–3 000	Declining	Medium
Totals			**48 871**	**30 180**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The South West Coastal groundwater area extends south into the South West Region. Refer to the South West Region for the remaining shallow groundwater resources of the South West Coastal groundwater area. The allocation limits for the South West Coastal resources within the Peel region are currently being updated through the *South West Coastal groundwater allocation plan: for public comment* (in preparation). The volumes presented here represent those of the plan for public comment.

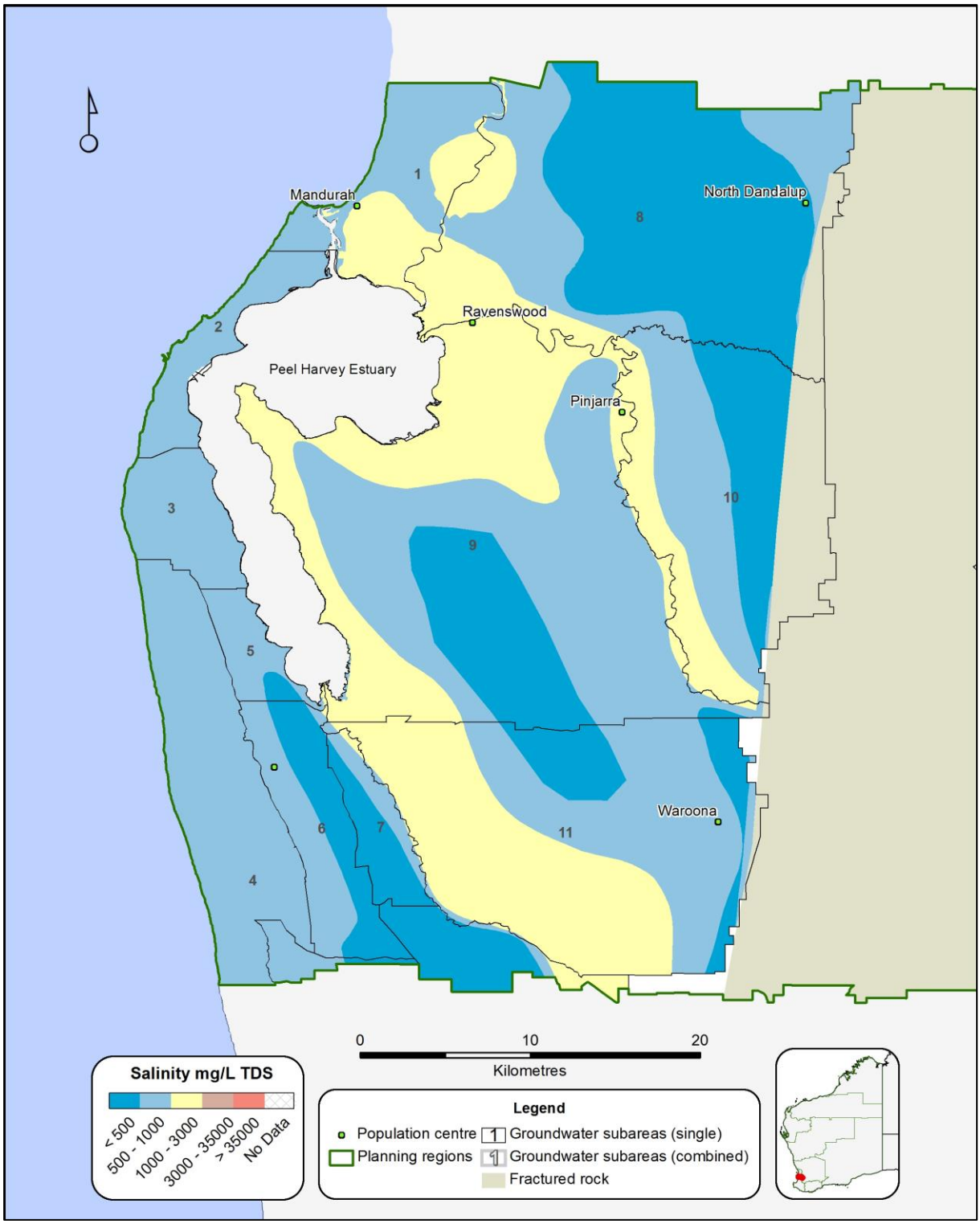

Figure 32 Peel Region shallow groundwater resources and water quality

Table 31 Peel Region middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
South West Coastal groundwater area[3]							
1	Mandurah	Perth – Leederville.	862	0	500–3 000	Declining	Initial
2	Falcon	Perth – Leederville.	1 583	0	500–3 000	No data	Initial
3	Whitehills	Perth – Leederville.	0	0	500–1 000	No data	Initial
4	Coastal	Perth – Leederville.	20	0	500–1 000	No data	Initial
5	Island Point	Perth – Leederville.	0	0	500–1 000	No data	Initial
6	Lake Clifton	Perth – Leederville.	0	0	500–1 000	No data	Initial
7	Colburra Downs	Perth – Leederville.	0	0	500–1 000	No data	Initial
Murray groundwater area							
8	Nambeelup	Perth – Lower Leederville.	3 000	1 826	500–3 000	Declining	Initial
		Perth – Upper Leederville.	3 000	1 094	500–3 000	Declining	Initial
9	Coolup	Perth – Upper Leederville.	4 500	3 382	500–3 000	No data	Initial
		Perth – Lower Leederville.	1 158	46	500–3 000	No data	Initial
10	Pinjarra	Perth – Lower Leederville.	1 800	1 184	500–3 000	Declining	Initial
11	Waroona	Perth – Lower Leederville.	1 500	1 489	500–3 000	Declining	Initial
		Perth – Upper Leederville.	2 200	2 200	500–3 000	Declining	Initial
Totals			**19 623**	**11 221**			

[1] A full stop at the end of the aquifer name identifies that it is a confined resource.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[3] The South West Coastal groundwater area extends south into the South West Region. Refer to the South West Region for the remaining middle level groundwater resources of the South West Coastal groundwater area. The allocation limits for the South West Coastal resources within the Peel region are currently being updated through the *South West Coastal groundwater allocation plan: for public comment* (in preparation). The volumes presented here represent those of the plan for public comment.

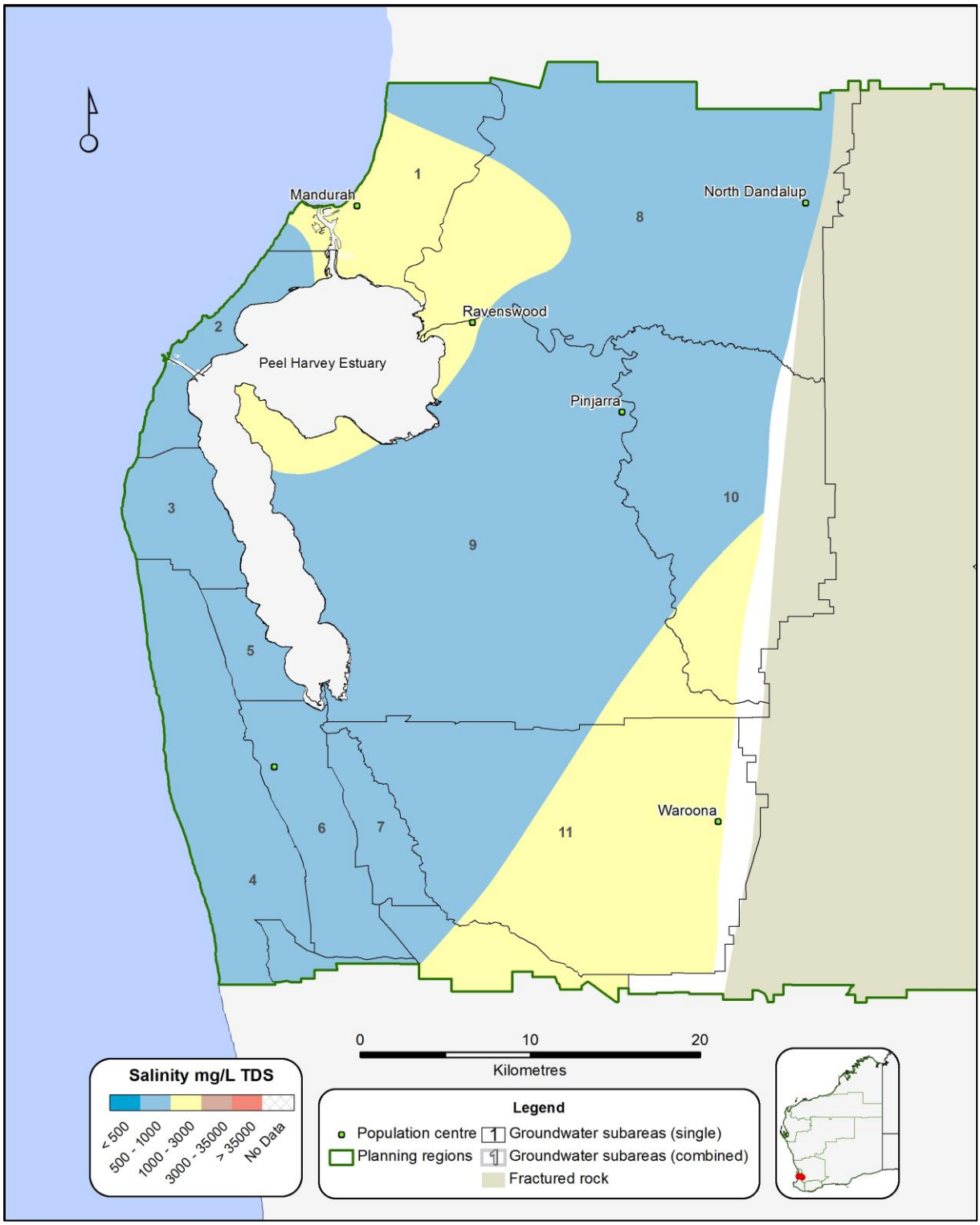

Figure 33 Peel Region middle groundwater resources and water quality

Table 32 Peel Region deep groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
South West Coastal groundwater area[3]							
1	Mandurah	Perth – Cattamarra Coal Measures.	Not set	–	1 000–3 000	No data	Initial
Murray groundwater area							
2	Nambeelup	Perth – Cattamarra Coal Measures.	600	5	0–3 000	Declining	Initial
2	Nambeelup	Perth – Yarragadee North.	Not set	-	0–3 000	Declining	Initial
3	Coolup	Perth – Cattamarra Coal Measures.	100	90	500–3 000	No data	Initial
4	Pinjarra	Perth – Cattamarra Coal Measures.	2 600	0	0–3 000	Declining	Medium
5	Waroona	Perth – Cattamarra Coal Measures.	100	100	3 000–35 000	No data	Initial
Totals			**3 400**	**195**			

1 A full stop at the end of the aquifer name identifies that it is a confined resource.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

3 The South West Coastal groundwater area extends south into the South West Region. Refer to the South West Region for the remaining deep groundwater resources of the South West Coastal groundwater area.

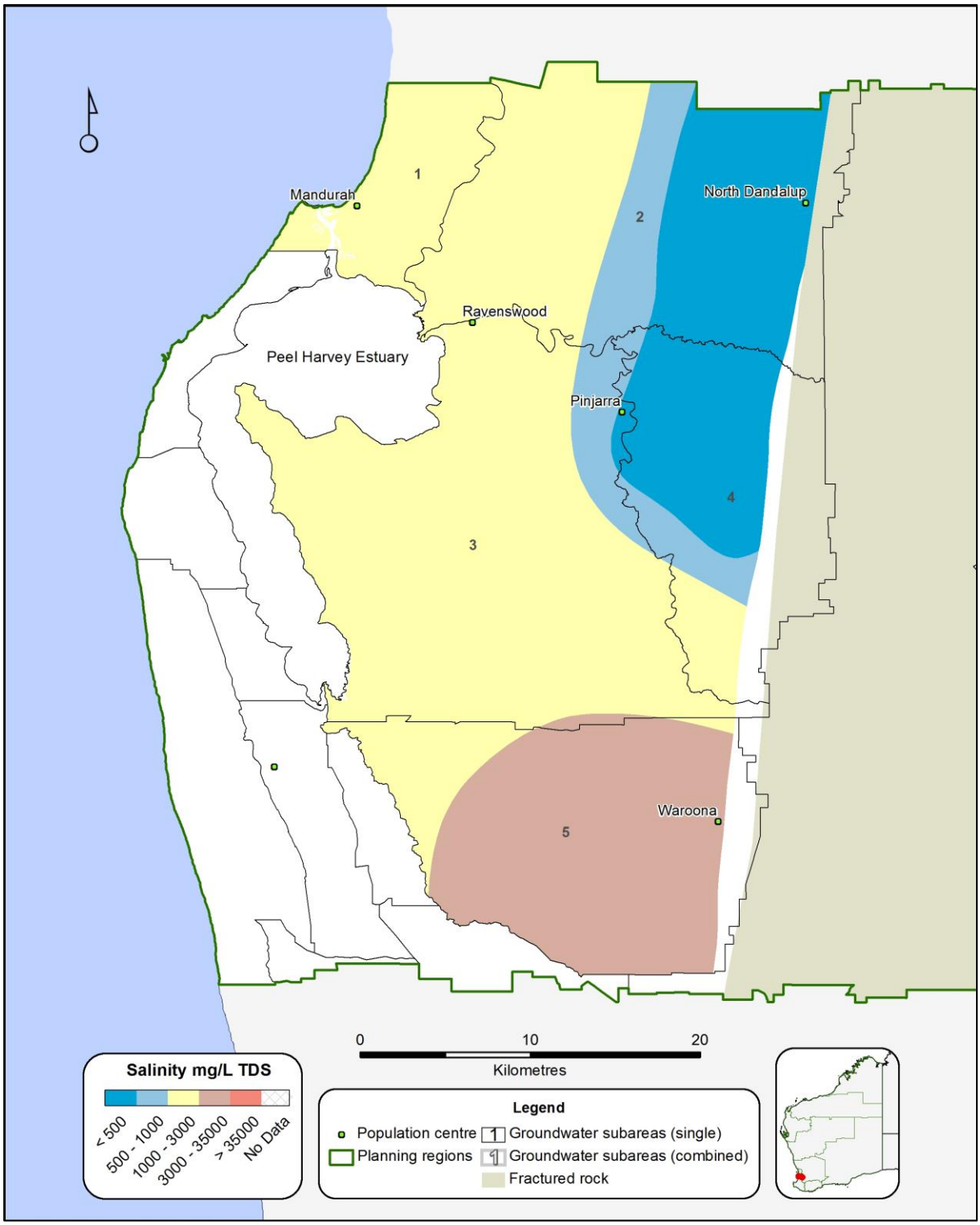

Figure 34 Peel Region deep groundwater resources and water quality

9 South West water resources

Surface water

Surface water is very important in the South West, and provides more than half of the water used in the region. Streams in the Warren and Donnelly catchments, coastal streams between Capel and Augusta, the Preston River and the Collie River and tributaries, flow after winter rains. Seasonal streamflow varies from year to year. The Shannon, Gardner and Deep Rivers east of Warren are also seasonal. The Wellington Reservoir on the Collie River is the largest water storage in the South West.

Water is generally fresh in the smaller streams. The lower tributaries of the main rivers – the Blackwood, Collie and Warren – are fresh, but water is saline in the upper parts of the catchments and along the mainstream channels. The Blackwood River is the largest river in the South West. Below Nannup the river is recharged by fresh groundwater when surface water flows recede in summer. This sustains the river ecology which move into the main channel when the small freshwater tributaries in forested areas dry over summer. Connectivity with groundwater is also important for the Capel and Margaret rivers.

The main uses of surface water in the South West Region are irrigation, industry and town water supply.

Reliably available surface water is fully utilised in the most highly developed subcatchments. There is still surface water available (up to 139 000 ML/year) for further general purpose licensing in less developed catchments across the region.

Part of the Harvey Irrigation District is in the South West Region (see Peel Region). Surface water from the Wellington Reservoir is distributed for irrigation in the Collie River Irrigation District. Poor water quality due to saline inflow from cleared catchments of the upper Collie River constrains the crop options for irrigation. There is some water from the reservoir committed for future industrial use. Releases from the Wellington Reservoir are important for the downstream environment of the lower Collie River.

Even though inflows are generally declining, storage is often not fully drawn down so the reservoir overflows in some years. Water sharing arrangements are in place for years when the storage is relatively low at the end of winter.

Water from the smaller catchments is used for self-supply irrigation, particularly for horticulture and viticulture. Water is primarily taken from small on-stream dams with some direct pumping from streams. To maintain water security for self-supply users, water allocations are set to be highly reliable in all but the driest years. Options for self-supply water users take and store additional water in wetter years are being trialled in fully allocated catchments of the Warren–Donnelly system.

Historically, many of the towns in the region have relied on water from small local dams. In response to the drying climate trend, South West towns are increasingly being supplied by a combination of surface water and groundwater.

Streamflow is generally declining with the drying climate and the drying trend is projected to continue. However, with water sharing, increases in water use efficiency, alternative sources and utilising additional water in wetter years, surface water will continue to provide significant water supplies in the South West.

In the South West Region, surface water abstraction is licensed under a number of irrigation districts, surface water areas and rivers that are proclaimed under the *Rights in Water and Irrigation Act 1914*. Proclaimed surface water areas include Mullalyup, Balingup, Dumpling Gully, Hester, Millstream, Tanjannerup Creek, Cape to Cape North, Brunswick, Geographe Bay, Lower Blackwood, Cape to Cape South, Warren and Donnelly. Proclaimed irrigation districts include Harvey, Collie River and Preston Valley. Proclaimed rivers are the Ferguson and Margaret.

The way in which water is allocated and managed is described in the following allocation plans:

- *Warren-Donnelly surface water allocation plan* (DoW 2012c)
- *Draft Lower Collie surface water allocation plan* (DoW 2011b)
- *Whicher surface water allocation plan* (DoW 2009d)
- *Upper Collie water allocation plan* (DoW 2009c).

Table 33 South West Region surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year[1]	Further water available ML/year[2]	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
Harvey[3]	Logue Brook Reservoir	(6 109)	0	0–500	Declining	High
	Stirling Reservoir	(30 508)	0	0–500	Declining	High
	Harvey Reservoir	(22 214)	0	0–500	Declining	High
	Rivers & tributaries	Not set	-	0–500	Declining	High
Collie (upper)	Harris River	15 000	0	0–500	Stable	High
	Wellington Reservoir	85 100	5 100[4]	1 000–3 000	Declining	High
	Mungalup Reservoir	500	0	500–1 000	Declining	High
	Rivers & tributaries	22 250	19 344	0–35 000	Declining	High
Collie (lower)	Worsley Reservoir	2 600	0	0–500	Declining	High
	Rivers & tributaries	7 645	5 838	500–35 000	Declining	High
Preston Area	Rivers & tributaries	Not set	-	0–35 000	Declining	Medium
Capel River	Rivers & tributaries	10 550	5 536	0–1 000	Declining	Medium
Busselton Coast	Rivers & tributaries	41 430	31 765	0–1 000	Declining	Medium
Middle Blackwood	Rivers & tributaries	Not set	-	0–35 000	Declining	Medium
Lower Blackwood	Rivers & tributaries	42 810	38 516	0–35 000	Declining	Medium
Donnelly River & tributaries	Rivers & tributaries	23 027	13 256	500–1 000	Declining	Medium
Warren River &tributaries	Rivers & tributaries	48 944	16 681	0–35 000	Declining	Medium
Muir-Unicup	Rivers & tributaries	Not set	-	1 000–35 000	Stable	Initial
Shannon-Gardner	Rivers & tributaries	Not set	-	0–500	Declining	Initial
Totals		**(358 687)**	**136 036**			

1 Allocation limits shown in brackets have not been formally set but are an indication of the total volume of water available. These volumes are based on the average inflows to the reservoirs from 2006 to 2011.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

3 The Harvey surface water management area extends north into the Peel Region. Refer to the Peel Region for the remaining surface water resources of the Harvey surface water management area.

4 All unallocated water from the Wellington Reservoir has been applied for and is undergoing licence assessment.

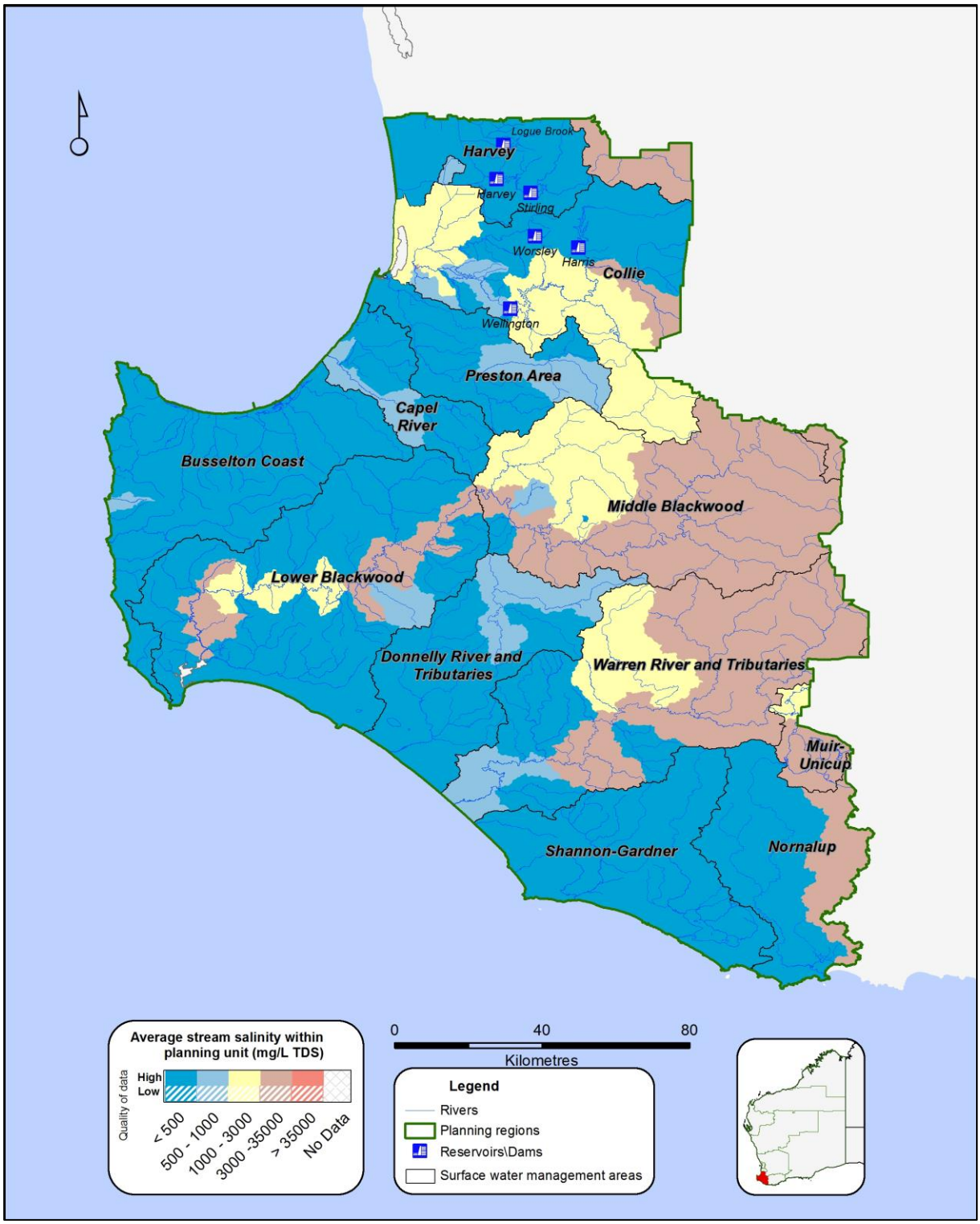

Figure 35 South West Region surface water resources and water quality

Groundwater

The South West Region contains significant fresh groundwater resources stored in a thick succession of sedimentary aquifers of the southern Perth Basin and the Collie Basin.

The major aquifers in the southern Perth Basin are the Superficial, Leederville and Yarragadee.

The smaller Collie Basin sits higher in the landscape, above the Darling Scarp, and is separated from the southern Perth Basin by large expanses of impervious crystalline rock. The Collie Basin is a multi-layered aquifer system and the major aquifers are the Nakina, Muja, Lower Collie Group and the Stockton.

The majority of groundwater is abstracted for public water supply, mining and agriculture. Fractured rock aquifers occur but are relatively minor.

Across the region (apart from in the Collie groundwater area) there is still additional water available (up to 51 000 ML/year) for general purpose licensing. Most of the good water quality resources are now fully allocated or approaching full allocation. In these cases trading can be used to secure additional groundwater entitlements. Many of the groundwater resources where additional water is available for general licensing are small, localised and characterised by more marginal water quality.

The groundwater system of the Collie Basin is highly disturbed due to mining and the need to dewater aquifers for mining below the watertable. Groundwater storage is being depleted by dewatering. The water produced is utilised by the local power industry with some surplus dewater being discharged to the Collie River East Branch. In 2011–12 approximately 16 000 ML of surplus mine dewater was discharged that could have been used opportunistically (opportunistic because it is an unreliable supply). Some recovery of water levels is occurring in the Cardiff subarea of the Collie Basin where mining has ended.

In the southern Perth Basin, water levels in the Superficial aquifer are mostly stable as they are replenished by winter rainfall and the level of use is generally sustainable. However, lower-than-average rainfall over the past decade has contributed to slight declines in some areas. In the Myalup area, the Superficial aquifer is highly utilised for horticulture and is showing signs of unsustainable use. Water quality is deteriorating as a result of fertiliser application and the recycling of salts.

Water levels in the Leederville and Yarragadee aquifers are generally declining. Rates of decline are slightly higher in areas of high abstraction.

The understanding of groundwater in this region has been greatly improved through work carried out by the Department of Water and the Water Corporation over the last decade. Due to the high costs of deep aquifer investigations, information is generally at a regional scale. Local investigations have been completed for those areas with higher levels of abstraction.

Over the past two decades the groundwater monitoring network and the frequency and consistency of data collection have been progressively improved. We are

collecting high resolution water level data using data loggers in critical management areas.

The Department of Water is currently investigating how much abstraction affects the inland movement of the saltwater interface in the southern Swan and Scott coastal plains. This work is funded through the Royalties for Regions program.

Groundwater abstraction in the South West Region is licensed under the Blackwood, Bunbury, Busselton and Collie groundwater areas that are proclaimed under the *Rights in Water and Irrigation Act 1914*.

The following documents describe how groundwater is allocated and managed:

- *South West groundwater areas allocation plan* (DoW 2009b)
- *Kemerton groundwater subareas water management plan* (DoW 2007d)
- *Upper Collie water allocation plan* (DoW 2009c).

Table 34 South West Region shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
South West Coastal groundwater area[2]							
1	Harvey	Perth – Superficial Swan	11 500	9 851	0–1 000	Stable	Medium
2	Lake Preston North	Perth – Superficial Swan	9 300	8 073	0–1 000	Declining	Medium
3	Lake Preston South	Perth – Superficial Swan	10 500	0	0–1 000	Stable	Medium
4	Kemerton Industrial Park North	Perth – Superficial Swan	790	759	0–1 000	Stable	Medium
5	Wellesley	Perth – Superficial Swan	2 150	1 262	0–35 000	Stable	High
6	Myalup	Perth – Superficial Swan	7 350	92	0–1 000	Stable	High
Bunbury groundwater area							
7	Kemerton Industrial Park South	Perth – Superficial Swan	210	2	0–500	No data	Initial
8	Australind	Perth – Superficial Swan	690	0	0–35 000	Stable	High
9	Dardanup	Perth – Superficial Swan	290	0	500–3 000	Declining	Medium
10	Bunbury East	Perth – Blackwood Surficial	5	5	500–3 000	No data	Medium
		Perth – Superficial Swan	645	0	500–3 000	Stable	Medium
11	Bunbury West	Perth – Superficial Swan	2 000	709	500–3 000	Declining	Medium
Busselton-Capel groundwater area							
12	Donnybrook	Perth – Blackwood Surficial	495	18	500–1 000	No data	Initial
		Perth – Superficial Swan	5	5	500–1 000	No data	Initial
13	Busselton-Capel	Perth – Superficial Swan	7 200	3 263	0–35 000	Stable	Medium
		Perth – Blackwood Surficial	800	642	0–35 000	No data	Initial
14	Blackwood Plateau North	Perth – Superficial Swan	5	5	500–1 000	No data	Initial
		Perth – Blackwood Surficial	45	45	500–1 000	No data	Initial

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012

[2] The South West Coastal groundwater area extends north into the Peel Region. Refer to the Peel Region for the remaining shallow groundwater resources of the South West Coastal groundwater area.

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
15	Dunsborough-Vasse	Perth – Superficial Swan	3 660	224	0–35 000	Stable	Initial
		Leeuwin – Surficial	20	19	0–35 000	No data	Initial
		Perth – Blackwood Surficial	670	0	0–35 000	No data	Initial
16	Cowaramup	Perth – Blackwood Surficial	890	0	500–1 000	No data	Initial
		Leeuwin – Surficial	10	0	500–1 000	No data	Initial
17	Cape to Cape North	Perth – Blackwood Surficial	55	0	1 000–3 000	No data	Initial
		Leeuwin – Surficial	780	20	1 000–3 000	No data	Initial
Blackwood groundwater area							
18	Blackwood Plateau South	Perth – Blackwood Surficial	45	42	500–1000	No data	Initial
		Perth – Superficial Scott	5	5	500–1000	No data	Medium
19	Rosa	Leeuwin – Surficial	5	5	500–1000	No data	Initial
	Rosa	Perth – Blackwood Surficial	165	3	500–1000	No data	Initial
20	Cape to Cape South	Perth – Superficial Scott	5	5	500–3000	No data	Initial
		Perth – Blackwood Surficial	10	0	500–3000	No data	Initial
		Leeuwin – Surficial	485	183	500–3000	No data	Initial
21	Beenup	Leeuwin – Surficial	5	5	0–1000	No data	Initial
		Perth – Blackwood Surficial	25	22	0–1000	No data	Initial
		Perth – Superficial Scott	1 370	1 360	0–1 000	Stable	Initial
22	Scott	Perth – Blackwood Surficial	10	10	0–1 000	No data	Initial
		Perth – Superficial Scott	1 990	1 485	0–1 000	Stable	Medium
23	Jasper	Perth – Superficial Scott	1 800	1 712	0–500	Stable	Medium
		Perth – Blackwood Surficial	200	200	0–500	No data	Initial
Collie groundwater area							
24	Cardiff	Collie – Muja.	1 790	0	0–500	Increasing	High
		Collie – Nakina	0	0	0–500	Increasing	High
25	Premier	Collie – Nakina	0	0	0–500	Declining	High
		Collie – Muja.	0	0	0–500	Declining	High
Totals			**67 975**	**30 031**			

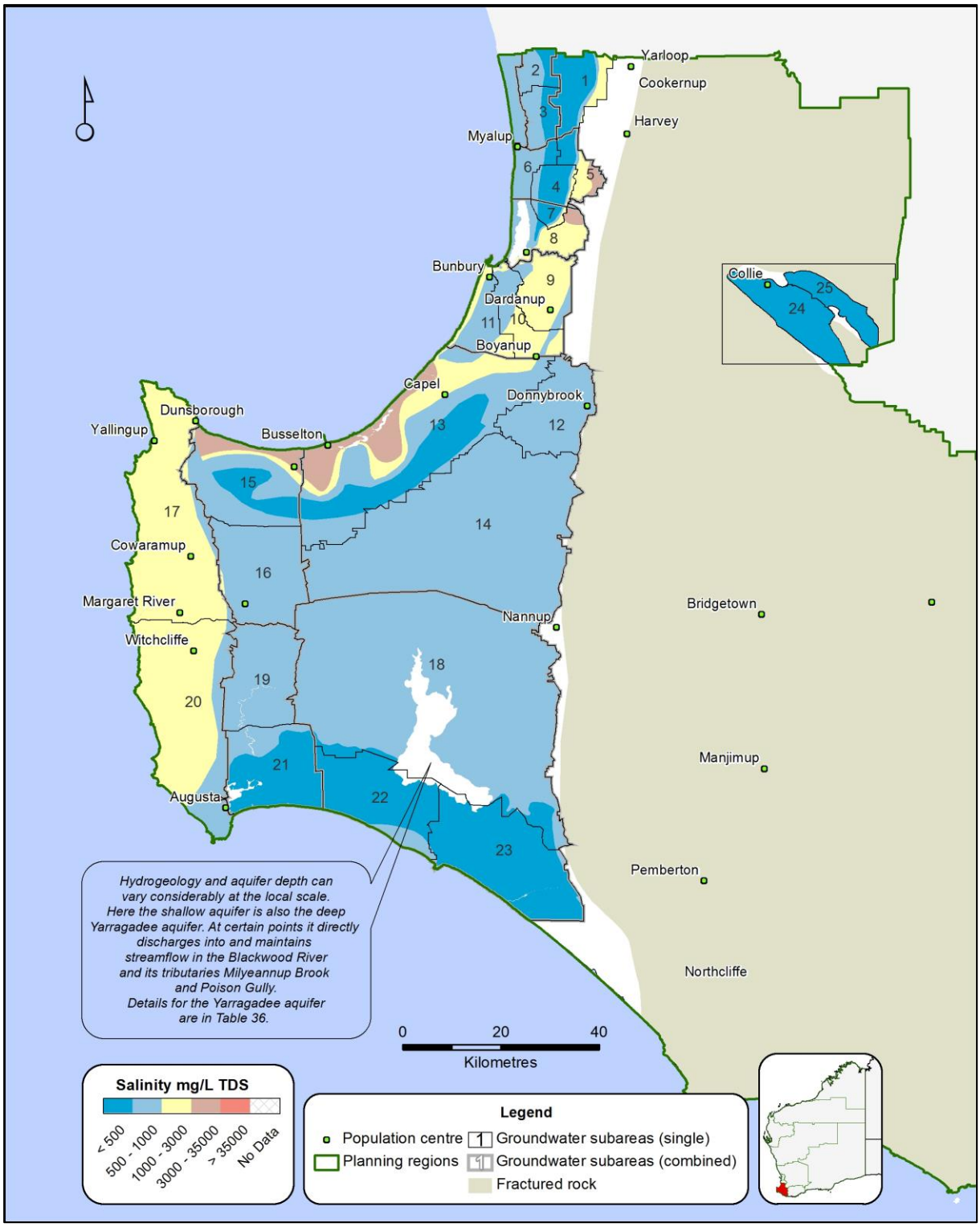

Figure 36 South West Region shallow groundwater resources and water quality

Table 35 South West Region middle groundwater resources and status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
South West Coastal groundwater area[3]							
1	Lake Preston	Perth – Leederville.	500	0	500–3 000	No data	Medium
2	Harvey	Perth – Leederville.	50	50	1 000–35 000	Stable	Medium
3	Kemerton North	Perth – Leederville.	3 500	19	1 000–35 000	Declining	Medium
Bunbury groundwater area							
4	Kemerton South	Perth – Leederville.	5 000	0	0–1 000	Declining	Medium
5	Dardanup	Perth – Leederville.	3 500	1	0–1 000	Declining	Medium
6	Bunbury East	Perth – Leederville.	2 000	0	0–1 000	Declining	High
7	Bunbury West	Perth – Leederville.	35	24	No data	No data	High
Busselton-Capel groundwater area							
8	Donnybrook	Perth – Leederville.	2 400	0	0–500	Declining	Medium
9	Busselton-Capel	Perth – Leederville.	10 500	2667	0–3 000	Declining	Medium
10	Blackwood Plateau North	Perth – Leederville.	250	128	0–500	Declining	Medium
11	Dunsborough-Vasse	Perth – Leederville.	5 400	0	0–3 000	Declining	Medium
12	Cape to Cape North	Perth – Leederville.	205	175	No data	No data	Initial
13	Cowaramup	Perth – Leederville.	1 595	735	0–500	Declining	Medium
Blackwood groundwater area							
14	Blackwood Plateau South	Perth – Leederville.	250	39	0–1 000	Declining	Medium
15	Rosa	Perth – Leederville.	930	259	0–1 000	Declining	Medium
16	Cape to Cape South	Perth – Leederville.	130	130	No data	No data	Initial
17	Beenup	Perth – Leederville.	950	751	0–1 000	Stable	Medium
18	Scott	Perth – Leederville.	3 200	3096	0–500	Stable	Medium
19	Jasper	Perth – Leederville.	50	50	0–500	Stable	Medium
Collie groundwater area							
20	Cardiff	Collie – Lower Collie Group.	2 510	0	0–500	Increasing	High
21	Premier	Collie – Lower Collie Group.	2 200	0	0–500	Declining	High
Totals			**45 155**	**8124**			

[1] A full stop at the end of the aquifer name identifies that it is a confined resource. The Leederville is mostly confined in the southern Perth Basin.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[3] The South West Coastal groundwater area extends north into the Peel Region. Refer to the Peel Region for the remaining middle level groundwater resources of the South West Coastal groundwater area.

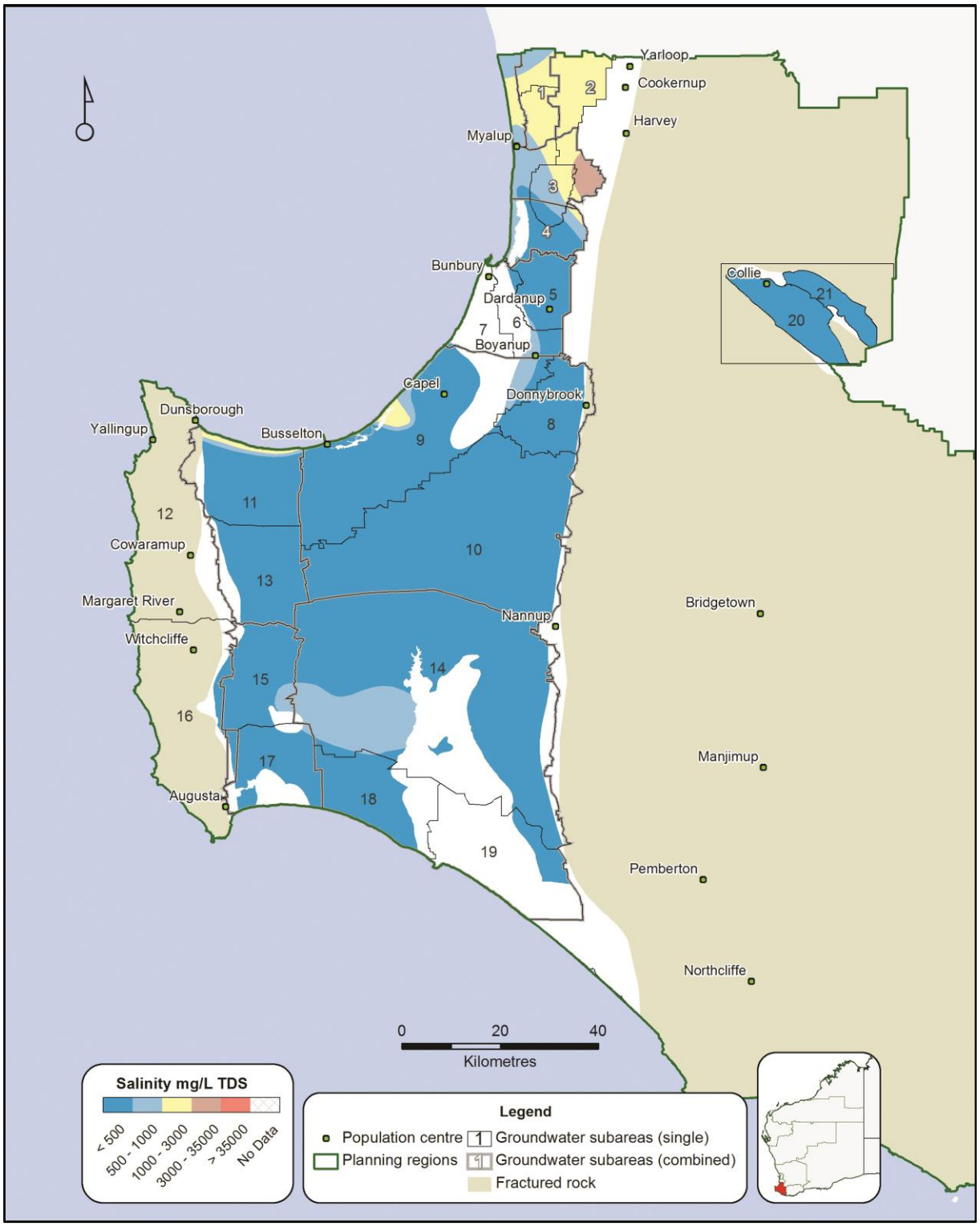

Figure 37 South West Region middle groundwater resources and water quality

Table 36 South West Region deep groundwater resources and their status

Map legend	Groundwater subarea	Aquifer[1]	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
South West Coastal groundwater area[3]							
1	Kemerton North	Perth – Cattamarra Coal Measures.		6 000	500–35 000	Stable	Initial
Bunbury groundwater area							
2	Kemerton South	Perth – Cattamarra Coal Measures.	4 000	3 008	0–3 000	Declining	Initial
3	Bunbury-Yarragadee	Perth – Yarragadee South.	26 500	310	0–500	Declining	Medium
Busselton-Capel groundwater area							
4	Busselton-Yarragadee	Perth – Yarragadee South.	45 500	0	0–500	Declining	Medium
5	Cowaramup-Vasse	Perth – Sue Coal Measures.	3 500	2 550	0–3 000	Declining	Initial
		Perth – Lesueur Sandstone South.	500	500	0–3 000	No data	Initial
Blackwood groundwater area							
6	Cape to Cape South	Perth – Lesueur Sandstone South.	10	0	0–500	No data	Initial
7	Rosa-Beenup	Perth – Sue Coal Measures.	0	0	0–3 000	Declining	Initial
		Perth – Yarragadee South.	0	0	0–3 000	No data	Initial
		Perth – Lesueur Sandstone South.	4 000	27	0–3 000	Declining	Initial
8	Blackwood-Yarragadee	Perth – Sue Coal Measures.	0	0	0–500	No data	Initial
		Perth – Lesueur Sandstone South.	0	0	0–500	No data	Initial
		Perth – Yarragadee South	0	0	0–500	Declining	High
		Perth – Yarragadee South.	14 410	10	0–500	Declining	High
Collie groundwater area							
9	Cardiff	Collie – Stockton.	0	0	0–500	Increasing	Medium
10	Premier	Collie – Stockton.	0	0	0–500	Declining	Medium
Totals			**104 420**	**12 405**			

1 A full stop at the end of the aquifer name identifies that it is a confined resource. The Yarragadee is mostly confined in the southern Perth Basin.

2 Water available for general purpose licensing from the general allocation limit component as of June 2012.

3 The South West Coastal groundwater area extends north into the Peel Region. Refer to the Peel Region for the remaining deep groundwater resources of the South West Coastal groundwater area.

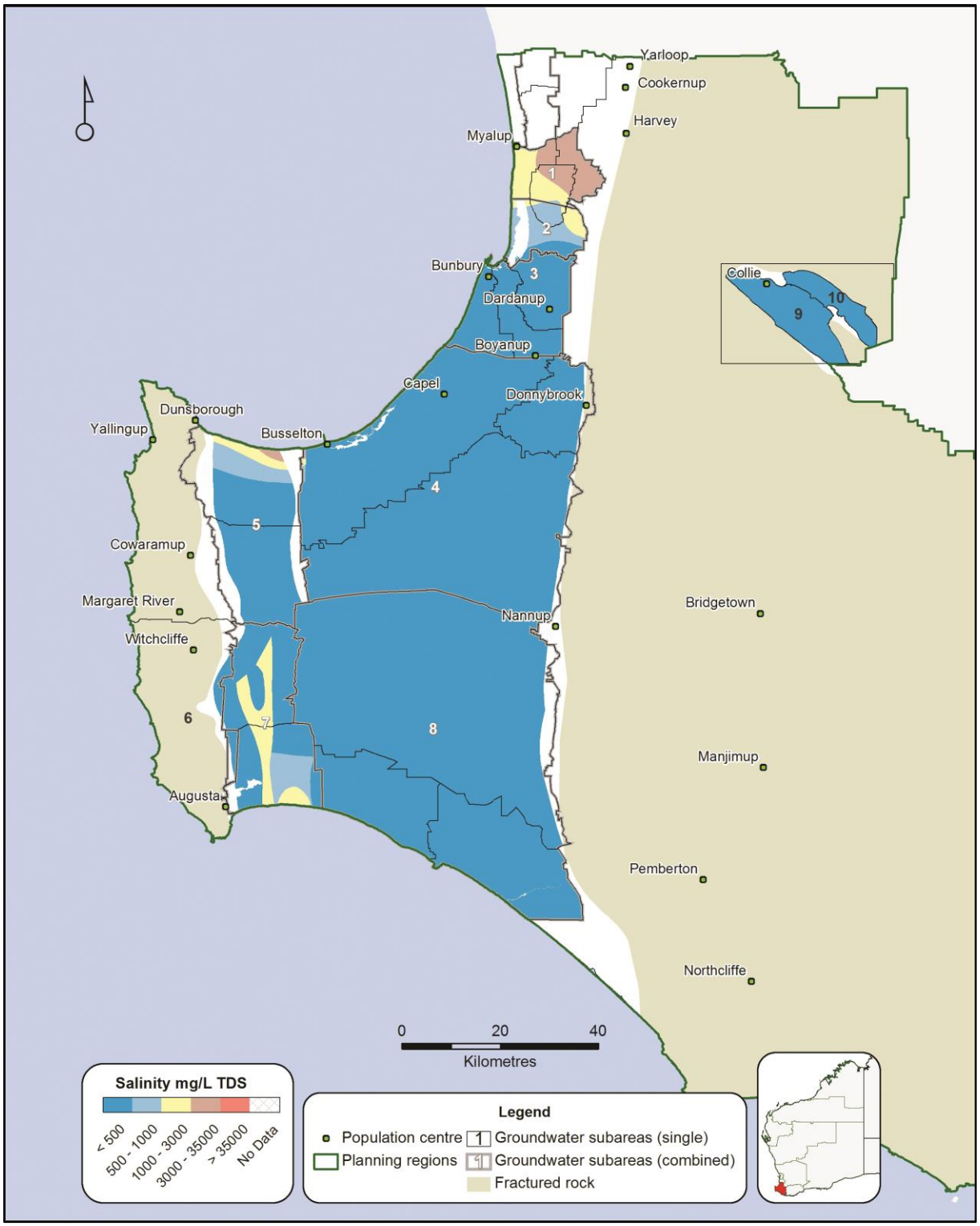

Figure 38 South West Region deep groundwater resources and water quality

10 Great Southern water resources

Surface water

The Great Southern Region contains more than 50 mostly small, southward flowing rivers. These rivers and their tributaries are generally fresh and perennial to the west, and intermittent and more naturally saline to the east and away from the coast.

Surface water use in the Great Southern Region is relatively low. The main uses are small-scale irrigated agriculture and public water supply. The Angove River in the Albany Coast area is one of the sources for the Lower Great Southern Town Water Supply Scheme which supplies the towns of Albany and Mount Barker. Denmark and Walpole have local surface water supplies. Surface water from the Harris Dam, outside the Great Southern Region, supplies towns on the Great Southern Town Water Supply Scheme.

Surface water supplements the predominantly groundwater-sourced Lower Great Southern Town Water Supply Scheme. Surface water is the principal source for hinterland towns not connected to the scheme and in dry seasons these towns are supplied by carting water from the scheme.

Streamflow is declining in response to our drying climate and flows are variable from year to year. Water harvesting in wetter years potentially provides options for future sources – either for aquifer recharge or through small storages to complement groundwater.

Currently, only the surface water resources for public or local water supply are proclaimed and require water licensing – Angove (Two People's Bay surface water area) is used for public water supply, Bolganup Creek is used for local, non-potable supply and Limeburner's Creek is licensed for public water supply, but is not used due to poor water quality. Surface water is used for irrigation in some areas, including the Denmark River and Marbelup Brook catchments, but these areas are currently not proclaimed under the *Rights in Water and Irrigation Act 1914* and so licensing is not required.

Table 37 Great Southern Region surface water resources and their status

Surface water management area	Resource description	Allocation limit (sum of all components) ML/year	Further water available ML/year	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
Albany Coast	Rivers & tributaries	Not set	–	0–35 000	Declining	Initial
Nornalup	Rivers & tributaries	Not set	–	0–35 000	Declining	Initial
Kent	Rivers & tributaries	Not set	–	0–35 000	Declining	Initial
Denmark	Rivers & tributaries	Not set	–	0–35 000	Declining	Medium
Totals		**Not set**	**–**			

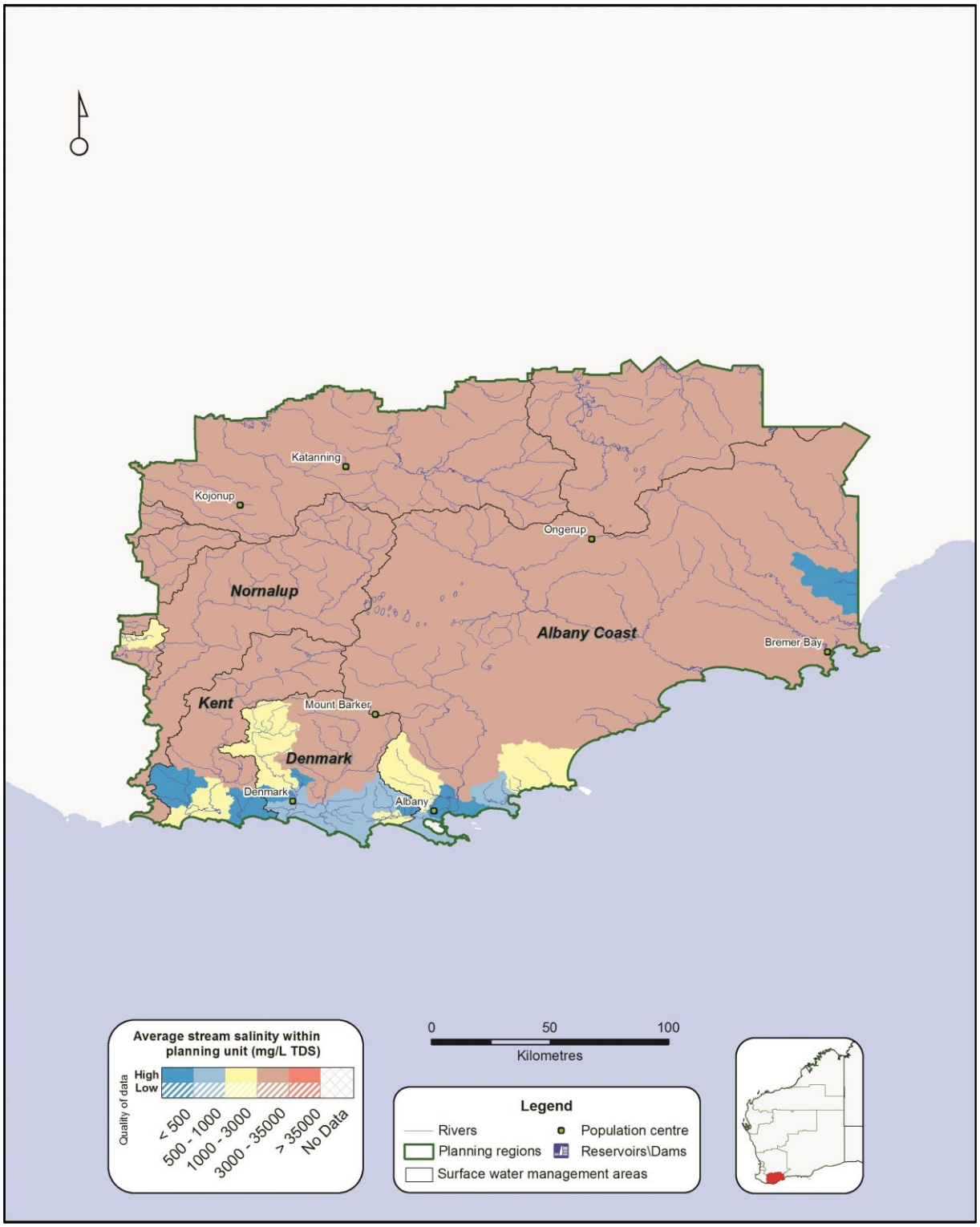

Figure 39 Great Southern Region surface water resources and water quality

Groundwater

Groundwater resources across the Great Southern Region are limited to a narrow and relatively small multi-layered sedimentary basin – the Bremer Basin. Fractured rock and other sparse aquifers occur in parts of the region. Groundwater quality varies. Good quality water from the Bremer Basin is pumped for the public water supply of Albany and Bremer Bay. Water levels across both the Albany and Bremer Bay groundwater areas are generally stable, or showing small declines. Levels fluctuate seasonally. The other small aquifers do not provide a significant supply and are not utilised much.

Across the region there is about 180 ML/year of groundwater available for further general purpose licensing though there are only very small volumes available from any one resource.

The Department of Water has detailed information on the groundwater resources in Albany and Bremer Bay. This is largely due to the monitoring and reporting undertaken by the Water Corporation as a condition of their licences to abstract groundwater. Because resources are small and use is low, information about other groundwater resources in the region is limited.

The Department of Water is currently investigating the potential of the Superficial and Sedimentary (Middle Sand and Werrillup) aquifers of the Bremer Basin for future water supplies. As part of this investigation we will assess the risk of seawater intrusion from pumping. This work is funded through the Royalties for Regions program.

Groundwater abstraction in the Great Southern Region is licensed in the Albany and Bremer Bay groundwater areas that are proclaimed under the *Rights in Water and Irrigation Act 1914*.

Table 38 Great Southern Region shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year[1]	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Bremer Bay groundwater area							
1	Bremer Bay	Bremer West – Superficial	200	21	500–1000	Stable	Medium
Albany groundwater area							
2	Marbelup	Bremer West – Superficial	135	0	No data	No data	Medium
3	Grasmere	Bremer West – Superficial	75	2	0–500	Stable	Medium
4	Racecourse	Bremer West – Superficial	850	0	No data	No data	Medium
5	Prison	Bremer West – Superficial	1 205	113	No data	No data	Medium
6	Sandpatch	Bremer West – Superficial	1 750	3	No data	No data	Medium
7	Frenchmans Bay	Bremer West – Superficial	30	12	No data	No data	Medium
Totals			**4 245**	**151**			

[1] Allocation limits are under review following recent resource investigations.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

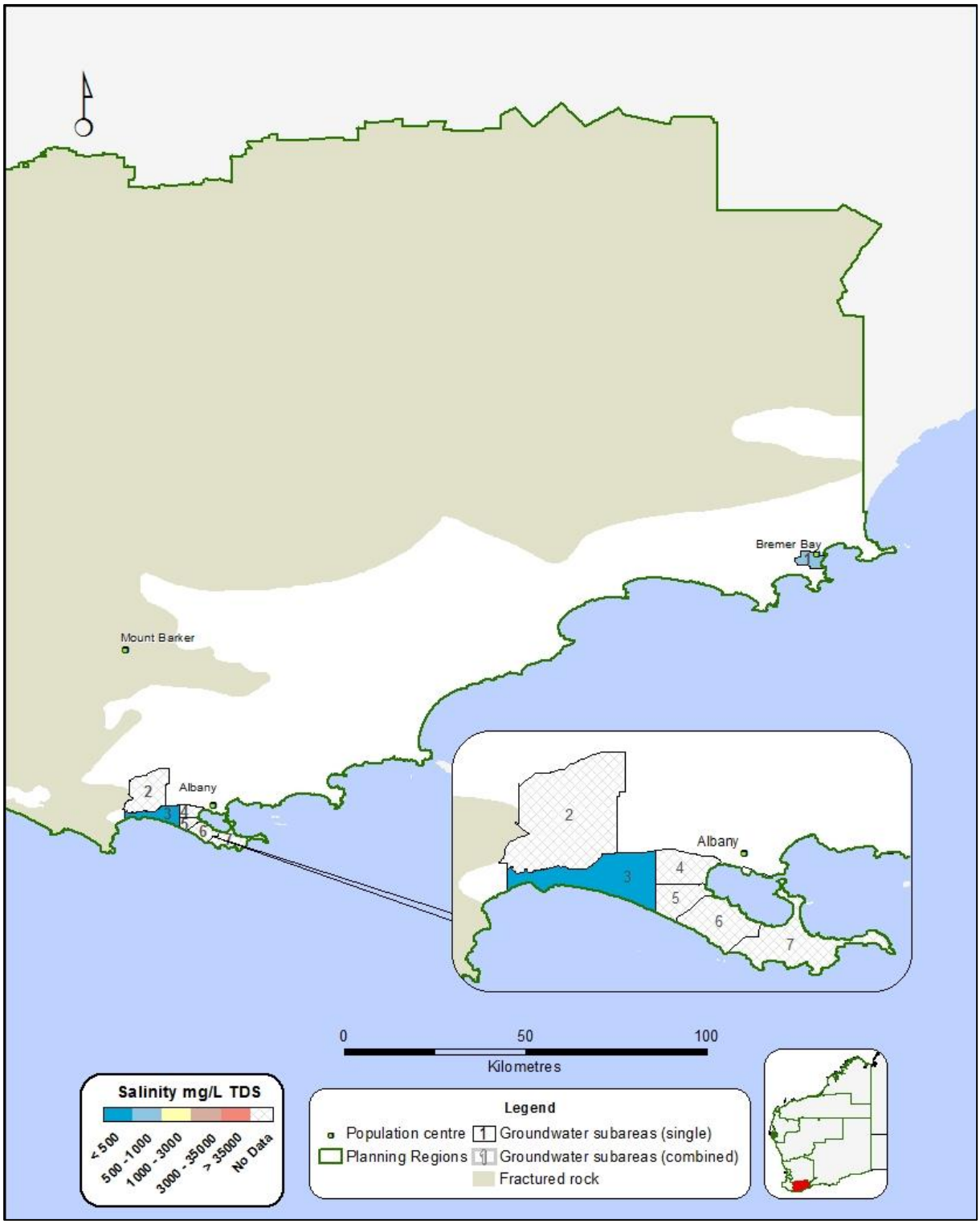

Figure 40 Great Southern Region shallow groundwater resources and water quality

Table 39 Great Southern Region middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year[1]	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Bremer Bay groundwater area							
1	Bremer Bay	Bremer West – Sedimentary	30	30	500–1 000	Stable	Medium
Albany groundwater area							
2	Marbelup	Bremer West – Sedimentary	Not set	-	No data	No data	Initial
3	Grasmere	Bremer West – Sedimentary	1 500	0	0–500	Stable	Medium
4	Racecourse	Bremer West – Sedimentary	Not set	-	0–500	Stable	Medium
5	Prison	Bremer West – Sedimentary	Not set	-	0–500	Stable	Medium
6	Sandpatch	Bremer West – Sedimentary	Not set	-	0–500	Stable	Medium
7	Frenchmans Bay	Bremer West – Sedimentary	900	0	No data	No data	Medium
Totals			**2 430**	**30**			

[1] Allocation limits are under review following recent resource investigations.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

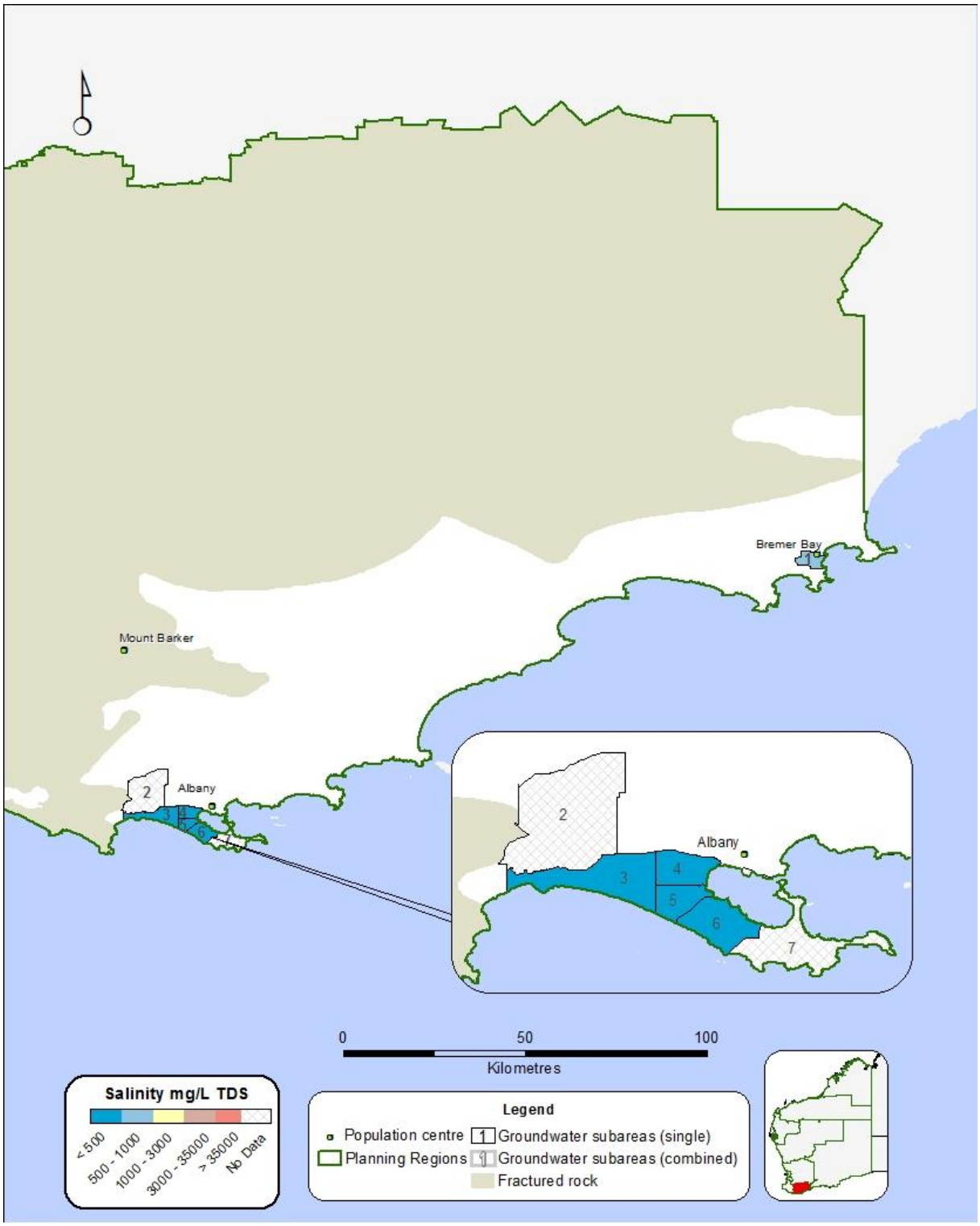

Figure 41 Great Southern Region middle groundwater resources and water quality

11 Goldfields–Esperance water resources

Surface water

The little rainfall that the Goldfields–Esperance region receives is intermittent. South flowing rivers along the Esperance coast are mostly quite short, and reach estuaries that open to the ocean infrequently. Longer, internally draining rivers in the Goldfields Region tend to be ephemeral and hyper saline.

The climate and drainage pattern means that fresh surface water is limited.

Surface water in the region is generally insignificant as a water supply. The only commercial surface water use is from the Jerdacuttup River. Town supplies for much of the region are piped from Perth through the Goldfields and Agricultural Water Supply Scheme.

Surface water abstraction in the Goldfields–Esperance region is licensed in the Ravensthorpe surface water area which is proclaimed under the *Rights in Water and irrigation Act 1914*. No other areas are proclaimed for surface water licensing across the region.

Table 40 Goldfields–Esperance Region surface water resources and their status

Surface water management area[1]	Resource description	Allocation limit (sum of all components) ML/year	Further water available ML/year	Average stream salinity range within planning unit mg/L TDS	Average annual streamflow trend	Level of technical information
Warburton	Inland desert	Not set	–	No data	Not assessed	Initial
Salt Lake Basin	Inland desert	Not set	–	No data	Not assessed	Initial
Nullarbor	Inland desert	Not set	–	No data	Not assessed	Initial
Esperance Coast	Rivers & tributaries	Not set	–	0–35 000	Not assessed	Medium
Totals		**Not set**	**–**			

[1] The Warburton and Nullarbor surface water management areas cover a very large area to the north and east of the map area. They are not shown due to the scale of the map.

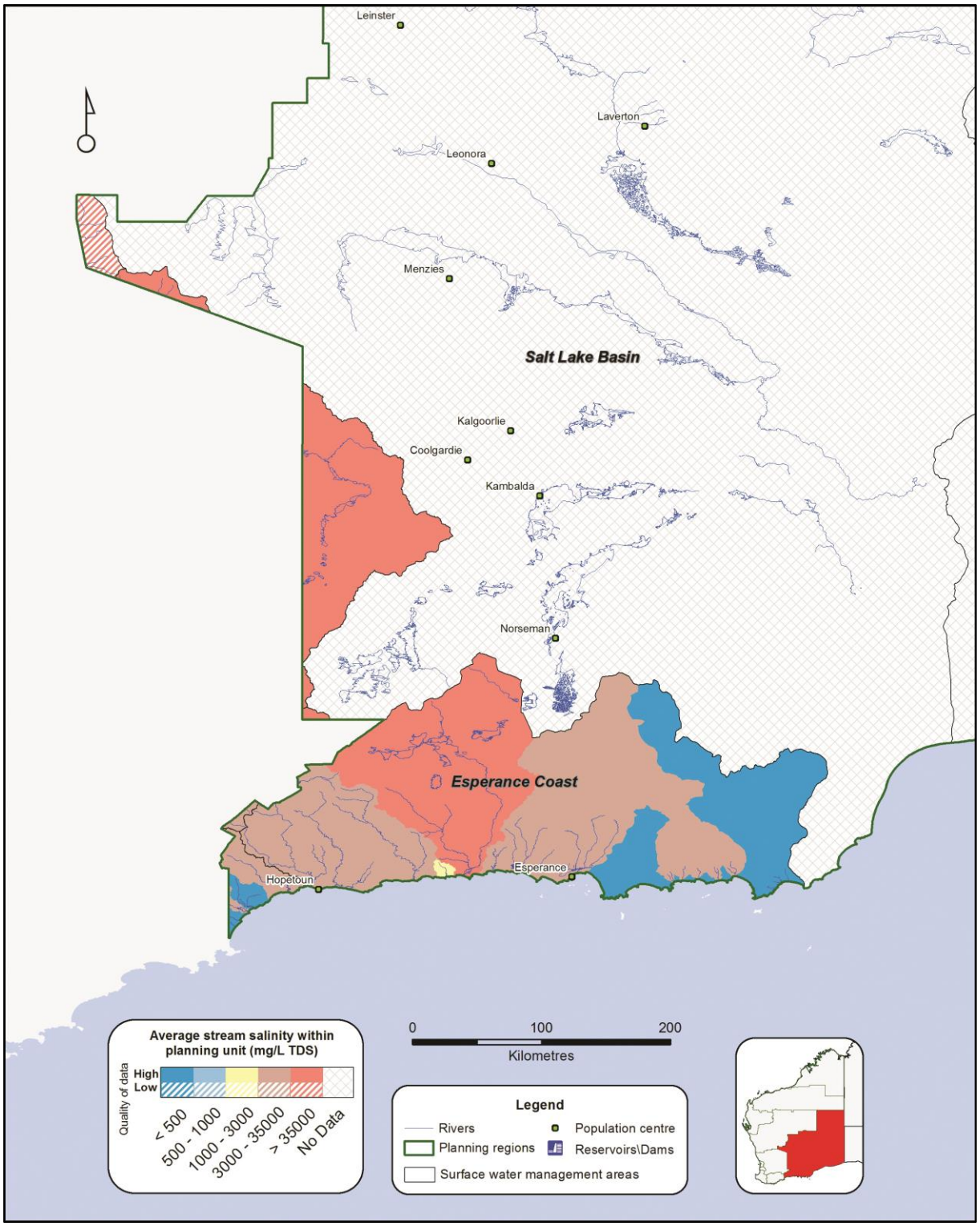

Figure 42 Goldfields–Esperance Region surface water resources and water quality

Groundwater

Across the Esperance–Goldfields region groundwater is a vital and valuable resource. In the Goldfields Region, because recharge is low, groundwater resources are saline and essentially non-renewable, yet groundwater is the only water supply option for much of the region.

The region covers a large area and large volumes of groundwater of various qualities are stored in several types of aquifer systems including confined palaeochannels; unconfined alluvial and calcrete aquifers; fractured rock; and the Eucla, Officer and Bremer sedimentary basins.

Groundwater in palaeochannels tends to be hyper saline, and other aquifers can range from fresh to brackish to saline. Fresh groundwater occurs in the Bremer Basin near the coast where rainfall is higher.

Public water supply for coastal towns is mainly drawn from local aquifers of the Bremer Basin. Groundwater levels are generally declining in the Hopetoun groundwater area and there are some declines in the Superficial aquifer in the Esperance groundwater area, but trends are generally stable in other areas.

In the Goldfields Region, large quantities of variable quality, local groundwater is pumped for fit-for-purpose gold and nickel mining and ore processing.

Across the region there is a further 64 000 ML/year of groundwater available for general purpose licensing from the sedimentary aquifer resources. While the coastal Bremer Basin is largely allocated, additional water for future fit-for-purpose use is available from other areas and from fractured rock aquifers. Water quality and yield are quite variable and subject to aquifer characteristics and location.

The department has technical information for most sedimentary resources across the region and detailed information for those resources abstracted for public water supply. Detailed water information associated with mining supports site-specific water management.

Groundwater abstraction in the Goldfields–Esperance Region is licensed under the proclaimed Condingup, Esperance, Gibson, Goldfields, Hopetoun and Nullarbor groundwater areas. The way in which water is allocated and managed in Esperance is described in the *Esperance groundwater area water management plan* (DoW 2007c).

Table 41 Goldfields–Esperance Region shallow groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Goldfields groundwater area							
1	Great Victoria Desert	Eucla – Surficial	100	100	3 000–35 000	Stable	Initial
		Officer – Surficial	50 000	50 000	3 000–35 000	Stable	Initial
		Eucla – Limestone	100	100	3 000–35 000	Stable	Initial
2	Minigwal	Eucla – Limestone	100	100	>35 000	Stable	Initial
		Officer – Surficial	100	100	>35 000	Stable	Initial
		Eucla – Surficial	100	100	>35 000	Stable	Initial
Nullarbor groundwater area							
3	Nullarbor	Eucla – Limestone	Not set	-	500–3 000	Stable	Initial
		Bremer East – Superficial	Not set	-	500–3 000	Stable	Initial
		Eucla – Surficial	Not set	-	500–3 000	Stable	Initial
Esperance groundwater area							
4	Warden	Bremer East – Superficial	Not set	-	No data	No data	Initial
5	Butty	Bremer East – Superficial	4 200	3 250	0–500	Stable	Initial
6	Twilight	Bremer East – Superficial	700	42	0–500	Stable	Initial
7	Town	Bremer East – Superficial	1 900	239	0–500	Declining	Medium
Hopetoun groundwater area							
8	Springdale West	Bremer East – Superficial	16	4	500–1 000	Declining	Initial
9	Springdale	Bremer East – Superficial	16	16	500–1 000	Declining	Initial
10	Town of Hopetoun	Bremer East – Superficial	16	16	500–1 000	Stable	Initial
Gibson groundwater area							
11	Gibson	Bremer East – Superficial	30	25	500–1 000	Stable	Medium
		Bremer East – Sedimentary	50	25	500–1 000	Stable	Medium
Condingup groundwater area							
12	Condingup	Bremer East – Superficial	10	10	No data	No data	Medium
East Murchison groundwater area[2]							
13	Officer	Officer – Surficial	-	-	500–35 000	No data	Initial
		Officer – Grant	-	-	1 000 – 3 000	No data	Initial
Totals			**57 438**	**54 127**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The East Murchison groundwater area extends into the Mid West region. Refer to the Mid West region for the allocation limits and water available from the East Murchison groundwater area.

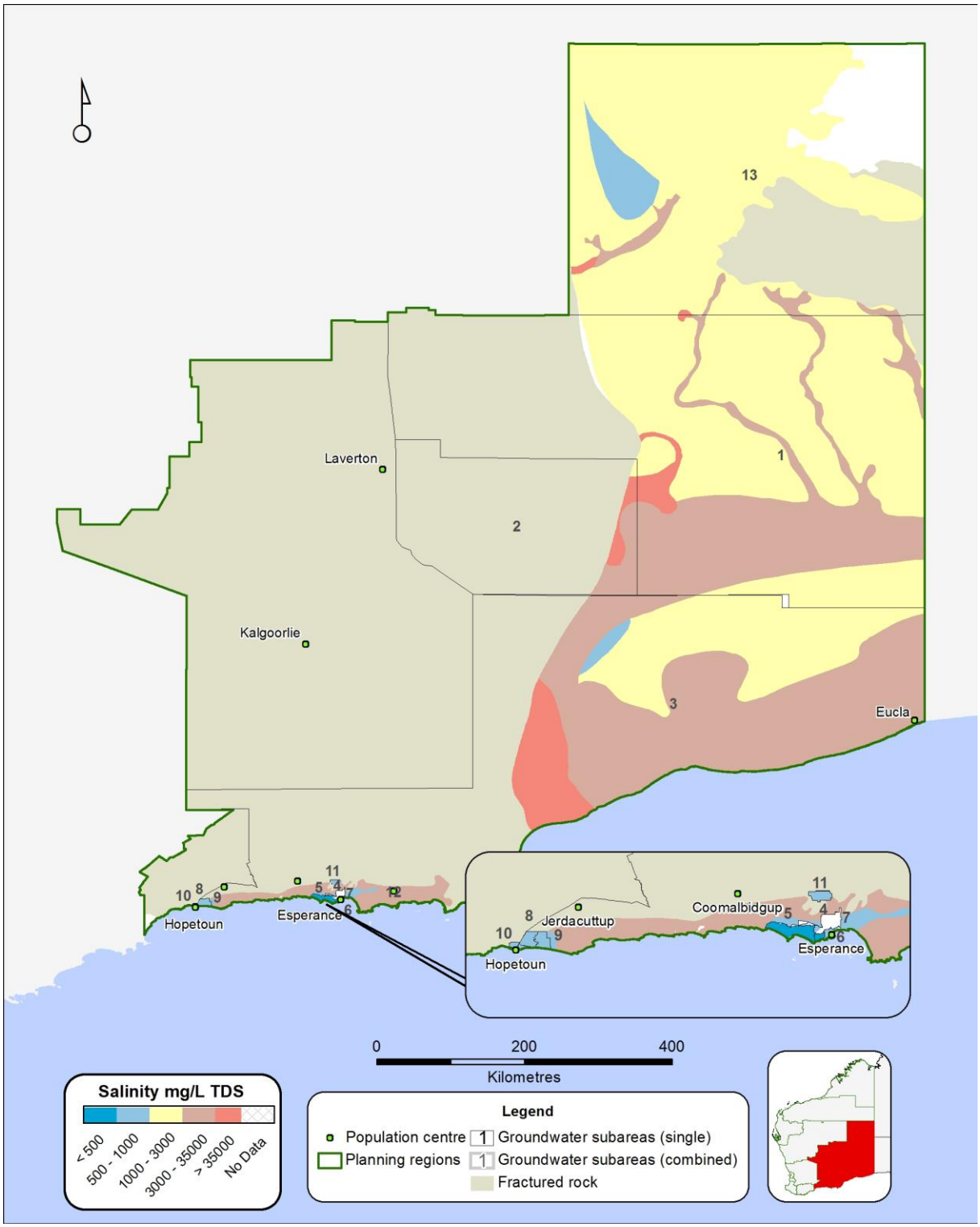

Figure 43 Goldfields–Esperance Region shallow groundwater resources and water quality

Table 42 Goldfields–Esperance Region middle groundwater resources and their status

Map legend	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[1]	Salinity range mg/L TDS	Water level trend	Level of technical information
Goldfields groundwater area							
1	Great Victoria Desert	Officer – Sedimentary	10 000	10 000	No data	Stable	Initial
		Eucla – Hampton	100	100	1 000–35 000	Stable	Initial
2	Minigwal	Officer – Sedimentary	100	100	No data	Stable	Initial
		Eucla – Hampton	100	100	3 000–35 000	Stable	Initial
Nullarbor groundwater area							
3	Nullarbor	Eucla – Hampton	Not set	-	3 000–35 000	Stable	Initial
		Bremer East – Sedimentary	Not set	-	No data	Stable	Initial
Esperance groundwater area							
4	Warden	Bremer East – Sedimentary	Not set	-	No data	No data	Initial
5	Butty	Bremer East – Sedimentary	Not set	-	No data	No data	Initial
6	Twilight	Bremer East – Sedimentary	Not set	-	No data	No data	Initial
7	Town	Bremer East – Sedimentary	Not set	-	No data	No data	Initial
Hopetoun groundwater area							
8	Springdale West	Bremer East – Sedimentary	75	0	500–1 000	Declining	Medium
9	Springdale	Bremer East – Sedimentary	150	0	500–1 000	Declining	Medium
10	Town of Hopetoun	Bremer East – Sedimentary	80	0	500–1 000	Stable	Medium
Condingup groundwater area							
11	Condingup	Bremer East – Sedimentary	50	30	500–1 000	Stable	Medium
East Murchison groundwater area[2]							
12	Officer	Officer – Sedimentary	-	-	1 000–3 000	No Data	Initial
Totals			**10 655**	**10 330**			

[1] Water available for general purpose licensing from the general allocation limit component as of June 2012.

[2] The East Murchison groundwater area extends into the Mid West Region. Refer to the Mid West region for the allocation limits and water available from the East Murchison groundwater

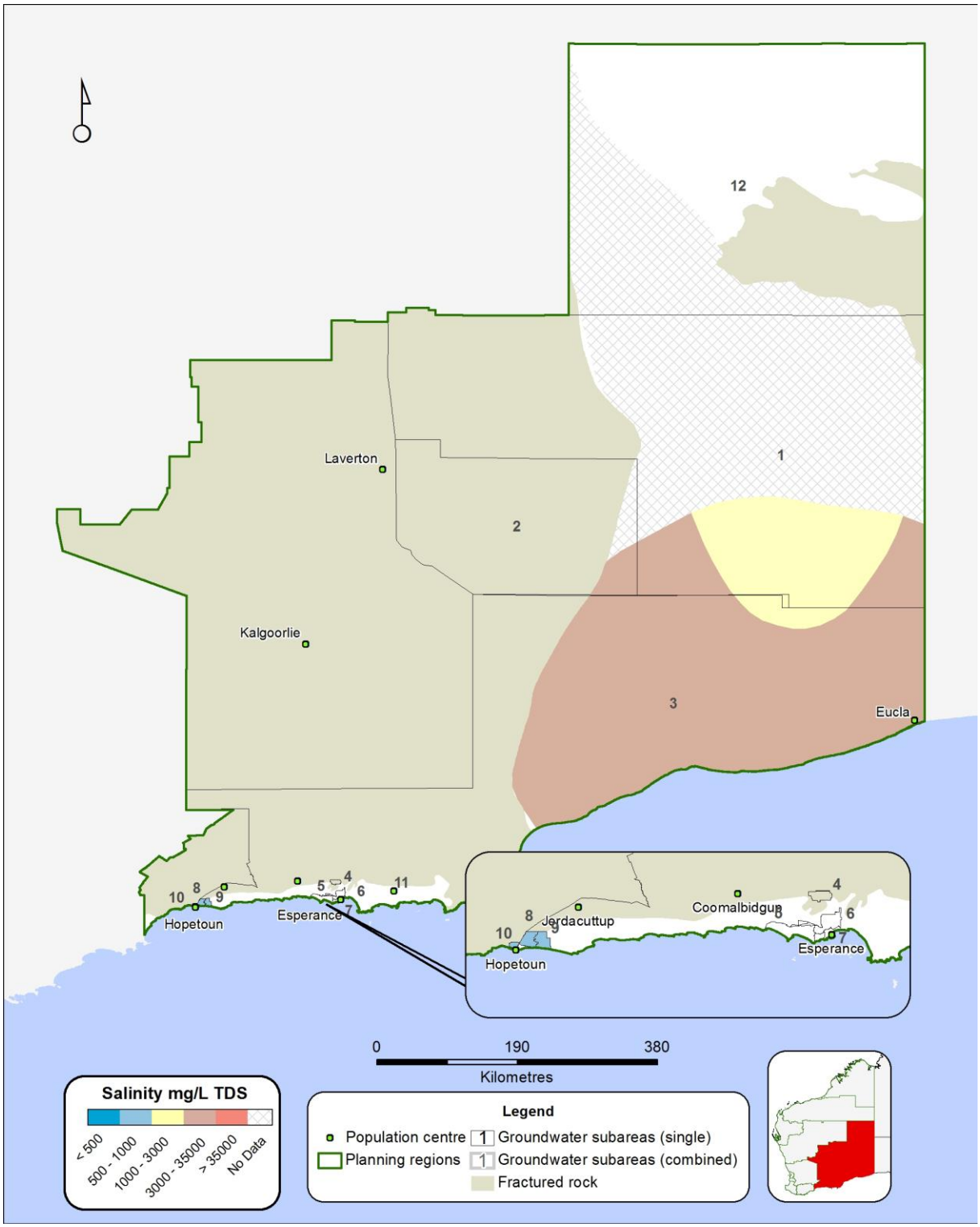

Figure 44 Goldfields–Esperance Region middle groundwater resources and water quality

Table 43 Goldfields–Esperance Region deep groundwater resources and their status

Map legend[1]	Groundwater subarea	Aquifer	Allocation limit (sum of all components) ML/year	Further water available ML/year[2]	Salinity range mg/L TDS	Water level trend	Level of technical information
Goldfields groundwater area							
1	Great Victoria Desert	Eucla – Loongara	100	100	No data	Stable	Initial
2	Minigwal	Eucla – Loongara	100	100	No data	Stable	Initial
Nullarbor groundwater area							
3	Nullarbor	Eucla – Loongara	Not set	–	No data	Stable	Initial
Totals			**200**	**200**			

[1] No map provided as there is no water quality data to show.

[2] Water available for general purpose licensing from the general allocation limit component as of June 2012.

Appendices

Appendix A — State-wide surface water map (Figure 1) accompanying details

Department of Planning region	Total volume under allocation limits GL/year[1]	Water availability status	DWAID[2] resources included
Kimberley	905	Available	Ord River and tributaries surface water management area - Carlton-Mantinea (Kununurra Diversion Dam), Upper Ord and the Main Ord River (Lake Argyle) used for irrigated agriculture and hydro-power generation While there is actually a large volume of surface water available under allocation limits (529 GL/year) in the Ord area, water demand for existing and future irrigation, and current obligations to hydro-power generation, mean that the resources are effectively fully committed today
Pilbara	–	Not applicable	Allocation limits have not been set
Gascoyne	–	Not applicable	Allocation limits have not been set
Midwest	–	Not applicable	Allocation limits have not been set
Wheatbelt	4	Fully allocated	Gingin Brook & tributaries surface water management area – all rivers and tributaries used for self-supply
Perth North	0.5	Over allocated	Swan River & tributaries surface water management area – Brockman and Marbling rivers used for self-supply
	(13)	Fully allocated	Helena River surface water management area – Mundaring Reservoir and Lower Helena pumpback used for public water supply
Perth South	(23)	Fully allocated	Canning River surface water management area - New Victoria, Canning, Churchman's Brook, Wungong reservoirs and Canning pipehead used for public water supply
Peel	(25)	Fully allocated	Dandalup River System surface water management area – North and South Dandalup reservoirs and South Dandalup pumpback and Conjurunup Creek pipehead used for public water supply
Peel & South West	(70)	Fully allocated	Harvey surface water management area – Samson Brook Reservoir and pipehead, Logue Brook, Stirling and Harvey reservoirs used for public water supply and irrigated agriculture
South West	30	Available	Collie surface water management area – all rivers and tributaries used for self-supply
	103	Limited	Collie surface water management area – Wellington, Harris and Worsley reservoirs used for public water supply, irrigated agriculture and industry Water quality of the Wellington Reservoir is brackish and not suitable for all types of use. Although there is water available (5 GL) from the Wellington Reservoir, under the allocation limit, this volume has been applied for and is undergoing licence assessment. There is no additional surface water available for allocation from the Harris or Worsley reservoirs. Streamflow has declined and is projected to decline further under the drying climate
	10	Available	Capel surface water management area – all rivers and tributaries used for self-supply
	41	Available	Busselton Coast surface water management area – all rivers and tributaries used for self-supply

[1] Figures in brackets indicate an average inflow to reservoirs from 2006–2011, rather than allocation limits.

[2] Divertible water and allocation inventory database.

Department of Planning region	Total volume under allocation limits GL/year[1]	Water availability status	DWAID[2] resources included
	43	Available	Lower Blackwood surface water management area – all rivers and tributaries used for self-supply
	23	Available	Donnelly River & tributaries surface water management area – all rivers and tributaries used for self-supply
	49	Available	Warren River & tributaries surface water management area – all rivers and tributaries used for self-supply
Great Southern	–	Not applicable	Allocation limits have not been set
Goldfields-Esperance	–	Not applicable	Allocation limits have not been set

Appendix B — State-wide groundwater map (Figure 2) accompanying details

Department of Planning region	Total volume under allocation limits GL/year	Water availability status	DWAID[1] resources included in circle volumes
Kimberley	6	Available	Canning-Kimberley groundwater area - Canning-Kimberley subarea - Bonaparte aquifers
	1	Available	Canning-Kimberley groundwater area - Canning-Kimberley subarea - Ord aquifer
	7	Available	Derby groundwater area – all aquifers
	60	Available	Canning-Kimberley groundwater area - Canning-Pender subarea – all aquifers
	58	Available	Broome groundwater area – all aquifers
	50	Available	Canning-Kimberley groundwater area - La Grange north and south subareas – all aquifers
	133	Available	Canning-Kimberley groundwater area - Canning-Kimberley subarea – Erskine, Grant, Limestone, Liveringa, Sandstone, Wallal and Officer aquifers
Kimberley & Pilbara	41	Limited	Canning-Kimberley and Pilbara groundwater areas - West Canning Basin – Wallal and Broome aquifers
Pilbara	10	Fully allocated	Pilbara groundwater area - Ashburton subarea - Pilbara – Lower De Grey alluvial aquifer
	2	Fully allocated	Pilbara groundwater area - Ashburton subarea - Pilbara – Coastal saline aquifer
	7	Limited	Pilbara groundwater area - Ashburton subarea - Pilbara alluvial aquifer
	10	Fully allocated	Pilbara groundwater area - Ashburton subarea - Pilbara – Lower Yule alluvial
	0.4	Fully allocated	Pilbara groundwater area - Ashburton subarea - Lower Turner alluvial
	7	Available	Pilbara groundwater area - Ashburton subarea - Lower Fortescue alluvial
	5	Available	Pilbara groundwater area - Ashburton subarea - Carnarvon-Lower robe alluvial
	1	Limited	Pilbara groundwater area - Ashburton subarea - Lower Cane alluvial
	2	Limited	Pilbara groundwater area - Ashburton subarea - Carnarvon – Birdrong, Cape range Limestone and superficial aquifers
	16	Fully allocated	Pilbara groundwater area - Ashburton subarea – Millstream aquifer
	10	Fully allocated	Pilbara groundwater area - Ashburton subarea – Lower Bungaroo Valley aquifer
	70	Available	Pilbara groundwater area - Ashburton and east Pilbara subareas - Wittenoom-Wittenoom aquifer
	(160)	–	The Department of Water estimates that in 2011/12 there was 160 GL of surplus mine dewater that could be used for other purposes across the Pilbara. Source Draft Pilbara water supply strategy
Gascoyne	6	Available	Gascoyne groundwater area - Exmouth subareas - Carnarvon – Cape Range Limestone aquifer
	6	Available	Gascoyne groundwater area - Exmouth subareas - Saline Resource
	30	Limited	Gascoyne groundwater area - Zuytdorp/Ningaloo subarea - Carnarvon-Birdrong aquifer

[1] Divertible water and allocation inventory database.

Department of Planning region	Total volume under allocation limits GL/year	Water availability status	DWAID[1] resources included in circle volumes
	21	Limited	Gascoyne groundwater area - Area A, Area B-L and Yandoo subareas - Lower Gascoyne Alluvial and Carnarvon surficial aquifers
	22	Available	Gascoyne groundwater area - Zuytdorp/Ningaloo subarea - Carnarvon – sedimentary, alluvium, superficial, Tumblagooda and Windalia aquifers
	58	Available	Gascoyne groundwater area - Talisker/Mia Mia subarea - Carnarvon – sedimentary, alluvium, superficial, Tumblagooda and Windalia aquifers and the Keogh-Ballythanna aquifer
Mid West	10	Available	Murchison GWA/Officer subarea – all aquifers
	6	Available	Gascoyne groundwater area - Kalbarri / Eurardy subarea – all aquifers
	7	Available	Gascoyne groundwater area - Northampton/Gelena subarea – all aquifers
	7	Available	Gascoyne groundwater area - Yuna/Eradu subarea – all aquifers
	16	Available	Gascoyne groundwater area - Casuarinas subarea – all aquifers
	189	Available	Arrowsmith groundwater area – all subareas and all aquifers
	(6)		The Department of Water estimates that in 2011/12 there was 6 GL of surplus mine dewater that could be used for other purposes across the Mid West, from the Meekatharra, Egerton and Mullewa / Byro subareas. Source Mid West water supply strategy
Wheatbelt	94	Available	Jurien groundwater area – all subareas and all aquifers
	257	Limited	Gingin groundwater area – all subareas and all aquifers Note 22 GL of water from the Gingin groundwater area is managed under the Gnangara allocation plan and so this volume is often included in totals of allocation limits and availability in the Gnangara plan area.
Perth (north)	254	Very limited	All aquifers of the Gnangara, Gwelup, Mirrabooka, Swan, Wanneroo, Rottnest, Yanchep groundwater areas and all aquifers of the Perth groundwater area that occur north of the Swan River (often referred to as the Gnangara plan area, but the Gnangara plan area includes additional 22 GL of water from the Gingin groundwater area)
Perth (south)	195	Limited	All aquifers of the Cockburn, Jandakot, Rockingham, Serpentine and Stakehill groundwater areas plus all aquifers of the Perth groundwater area that occur south of the Swan River.
Peel	72	Limited	Murray groundwater area – all aquifers plus South West Coastal groundwater area –Coastal, Colburra Downs, Falcon, Island point, Lake Clifton, Mandurah and Whitehills subareas – all aquifers
South West	97	Limited	Bunbury groundwater area – all aquifers plus South West Coastal groundwater area – Harvey, Kemerton Industrial Park North, Kemerton North, Lake Preston, Myalup and Wellesley subareas – all aquifers
	85	Limited	Busselton-Capel groundwater area – all subareas and all aquifers
	7	Fully allocated	Collie groundwater area – all subareas and all aquifers Note 68 GL/year is currently licensed for mine dewatering activities. This volume is not reflected in the allocation limit. The allocation limits caps the volume of water that can be abstracted for all other purposes such as production bores for power station water supply.
	(16)	-	The Department of Water estimates that in 2011–12 there was 16 GL of surplus mine dewater that could be used for other uses. However this would be on an opportunistic basis, as the majority of surplus mine dewater is currently supplied for power station water requirements.
	30	Limited	Blackwood groundwater area – all subareas and all aquifers
Great	6	Limited	Albany groundwater area – all subareas and all aquifers

Department of Planning region	Total volume under allocation limits GL/year	Water availability status	DWAID[1] resources included in circle volumes
Southern Great Southern	0.2	Limited	Bremer Bay groundwater area – all subareas and all aquifers
Goldfields–Esperance	0.4	Limited	Hopetoun groundwater area – all subareas and all aquifers
	7	Available	Esperance groundwater area – all subareas and all aquifers
	0.1	Available	Gibson groundwater area – all subareas and all aquifers
	0.1	Available	Condingup groundwater area – all subareas and all aquifers
	81	Available	Murchinson, Goldfields and Nullarbor groundwater areas – all subareas and all aquifers

Appendix C — Map information and disclaimer

Datum and projection information

Vertical datum: Australian Height Datum (AHD)

Horizontal datum: Geocentric Datum of Australia 94

Projection: Unprojected

Spheroid: GRS 80

Project information

Client: Trudy Evans

Map author: Gary Floyd and Chelsea Samuel

Filepath:
J:\gisprojects\Project\330\80000_89999\3308480_SS_GIS\00001_State_ot_Resources_Salinity\mxd...For all maps

Filename:
J:\gisprojects\Project\330\80000_89999\3308480_SS_GIS\00001_State_ot_Resources_Salinity\mxd... For all maps

Compilation date: 31 August 2012

Disclaimer

These maps are a product of the Department of Water, Water Assessment and Allocation Division and were printed as shown.

These maps were produced with the intent that they be used for information purposes at the scale as shown when printing.

While the Department of Water has made all reasonable efforts to ensure the accuracy of this data, the department accepts no responsibility for any inaccuracies and persons relying on this data do so at their own risk.

Sources

The Department of Water acknowledges the following datasets and their custodians in the production of this map:

DWAID Aquifers – DoW – 2012

DWAID Geological Provinces – DoW – 2012

DWAID Groundwater Resources – DoW – 2012

Groundwater Subareas – DoW – 2012

Groundwater Salinity, Statewide – DoW – 2000

Groundwater Salinity, Confined Aquifers – DoW – 2001

Hydrogeology, Statewide – DoW - 2002

Hydrography, Linear (Hierarchy) – DoW – 2007

Perth Basin, Superficial aquifer groundwater salinity – DoW – 2009

Surface Water Resources (DWAID) – DoW – 2012

Surface Water Allocation Areas – DoW – 2012

Australian Coastline Derived – DEWHA – 2009

Referable Dams Register – Water Corporation – 2012

Region Base (WA) – DoP – 2012

Western Australian Towns – Landgate – 2012

Shortened forms

Shortened forms

DoW	Department of Water
DWAID	Divertible water and allocation inventory database
DEWHA	Department of the Environment, Water, Heritage and the Arts (Commonwealth)
DoP	Department of Planning
mg/L	Milligrams per litre
ML/year	Megalitre per year
TDS	Total dissolved solids
WA	Western Australia
WRC	Water and Rivers Commission

Volumes of water

One litre	1 litre	1 litre	(L)
One thousand litres	1000 litres	1 kilolitre	(kL)
One million litres	1 000 000 litres	1 megalitres	(ML)
One thousand million litres	1 000 000 000 litres	1 gigalitre	(GL)

Glossary

Allocated versus committed	Allocated refers to current licensed entitlements whereas committed refers to in force licences for future use commitments such as conditional approval and development commitments. Water availability in this report refers to the remaining water available in the allocation limit after allocated and committed volumes are considered.
Allocation limit	Annual volume of water set aside for consumptive use from a water resource.
Alluvium	Sediment consisting of mud, silt, sand and gravels deposited by flowing water on flood plains, in riverbeds and in estuaries.
Aquifer	A geological formation or group of formations capable of receiving, storing and transmitting significant quantities of water. Usually described by whether they consist of sedimentary deposits (sand and gravel) or fractured rock. Aquifer types include unconfined and artesian.
Confined aquifer	An aquifer lying between confining layers of low permeability strata (such as clay, coal or rock) so that the water in the aquifer cannot easily flow vertically.
Dewatering	Removing underground water for construction or other activity. It is often required in mining below the watertable or as a preliminary step to developments in an area.
Fractured rock aquifer	A fractured rock aquifer is one where groundwater is stored in fractures, joints, bedding planes and cavities in an otherwise solid rock mass. Groundwater yield is extremely variable and dependent on the distribution of major fractures.
Licence (or licensed entitlement)	A formal authority that entitles the licence holder to take water from a watercourse, wetland or underground source under the *Rights in Water and Irrigation Act 1914*.
Management area	A defined surface water area or groundwater area proclaimed under the *Rights in Water and Irrigation Act 1914*.
Over-allocated	Where the total volume of water allocated from the resource (that could be abstracted at any time) is over the set allocation limit.
Palaeochannel	A channel that is no longer part of the contemporary fluvial system; i.e. that has been abandoned or buried.
Pipehead	Small dam allowing diversion of some of the water flowing in a stream into a pipe for water supply use. Does not provide any significant storage capacity, relying on "run of the river" flows.
Potentiometric	A potentiometric surface represents the static water level (or head) of groundwater.

Pumpback	A scheme in which water is diverted by means of a dam or pipe-head dam and "pumped back" into a reservoir located further upstream. This allows the storage reservoir to obtain water from a greater catchment area than it would normally utilise, and hence increasing its yield.
Reserved water	Reserved volumes refer to volumes of water set aside for future supply where there is sufficient water. This includes Public Water Supply Reserves and the Northern Territory Reserve (Ord surface water area only).
Subarea	A subdivision within a surface water or groundwater area defined to better manage water allocation. Subarea boundaries are not proclaimed and can therefore be amended without being gazetted.
Unconfined aquifer	Is the aquifer nearest the surface, having no overlying confining layer. The upper surface of the groundwater within the aquifer is called the watertable. The aquifer contains water with no upper non-porous material to limit its volume or to exert pressure.
Water entitlement	The volume of water that a person is entitled to take on an annual basis in accordance with the *Rights in Water and Irrigation Act 1914* and a licence.

References

Department of Water 2007a, *Carnarvon Artesian Basin water management plan*, Department of Water, Perth.

——2007b, *Cockburn groundwater area water management plan*, Department of Water, Perth.

——2007c, *Esperance groundwater area water management plan*, Department of Water, Perth.

——2007d, *Kemerton groundwater subareas water management plan*, Department of Water, Perth.

——2008a, *Rockingham-Stakehill groundwater management plan*, Department of Water, Perth.

——2009a, *Gnangara groundwater areas allocation plan*, Department of Water, Perth.

——2009b, *South West groundwater areas allocation plan*, Department of Water, Perth.

——2009c, *Upper Collie water allocation plan*, Department of Water, Perth.

——2009d, *Whicher area surface water allocation plan*, Department of Water, Perth.

——2010a, *Arrowsmith groundwater allocation plan*, Department of Water, Perth.

——2010b, *Jurien groundwater allocation plan*, Department of Water, Perth.

——2010c, *La Grange groundwater allocation plan*, Department of Water, Perth.

——2011a, *Gingin surface water allocation plan*, Department of Water, Perth.

——2011b, *Draft Lower Collie surface water allocation plan: for public comment*, Department of Water, Perth.

——2011c, *Lower Gascoyne water allocation plan*, Department of Water, Perth.

——2012a, *Middle Canning River surface water allocation plan*, Department of Water, Perth.

——2012b, *Murray groundwater allocation plan*, Department of Water, Perth.

——2012c, *Warren-Donnelly surface water allocation plan*, Department of Water, Perth.

——2013a, *Gingin groundwater area allocation plan: for public comment*, Department of Water, Perth.

——2013b, *Ord surface water allocation plan*, Department of Water, Perth.

——2013c, *Pilbara groundwater allocation plan*, Department of Water, Perth.

——2013d, *Pilbara regional water supply strategy*, Department of Water Perth.

——in preparation, *South West Coastal groundwater allocation plan: for public comment*, Department of Water Perth.

Water and Rivers Commission 1999, *Groundwater allocation plan: Exmouth groundwater subarea*, Water resource allocation and planning series report no 9, Water and Rivers Commission, Perth.

Further reading

The following references are not specifically referenced in the document but are the sources of water quality and trend information used in the assessment.

CSIRO 2009, *Surface water yields in south-west Western Australia – A report to the Australian Government from the CSIRO South-West Western Australian Sustainable Yields Project*, CSIRO Water for a Healthy Country Flagship, Australia.

——2009, *Water in northern Australia – Summary of reports to the Australian Government from the CSIRO Northern Australia Sustainable Yields Project*, CSIRO, Australia. 12pp.

Department of Environment and Conservation 2009, *Resource Condition Report for a Significant Western Australian Wetland: Lake Gore,* Department of Environment and Conservation, Perth.

Department of Water 2008, *Statewide River Water Quality Assessment,* Water Science Branch, Department of Water, Perth.

——2009, *Streamflow trends in south-west Western Australian*, Surface Water Hydrology Series - report no. HY32, Department of Water.

Hem 1970, *Study and interpretation of the chemical characteristics on nature water*, Geological Survey Water Supply Paper 1473. USGS.

Loh, I.C., Ventriss, H.B. and Collins, P.D.K. 1983, *Water Quality Characteristics of Western Australia – Paper presented at a seminar entitled 'Water Quality – Its Significance in Western Australia'*, Perth 12-14 October 1983. Water Research Foundation of Australia.

Mayer, XM, Ruprecht, JK & Bari, MA 2005, *Stream salinity status and trends in south-west Western Australia,* Salinity and Land Use Impacts Series, Report No. SLUI 38, Department of Environment, Perth.

Public Works Department 1984, *Streamflow Records of Western Australia to 1982,* Water Resources Branch of the Public Works Department, Western Australia.

Smith et al. 2007, *Helena River Salinity Situation Statement*, Department of Water, Perth.