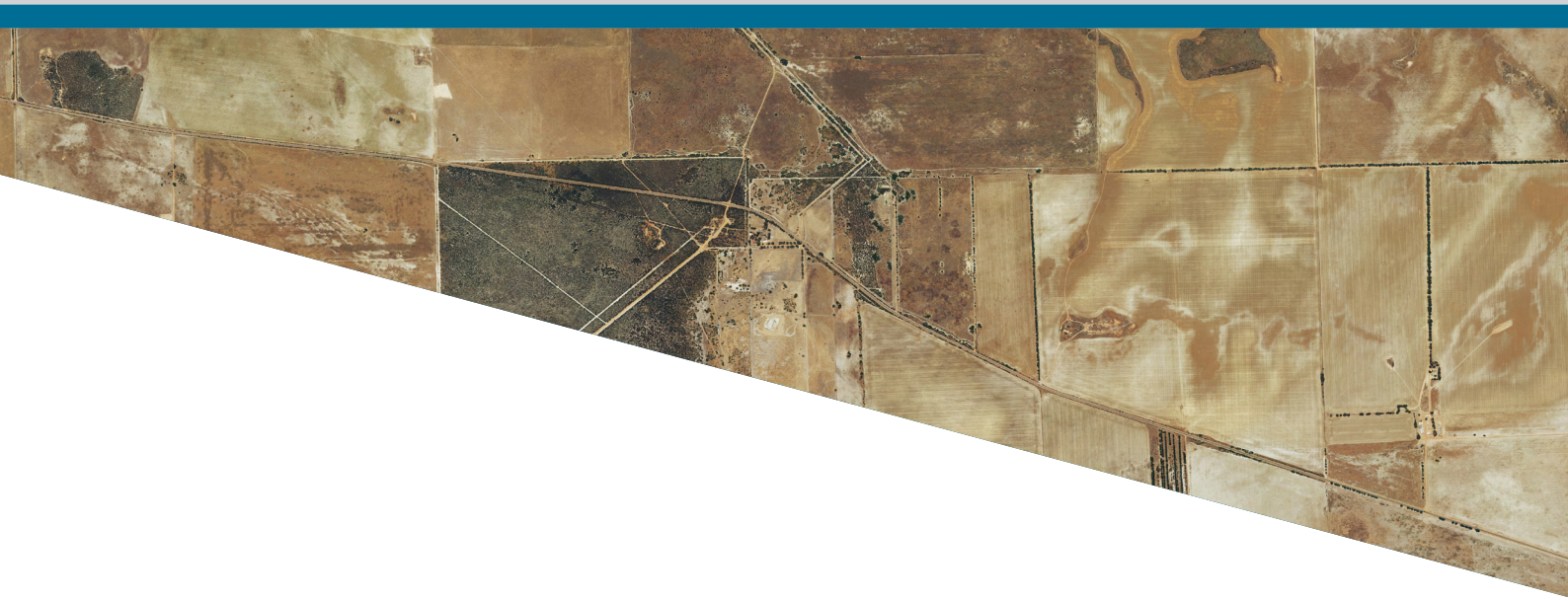
Government of Western Australia
Department of Water and Environmental Regulation

Allanooka–Dongara Water Reserve

drinking water source protection review



Geraldton Dongara Regional Water Supply

Water resource protection series
Report WRP152
November 2019

Government of **Western Australia**
Department of **Water and Environmental Regulation**

Important information

The *Allanooka and Dongara-Denison water reserves water source protection plan* (2002, WRP no. 47) was reviewed in 2019.

Please ensure you read the *Allanooka-Dongara Water Reserve drinking water source protection review* (2019, WRP no. 152) alongside the 2002 plan to obtain all of the information about this drinking water source.

The 2019 review considers changes that have occurred in and around the Allanooka-Dongara Water Reserve since the completion of the 2002 plan. Additional recommendations have been prepared to ensure the ongoing protection of this public drinking water source area:

- update the boundary, priority areas and WHPZs of the Allanooka-Dongara Water Reserve to reflect the current protection status and bore locations
- Water Corporation to undertake a risk assessment in accordance with the August 2018 edition of the *Australian drinking water guidelines* (NHMRC & NRMMC 2011) prior to constructing the proposed production bores, in consultation with the department
- review the boundary of the Allanooka-Dongara Water Reserve based on hydrogeological modelling of the recharge area for existing and future production bores
- improve management practices on the department's land, which is leased to a farm operator for cropping and grazing.

You can find the 2019 *Allanooka-Dongara Water Reserve drinking water source protection review* at www.dwer.wa.gov.au or by contacting the Department of Water and Environmental Regulation on +61 8 6364 7000 or drinkingwater@dwer.wa.gov.au.

Allanooka–Dongara Water Reserve drinking water source protection review

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For more information about this report, contact the Water Source Protection Planning team on 08 6364 7000 or drinkingwater@dwer.wa.gov.au.

Cover photograph: Aerial photograph showing the Allanooka–Dongara Water Reserve

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This publication is available at our website www.dwer.wa.gov.au or for those with special needs it can be made available in alternative formats such as audio, large print or Braille.

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Summary

This drinking water source protection review considers changes that have occurred in and around the Allanooka–Dongara Water Reserve since completion of the *Allanooka and Dongara–Denison water reserves water source protection plan* (Water and Rivers Commission 2002). This review should be read with the 2002 plan, because it does not repeat information in the plan that is still current. Both documents are available on our website or by contacting us.

The Allanooka–Dongara Water Reserve is in the Shire of Irwin (see Figure A1) and consists of three bore fields – Allanooka, Mount Hill and Wye Farm. Water Corporation draws water from these bores to supply the Geraldton Dongara Regional Water Scheme. This integrated scheme supplies drinking water to Geraldton, Dongara, Port Denison, Walkaway, Narngulu, Northampton, Mullewa and Eradu, as well as services that draw water directly from the pipeline between Geraldton and Mullewa. Nabawa and Yuna also receive water from this source via carting. This water reserve is the sole supply of water to these locations.

The Department of Water and Environmental Regulation (DWER) owns several freehold parcels of land within the water reserve where 13 of the 21 bores are located.

The main changes since the 2002 plan are:

- The Allanooka Water Reserve and the Dongara-Denison Water Reserve were abolished and a new water reserve called the Allanooka–Dongara Water Reserve was proclaimed in 2004 (as recommended in the 2002 plan).
- Water Corporation is currently investigating the development of five new bores within the existing water reserve boundary to meet future water demand (see Figure A4).
- DWER has changed some land from priority 2 (P2) to priority 1 (P1) to reflect its ownership by government (see Figure A4). This does not change the zoning of land, but gives primacy to the protection of water quality and public health. This was discussed with affected stakeholders in 2014.
- DWER has produced the *Arrowsmith groundwater allocation plan* (2010) to support water resource management and planning in the area, and continues to work toward better management of the current and future public drinking water supply.
- Suspected contaminated sites have been reported and are awaiting classification under the *Contaminated Sites Act 2003.*
- Bores 4/96 and 5/96 in the Mount Hill bore field have returned elevated microbiological counts and have been turned off as an interim measure. The cause of these results has been investigated and mitigation measures are being implemented. Once the sampling results return to normal these bores can be reopened (see section 1.8.9 under stock grazing).

DWER has prepared this document in consultation with key stakeholders, including state government agencies, land managers, the Water Corporation, the Yamatji

Marlpa Aboriginal Corporation and the Shire of Irwin. It was prepared with stakeholder input received between 2014 and 2019. All issues raised have been addressed in this review.

The review implements the *Australian drinking water guidelines* (ADWG) which are published by the National Health and Medical Research Council (NHMRC & NRMMC 2011, August 2018 update). The Minister for Health endorsed the August 2018 update of the ADWG as the basis for setting policy for drinking water quality, safety and risk management in WA.

This review is consistent with State planning policy no. 2.7: *Public drinking water source policy* (Western Australian Planning Commission 2003).

The following table shows important information about the Allanooka–Dongara Water Reserve.

Table 1 Key information for Allanooka–Dongara Water Reserve

Key information about the Allanooka–Dongara Water Reserve	
Status of this report	This report was prepared with stakeholder input received between 2014 and 2019. Public drinking water source area boundaries, priority areas, bore locations, wellhead protection zones and other data are subject to change. For up-to-date information, please email drinkingwater@dwer.wa.gov.au.
Local government authority	Shire of Irwin
Locations supplied	Geraldton Dongara Regional Water Supply (also known as Geraldton Regional Water Supply Scheme) is the sole drinking water supply to: Geraldton, Dongara, Port Denison, Walkaway, Narngulu, Northampton, Mullewa, Eradu, services along the pipeline between Geraldton and Mullewa, and water carting to Nabawa and Yuna.
Area of water reserve	263 km^2
Water service provider	Water Corporation
Water treatment plant	Water Corporation's water treatment plant is 20 km north-east of Dongara within a P2 area of this water reserve.
Aquifer and type	Yarragadee – varies between unconfined and semi-confined. This aquifer is vulnerable to contamination from surface land uses.
Licensed abstraction	Licence no. 65770(4) Allanooka and Mount Hill bore fields 14 000 000 kilolitres per year (kL/yr)

Key information about the Allanooka–Dongara Water Reserve	
	Licence no. 70001(4) Wye Farm (Dongara–Denison) bore field 650 000 kL/yr
Number of bores	Allanooka bore field – 13 Mount Hill bore field – 6 Wye Farm bore field – 1 Abandoned bore – 1 Future bores – 5 (subject to further investigation)
Bore details	Allanooka bore field (bores are 60–140 m deep within the locally unconfined Yarragadee Formation): - 1/82 (E 307 241, N 6 787 482, zone 50) – 6 April 1982 - 5/95 (E 307 462, N 6 786 713, zone 50) – 1 December 1995 - 6/95 (E 307 919, N 6 786 222, zone 50) – 29 November 1995 - 2/96 (E 307 619, N 6 785 140, zone 50) – 23 January 1996 - 1/96 (E 308 100, N 6 785 168, zone 50) – 17 January 1996 - 2/89 (E 306 289, N 6 784 031, zone 50) – 2 June 1989 - 1/92 (E 304 699, N 6 781 671, zone 50) – 23 October 1992 - 2/92 (E 306 040, N 6 781 570, zone 50) – 21 November 1992 - 2/83 (E 307 678, N 6 781 740, zone 50) – 3 April 1984 - 3/96 (E 308 709, N 6 781 726, zone 50) – 7 February 1996 - 6/98 (E 306 885, N 6 779 464, zone 50) – 26 August 1998 - 5/98 (E 306 693, N 6 778 581, zone 50) – 12 August 1998 - 4/98 (E 307 750, N 6 777 417, zone 50) – 22 July 1998 Mount Hill bore field (bores are 70–130 m deep within the locally unconfined Yarragadee Formation): - 12/85 (E 299 639, N 6 786 481, zone 50) – 24 September 1985 - 15/85 (E 300 379, N 6 786 811, zone 50) – 7 November 1985 - 16/85 (E 301 139, N 6 787 131, zone 50) – 18 November 1985 - 17/85 (E 301 169, N 6 786 171, zone 50) – 20 November 1982 - 4/96 (E 301 653, N 6 785 796, zone 50) – 8 April 1996 - 5/96 (E 302 129, N 6 785 399, zone 50) – 26 March 1993 Wye Farm bore field (bores are 70–75 m deep within the locally unconfined Yarragadee Formation): - 1/81 (E 304 181, N 6 771 586, zone 50) – 24 June 1981 (abandoned and removed from licence, needs to be decommissioned) - 1/92 (E 306 684, N 6 771 837, zone 50) – 29 November 1992 Potential future bores at Piggery Lane: - A (E 310 022, N 6 777 398, zone 50) - B (E 311 036, N 6 777 427, zone 50) - C (E 310 040, N 6 776 530, zone 50) - D (E 310 053, N 6 775 612, zone 50) - E (E 310 069, N 6 774 660, zone 50)

Key information about the Allanooka–Dongara Water Reserve	
Dates of drinking water source protection reports	2002 – *Allanooka and Dongara–Denison water reserves water source protection plan* 2014 – *Draft Allanooka–Dongara Water Reserve drinking water source protection review* (unpublished) 2019 – *Allanooka–Dongara Water Reserve drinking water source protection review* (this report)
Consultation	2002 – Community consultation during development of the *Allanooka and Dongara–Denison water reserves water source protection plan.* A working group was established, public meetings were held and the draft plan was released for public comment. 2014 – The draft review was consulted with Shire of Irwin, AWE Ltd, Wellard Agri Ltd, Water Corporation, Department of Health, Main Roads WA and the former Department of Mines and Petroleum. 2018/19 – This review has been consulted with Department of Planning, Lands and Heritage, National Native Title Tribunal, Yamatji Marlpa Aboriginal Corporation, Department of Mines, Industry Regulation and Safety and the Water Corporation.
Gazettal status	The Allanooka Water Reserve was proclaimed in 1965 under the *Country Areas Water Supply Act 1947*. An extension was gazetted in 1989. The adjoining Dongara–Denison Water Reserve was proclaimed in 1990 under the *Country Areas Water Supply Act 1947.* The two above water reserves were then abolished and the new the Allanooka–Dongara Water Reserve was proclaimed in 2004 under the *Country Areas Water Supply Act 1947.* When this document is next updated, DWER will assess the water reserve boundary and recommend any changes to its proclamation at that time.

1 Review of the 2002 water source protection plan

1.1 Water supply scheme

Water Corporation supplies the Geraldton Dongara Regional Water Supply with groundwater from three bore fields: Allanooka, Mount Hill and Wye Farm (see Figure A5). This scheme is the sole supply of drinking water for Geraldton, Dongara, Port Denison, Walkaway, Narngulu, Northampton, Mullewa and Eradu, services along the pipeline that draw directly from the scheme supply between Geraldton and Mullewa, and Nabawa and Yuna, to which water is carted.

The Allanooka bore field is about 50 km south-east of Geraldton and comprises 13 production bores (1/82, 5/95, 6/95, 2/96, 1/96, 2/89, 1/92, 2/92, 2/83, 3/96, 6/98, 5/98 and 4/98). These bores are between 60 m and 140 m deep and abstract groundwater from the locally unconfined Yarragadee Formation. This bore field provides the main supply to the Geraldton Regional Water Supply Scheme.

The Mount Hill bore field is west of the Allanooka bore field and comprises six production bores (12/85, 15/85, 16/85, 17/85, 4/96 and 5/96). These bores are between 70 m and 130 m deep and also abstract groundwater from the locally unconfined Yarragadee Formation. This bore field is used to augment the supply from the Allanooka bore field.

The Wye Farm bore field is south of the Allanooka and Mount Hill bore fields, about 10 km north-east of Dongara, and is currently operated to supplement the Allanooka bore field. It comprises two production bores (1/81 and 1/92) between 60 m and 75 m deep, abstracting groundwater from the locally unconfined Yarragadee Formation. Currently, only bore 1/92 is used. Bore 1/81 is not being used due to water quality issues and needs to be decommissioned.

The Department of Water and Environmental Regulation (DWER) issues licences to take water under the *Rights in Water and Irrigation Act 1914*. DWER has issued licence 65770(4) to the Water Corporation which allows a groundwater draw of 14 000 000 kL per year from the Allanooka and Mount Hill bore fields. A second licence, number 70001(4), allows the Water Corporation to draw 650 000 kL of groundwater per year from the Wye Farm bore field.

Groundwater from the bore fields undergoes treatment as outlined in the *Allanooka and Dongara-Denison water reserves water source protection plan* (Water and Rivers Commission 2002). This includes chlorination and aeration of the abstracted water to remove iron, some carbon dioxide, adjust pH and control algal growth. The water is then chlorinated and fluoridated prior to distribution. Water from the Wye Farm bore field is also filtered to reduce iron levels.

Although treatment and disinfection are essential barriers against contamination, public drinking water source area (PDWSA) management is the first step in

protecting water quality and ensuring a safe drinking water supply. This approach is endorsed by the August 2018 edition of the *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 2011, August 2018 update) which is based on preventing risks and installing multiple barriers for providing safe drinking water to consumers. This combination of catchment protection and water treatment delivers more reliable, safer and lower cost drinking water to consumers than either approach could achieve individually.

1.2 Future water demand

The current licenced entitlements are not considered sufficient to meet expected future demand. The Water Corporation forecasts population growth at 1.4 per cent per year, with demand expected to exceed the licenced allocation by approximately 2041. Therefore, the Water Corporation proposes to expand the water supply scheme with five additional production bores located within the existing water reserve (see figures A4 and A5 for bore locations and *Summary* for bore details). This is subject to further water quality and quantity assessments.

Before the bores are constructed, Water Corporation in consultation with the Department of Water and Environmental Regulation needs to undertake a risk assessment in accordance with the August 2018 edition of the ADWG (NHMRC & NRMMC 2011, August 2018 update) to ensure the locations are appropriate (see recommendation 4).

1.3 Monitoring the source

The Water Corporation has a water resource management operating strategy as part of the conditions on its licence to take water under the *Rights in Water and Irrigation Act 1914*. This strategy stipulates how the source should be managed and protected to ensure the long-term beneficial use of the water source. The Water Corporation, in consultation with DWER, is currently working on an update of this strategy and has identified that the existing monitoring network requires improvement to appropriately model the effects of groundwater abstraction related to the water levels in the Yarragadee Aquifer. Improved strategies will be included in the revised operating strategy.

1.4 Boundary, priority areas and protection zones

The Allanooka–Dongara Water Reserve was proclaimed in 2004 under the *Country Areas Water Supply Act 1947*. This replaced the former Allanooka Water Reserve, proclaimed in 1989, and the adjoining Dongara–Denison Water Reserve, proclaimed in 1990.

The *Allanooka and Dongara-Denison water reserves water source protection plan* (Water and Rivers Commission 2002) assigned all freehold land in the water reserve as a priority 2 (P2) area and Crown reserve 1020 as a priority 1 (P1) area. It defined wellhead protection zones (WHPZs) around each production bore (with a 300 m

radius in P2 and a 500 m radius in P1) to protect the water source from immediate contamination threats (see figures A4 and A5). The boundary, priority areas and protection zones were determined in accordance with the department's policy at the time.

In 2014, after consultation with affected stakeholders, DWER changed some land that is owned by the government from P2 to P1, to be consistent with other government-owned land. These lots (7 and 47) are owned by DWER (see figures A3 and A4). This change provides increased protection for drinking water quality and public health. It also means that the WHPZs around each production bore in this area have increased in radius from 300 to 500 m.

The WHPZ of unused bore 1/81 in the Wye Farm bore field will be maintained until the Water Corporation properly decommissions the bore (see section 1.8.10).

To protect drinking water from contaminants, DWER's management approach is to define a PDWSA boundary that achieves more than 50 years of groundwater flow travel time from surrounding areas into the production bores. Hydrogeological calculations for the Allanooka–Dongara Water Reserve indicate that groundwater travels between 3.3 and 11.7 km over a 50-year period. This means that the water reserve boundary should ideally be located at least 3.3 km up-gradient of each production bore. This distance is currently not achieved for production bores 12/85, 15/85, 16/85, 17/85, 4/96, 5/96, 1/82, 5/95, 6/95, 1/96 and 2/96 (see Figure A4).

Additional hydrogeological modelling and consultation by DWER is required to consider extending this boundary, when this water reserve is next investigated (see recommendation 10). There are no significant risks posed to the water source by waiting for the next review for an updated boundary. Should any significant risks arise in the meantime, DWER can prioritise this review.

1.5 Aboriginal sites of significance and native title claims

Aboriginal sites of significance are important places with special cultural connections to Aboriginal people. They are important because they link Aboriginal cultural tradition to place, land and people over time. These sites are integral to the lives of Aboriginal people, and are found in urban, rural and remote areas. They are most common near rivers, lakes, swamps, hills and the coast. The *Aboriginal Heritage Act 1972* aims to protect all Aboriginal places and objects that are culturally important to Aboriginal people. It is against the law to disturb a site or to remove artefacts.

There are a number of recorded sites of significance and heritage places within the Allanooka–Dongara Water Reserve such as Aboriginal sites ID 1575 (Sandalwood) and ID18907 (Irwin River); and heritage place ID5175 (Allanooka Swamp). Any proposed works at these sites and places may need approval under the *Aboriginal Heritage Act 1972*.

Other recorded heritage places in the Allanooka-Dongara Water Reserve include ID18082 (Wire Thicket), ID 18016 (Midlands Rd Campsite) and ID 19056 (Table Top

& Pinnacle Site Complex). The Department of Planning, Lands and Heritage advised that these places have been assessed by the Aboriginal Cultural Materials Committee not to meet the requirements under the *Aboriginal Heritage Act 1972,* therefore no approvals would be required for any proposed works.

It is important to note, that not all Aboriginal sites of significance and heritage have been recorded and are on the register of Aboriginal sites. As such, it is important that traditional custodians are always consulted in regards to their country.

Native title is the recognition in Australian law that some Aboriginal people continue to hold native title rights and interests in lands and waters. There is one registered native title claim that covers the Allanooka–Dongara Water Reserve, being the Southern Yamatji claim (WC2017/002, WAD6002/2004). The Southern Yamatji claim is the combination of the Amangu People and Naaguja claims.

This review has not proposed any changes that will affect the way in which the abovementioned sites of significance and native title claims are managed.

1.6 Enforcing by-laws, surveying the area and maintenance

This review recommends that the Water Corporation continues by-law enforcement under the existing delegation arrangement (see recommendation 6). This includes:

- erecting and maintaining signs in accordance with S111 Source protection signage (Water Corporation 2013)
- maintaining security and fencing at production bore compounds and the water treatment plant (see Appendix C, photos C1 and C2)
- ongoing regular surveillance and inspections, regular water quality monitoring for aesthetic characteristics, health-related chemicals, microbiological contaminants and water level monitoring.

1.7 Related water resource management work

DWER has published other reports that relate to the Mid-West Gascoyne region, including the Allanooka–Dongara area. The reports are not directly linked to this review, but they provide context and background for water-related issues in the Allanooka–Dongara Water Reserve.

1.7.1 Allocation planning

DWER allocates groundwater that is used for a wide range of purposes (e.g. domestic, industry and agriculture). The department's aim is to ensure that the use of groundwater resources is efficient and fit-for-purpose. The Allanooka–Dongara Water Reserve is located within the Arrowsmith Groundwater Area (see Figure A2). The Allanooka and Mount Hill bore fields are located within the Allanooka subarea and the Wye Farm bore field is located within the Eneabba Plains subarea.

The Arrowsmith Groundwater Area was proclaimed in 1990 under the *Rights in Water and Irrigation Act 1914*. This proclamation authorised the licensing and management of groundwater abstraction to protect water resources for all users.

The *Arrowsmith groundwater allocation plan* (Department of Water 2010) describes the department's direction for the allocation and licensing of groundwater resources in the Arrowsmith Groundwater Area. The goal is to manage the groundwater resources in the best interests of the whole community, considering the water needs of regional development while maintaining the region's natural water assets.

In 2012, the department published an evaluation statement, detailing the extent to which the objectives of the *Arrowsmith groundwater allocation plan* were met (DoW 2012).

These reports are available at www.dwer.wa.gov.au or by contacting us.

1.7.2 Groundwater investigation

DWER conducted a comprehensive groundwater investigation in the Allanooka and Casuarinas groundwater subareas between 2007 and 2011. The investigation included the Allanooka–Dongara Water Reserve and improved the understanding of the hydrogeology within the area. Three-dimensional maps displaying salinity distribution were developed, showing that faults have a major influence on groundwater flow. The investigation found that the Allanooka–Dongara Water Reserve is located in a complex hydrogeological system bounded by faults that influence the local hydrogeology. Major faults act as hydraulic boundaries to groundwater movement.

Water levels were measured daily between 2011 and 2013. The hydrographs show a rapid response to rainfall even where there is a deep watertable (>100 m). This is a clear indication of rapid vertical infiltration.

The data suggests that a shallow, relatively fast-moving groundwater flow system occurs in the Allanooka–Dongara Water Reserve.

A more recent groundwater investigation indicates that the current allocation limits for the Allanooka subarea (Yarragadee aquifer) need revision to ensure better management of the current and future public water supply. The department is currently reviewing these allocation limits; expected completion is in 2019/20.

The results of this investigation support the need for water resource management planning and protection initiatives in the Allanooka–Dongara Water Reserve, where freshwater resources are in demand.

1.7.3 Water for Food

The Department of Primary Industries and Regional Development has identified some areas of high value agricultural land within the reserve. Therefore we can anticipate proposals for agricultural land uses in the water reserve in the future. These land uses will be assessed via the usual land use planning approvals process, and any decisions should consider the appropriateness of the land use in accordance

with DWER's Water quality protection note no. 25: *Land use compatibility for public drinking water source areas* (DoW 2016b).

1.8 Update on water quality risks

As part of this review, DWER has conducted an updated assessment of water quality contamination risks to the Allanooka–Dongara drinking water source, in accordance with the ADWG (NHMRC & NRMMC 2011, August 2018 update). This section discusses the risks that are new or have changed since the 2002 plan, and also includes risks that are still considered high.

1.8.1 Overall risk assessment for each bore field

Groundwater investigations indicate that water infiltrates rapidly in a vertical direction (see section 1.7.2). This means that the water reserve is vulnerable to contamination from overlying land uses.

Allanooka bore field (see Figure A5)

Bores 2/89 and 2/96 are located on Crown Reserve no. 1020 where the watertable is relatively shallow. This Crown Reserve is managed by the Department of Water and Environmental Regulation. The current level of protection as a P1 area is appropriate.

Bore 1/96 (within a road reserve about 9 m off Allanooka Springs Road) is screened between 45 and 62 m below ground level in an aquifer system that is considered vulnerable to overlying land uses. This bore is susceptible to stormwater run-off, which may contain residues of chemicals (e.g. hydrocarbons and pesticides) from road maintenance, accidental spills and clearing activities. It is located in a P2 area.

Bores 1/92, 2/92, 2/83, 3/96, 4/98, 5/98 and 6/98 are located on land owned by DWER (see section 1.8.9), which has recently been changed to P1.

Bores 1/82 and 5/95 are on freehold land owned by Water Corporation and the remaining two bores (6/95 and 1/96) are on freehold land owned privately. This land is assigned as a P2 area.

Mount Hill bore field (see Figure A5)

Bores 12/85, 15/85, 16/85, 17/85, 4/96, 5/96 are located on land owned by DWER (see section 1.8.9), which has recently been changed to P1.

Bores 4/96 and 5/96 are currently closed due to elevated microbiological counts. Once the cause of these results is determined and mitigated, and sampling results return to normal, they will be reopened for use (see section 1.8.9 under stock grazing).

Wye Farm bore field (see Figure A5)

Bore 1/81 is on freehold land owned by Water Corporation. This bore has been abandoned and removed from the licence to take water, and needs to be decommissioned.

Bore 1/92 is located in an easement on privately owned land to allow Water Corporation access to the water assets. This land is assigned as a P2 area.

Future bores (see Figure A5)

Water Corporation is proposing five new bores near Piggery Lane to meet increasing demand. These bore sites are located in a road reserve, with the land assigned as a P2 area. A risk assessment for these bores will need to be undertaken prior to installing the bores by the Water Corporation in consultation with DWER (recommendation 4).

1.8.2 Intensive grazing

The 2002 plan identified water quality risks from intensive grazing on Lot M363 Piggery Lane (near Midlands Road). This property is not within the current boundary and is no longer considered a risk to the drinking water source.

1.8.3 Other groundwater bores

Bores drilled near a public drinking water supply bore (such as for irrigation or private purposes) can cause contamination of the drinking water source. For example, a poorly constructed bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer.

It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source. This will be assessed through the Department of Water and Environmental Regulation's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914*. All bores should be constructed and decommissioned in accordance with *Minimum construction requirements for water bores in Australia* (National Uniform Drillers Licensing Committee 2012). It is important that GIS coordinates for all bores are recorded correctly, to ensure proper assessment of the risk to drinking water bores.

Currently, there are three licensed users nearby.

1.8.4 Mount Horner oilfield

The Mount Horner oilfield is 20 km north-east of Dongara, in the eastern part of the Allanooka–Dongara Water Reserve (see Appendix C, Photo C8). The facility was constructed in 1982 and its main infrastructure includes a production facility, 16 petroleum wells and pipework.

This oilfield is regulated under Petroleum production licence L7 administered by the Department of Mines, Industry Regulation and Safety. It is also managed as a prescribed premise under licence no. L6785/1995/11 issued by DWER under Part V

of the *Environmental Protection Act 1986*. The licence includes management conditions and an associated groundwater quality monitoring regime.

The 2002 plan identified potential risks to drinking water quality from hydrocarbon spills and leaks, and increased salinity due to wastewater irrigation of nearby tree farms. Approximately 3.3 GL of wastewater with a salinity of approximately 4500 mg/L total dissolved solids was discharged to the tree farms between 1984 and 2011. These potential risks have been managed through the above government approvals.

Under the Part V licence, monitoring of groundwater (e.g. chemical oxygen demand, total dissolved solids, pH, a number of heavy metals, total petroleum hydrocarbons, and light fractions organic compounds) was undertaken at several bores on a six-monthly basis. When the field was still producing, saline wastewater irrigation of the southern tree farm was monitored under this licence. When production ceased, the perched water table resided, resulting in some bores running dry. Subsequently, these bores were exempted from monitoring requirements and were removed from the licence. Monitoring of the camp water bore is ongoing.

The Mount Horner oilfield ceased producing in January 2011 and has been under care and maintenance since, with several of the production wells being decommissioned. Compliance with environmental management requirements continues to be administered by the Department of Mines, Industry Regulation and Safety pursuant to the environment plan(s) approved under the Petroleum and Geothermal Energy Resources (Environment) Regulations 2012, and by DWER under the Part V licence.

For the protection of the PDWSA, it is recommended that groundwater quality monitoring continue, to inform the abovementioned risks to drinking water quality.

Any pesticides used for weed management should be applied in accordance with legislative requirements and best management practices (i.e. in accordance with label directions). The Department of Health's *Public sector circular number 88* (PSC 88) recommends suitable herbicides for spot spray application in PDWSAs.

DWER periodically visits the Mount Horner site. If DWER identifies risks to drinking water quality, this information is shared with administering authorities and any required follow-up is progressed by the responsible agency.

Any expansion of the Geraldton Dongara Regional Water Supply will need to take into consideration the locations and past operations of the Mount Horner oilfield.

1.8.5 Contaminated sites

A number of known or suspected contaminated sites have been reported in the Allanooka–Dongara Water Reserve and are awaiting classification under the *Contaminated Sites Act 2003*, which is administered by this department. Sites that have been classified as contaminated (i.e. *contaminated – remediation required*, *contaminated – restricted use* or *remediated for restricted use*), are displayed on the department's contaminated sites database.

Hydrocarbons from exploration wells, pipeline leaks and old underground storage tanks pose potential high risks to the quality of the drinking water source. Sites that DWER has classified as requiring remediation should be addressed as soon as possible to reduce the risk of groundwater contamination.

1.8.6 Hydrocarbon and chemical spills

Main Roads WA has identified an area which crosses the western portion of the water reserve as having the potential for a future main road alignment. Main Roads will seek comments from stakeholders, including DWER, prior to developing options for the road's alignment.

Spilt fuel, oil and chemicals resulting from accidents or road transportation pose a risk to water quality. Road alignments need to consider the distance to production bores to ensure any spills can be contained and cleaned up promptly to prevent contaminants from reaching the bores. Guidance is provided in our Water quality protection note (WQPN) no. 44: *Roads near sensitive water resources.*

1.8.7 Extension Hill slurry pipeline

Extension Hill Pty Ltd proposes to construct and operate two pipelines through the Allanooka–Dongara Water Reserve to transport magnetite slurry and recovered water between the Extension Hill magnetite mine and the Geraldton Port. The pipelines will be located within a 30 m wide service corridor and buried to a depth of approximately 1–2 m. The proposed service corridor will be located in a P2 area. It will cross three minor seasonal watercourses within the reserve, two of which drain into a WHPZ, and it will come to within 150 m of a WHPZ. It is expected that the pipeline will be in operation for more than 40 years.

DWER has approved this proposal with conditions. Our WQPN no. 83: *Infrastructure corridors near sensitive water resources* provides more information on best management practices that we expect.

1.8.8 Water treatment plant

The Water Corporation's *Allanooka chemical dosing plant* treats groundwater from the bore fields to ensure if it safe to drink before supplying it to consumers. It is located on land owned by the Water Corporation approximately 20 km north-east of Dongara within a P2 area. The treatment compound is secured by fencing and displays appropriate signs (see Appendix C, Photo C2).

The Department of Mines, Industry Regulation and Safety's dangerous goods licence allows the Water Corporation to transport and store liquid chlorine and hydrated lime for drinking water treatment purposes.

Water is pooling from a leaky reservoir outside the secured water treatment plant (see Appendix C, Photo C3). The water and associated grass growth attracts cattle to congregate, which increases the risk of pathogens contaminating the groundwater. Water Corporation's capital works program has included replacing the reservoir with a tank, anticipated to be completed by 2021.

1.8.9 Department of Water and Environmental Regulation land

The department owns lots 7 and 47 with the water reserve (4421 ha in total, see Figure A3) and leases them to a farm operator for cropping and grazing. The current lease will expire in 2022, with an option to extend the lease until 2032. Farm activities are managed through the annual farm operational plan, which is part of the lease conditions.

This land is subject to rapid recharge and vertical infiltration which means the groundwater is particularly vulnerable to contamination from overlying land uses. To recognise this risk, and to reflect the land's status of government ownership, in 2014, we discussed changing this land from P2 to a P1 with affected stakeholders. Our online spatial data now recognises these lots as P1 (see Figure A4).

Extensive stock grazing and broadacre cropping are incompatible land uses in P1 areas (except stock grazing on pastoral leases) in our WQPN no.25: *Land use compatibility tables for public drinking water source areas* (DoW 2016). Given this risk, and the recent increases to stocking density by the farm operator, DWER recommends changes to the lease and farm operational plan:

- improving stock density (e.g. reduction in number of stock per hectare)
- maintaining all stock watering points with a backflow prevention device (see section 1.8.11)
- maintaining stock watering points outside WHPZs and keeping them in good repair (see Appendix C, Photo C7)
- fencing around the WHPZs (or at an agreed distance from drinking water supply bores)
- installing or improving buffers to prevent stock access to bore scouring pipe outlets and drainage lines, including Hunt Gully (see Appendix C, Photos C5 and C6).

The option of removing a source(s) of contamination should also be considered. This would mean replacing grazing with cropping, which reduces the risk of pathogen contamination.

The following sections discuss the risks from the farm operations in more detail.

Stock grazing

The lessee has recently increased stocking rates and installed a temporary stock holding yard. Cattle grazing and manure in WHPZs (in close proximity to the bores) poses a high risk of pathogen contamination. Stock congregating around production bores can cause soil subsidence and result in a shortened pathway for contaminants, such as pathogens, fertilisers and pesticides, to travel into the groundwater. Accumulated deposits of animal manure within the capture zones of the production bores provide the greatest risk to the source.

For more information about the risks that pathogens pose to PDWSAs, see our brochure: *Risks from pathogenic microorganisms in public drinking water source areas* (DoW 2008).

Water quality monitoring data from raw (untreated) water samples indicates that several bores have elevated concentrations of nitrogen and counts of *Escherichia coli* (an indicator for risk of pathogens). The levels of nitrogen remain below the ADWG's health-related levels. Options to address the *E. coli* levels are being investigated.

Bores 4/96 and 5/96 at the Mount Hill bore field have ongoing *E. coli* counts and are currently not used for the drinking water supply. These bores will only be used again if water quality improves and monitoring results are within the ADWG's recommended levels. The Mount Hill bore field is only required during periods of high demand (e.g. summer) or if multiple Allanooka bores were to fail.

Appropriate stocking density (i.e. number of animals per hectare) is generally based on nitrogen loading calculations and the carrying capacity of the land, guided by the Department of Primary Industries and Regional Development. However, where stock poses unacceptable risks to a sole, unconfined drinking water source and public health, appropriate measures need to be implemented to avoid or minimise this risk. The cost of developing alternative water sources is significant.

Additional guidance about best management practices for livestock is provided in our WQPN no. 80: *Stockyards* and WQPN no. 1: *Agriculture – dryland crops near sensitive water resources*.

Chemicals

In 2017, skeleton weed, a declared plant in WA (Category 2 – Eradication), was identified on a couple of land parcels. This weed needs to be eradicated under the *Biosecurity and Agriculture Management Act 2007*. A skeleton weed treatment program was prepared in consultation with the Department of Primary Industries and Regional Development, the lessee, Water Corporation and other relevant agencies. For more information on this declared plant, see *Skeleton weed in Western Australia: Early detection is the best prevention* (Department of Primary Industries and Regional Development 2017).

The types of pesticides that can be used on this land are limited to:

- those specified in the Department of Health's Circular no. PSC 88 *Use of herbicides in water catchment areas*
- those that have previously been approved for use on this land (having been assessed by DWER using the *Pesticide Impact Rating Index* pesticide risk indicator as having a low impact, and approved by the Department of Health.

Pesticides should always be applied in accordance with the manufacturer's label directions.

Water quality monitoring results indicate that there is no evidence of pesticides in the raw water in any of the Allanooka–Dongara Water Reserve bores. For more information on water quality results please see Appendix B.

Fertilisers should be applied in accordance with best management practices and consistent with the annual farm operation plan. For information on fertiliser management refer to our brochures *Fertiliser application on pasture or turf near sensitive water resources* and *Liquid chemicals on agricultural land: transport, blending, storage and disposal*.

1.8.10 Abandoned bores

There is an abandoned Water Corporation production bore (1/81) in the Wye Hill bore field that has been removed from the licence to take water, and two deeper bores in the Mount Hill bore field that were never used, up-gradient of bores 4/96 and 5/96. These three bores are on DWER's land.

There are several abandoned monitoring bores across all three bore fields that do not have suitable capping or sealing (see Appendix C, Photo C4).

Abandoned bores that have not been sealed provide a direct pathway for contaminants to enter the aquifer. For example, if livestock gain access to unsealed bores, pathogens and nutrients can contaminate the water source.

Water Corporation should decommission these bores consistent with the *Minimum construction requirements for water bores in Australia* (i.e. sealed, secured, capped and locked) so there is no risk of contamination of the drinking water source (see recommendation no. 8).

1.8.11 Stock watering points

Since the 2002 plan, the department identified some stock watering troughs, filled directly from the scheme, that were not fitted with backflow prevention devices. The pressure of the Allanooka water main can fluctuate depending on usage and potential pipe leaks, which could allow contaminated water from the trough to be drawn into the drinking water supply system.

This risk has since been addressed by installing approved backflow prevention devices. Stock drinking troughs comply with the Water Corporation's *PCY209 Water supply backflow prevention policy* (2012), which requires every connection to the supply to have a backflow device fitted at the property's boundary.

1.8.12 Mining, geothermal energy and other commodities

The Allanooka–Dongara Water Reserve is within the Perth basin. The Perth basin is a prospective area for a range of commodities such as minerals, petroleum and geothermal energy. These activities are regulated by the Department of Mines, Industry Regulation and Safety.

Petroleum fields, petroleum titles, mining tenements and geothermal titles occur within the water reserve.

There are four onshore petroleum titles and exploration permits (L7R1, L2R1, EP437R1 and EP368R4) in the Allanooka–Dongara Water Reserve within which there is the potential for hydraulic fracture stimulation. Government has accepted the recommendations of the *Independent Scientific Panel Inquiry into Hydraulic Fracture Stimulation in Western Australia* (Hatton et. al 2018) and has developed *Policy statement: Implementation of the Government's response to the Independent Scientific Panel Inquiry into hydraulic fracture stimulation in Western Australia* (Government of Western Australia 2019).

This requires that any hydraulic fracture stimulation proposals must be referred to the Environmental Protection Authority for assessment under Part IV of the *Environmental Protection Act 1986*. All onshore oil and gas exploration and production involving hydraulic fracture stimulation is prohibited within 2 km of gazetted PDWSAs, which includes the Allanooka–Dongara Water Reserve, in accordance with the above policy statement.

The Environmental Protection Authority is developing guidance material relating to formal assessment of all hydraulic fracture stimulation exploration and production proposals, which includes the requirement for the 2 km separation.

Mining activities (excluding mineral processing and tailing dams using chemical processing) are compatible with conditions in PDWSAs. Best management practices for the mining industry are provided in our Water quality protection guidelines 1–11: *Mining and mineral processing* (DoW 2000). Operators should follow these guidelines to help reduce potential water quality risks associated with mining and exploration activities. Exploration holes and excavated and cleared areas need to be appropriately decommissioned and rehabilitated (e.g. backfilled, capped and plugged) on mining tenements located in PDWSAs to the satisfaction of DWER.

1.9 Water quality information

The Water Corporation has provided water quality information for the Allanooka–Dongara Water Reserve. This is shown in Appendix B.

Raw (untreated) water provided to the Geraldton Dongara Regional Water Supply has been of acceptable quality, generally meeting ADWG values.

However, salinity and iron have on occasion exceeded the aesthetical guideline levels, which are naturally occurring in groundwater. Salinity and iron levels can affect the water's taste and appearance, and although not necessarily harmful to human health, water with properties like this will be less appealing to customers.

Minor fluctuations in salinity concentrations were observed throughout the water reserve. Concentrations generally ranged between 500 mg/L and 1300 mg/L. The underlying long-term trend at all the bore fields is stable, except for a rising trend at production bore 2/83 in the Allanooka bore field. Fresh groundwater in the Allanooka area occurs in the top 100–250 m of the aquifer overlying brackish to saline groundwater. This bore field requires careful management of abstraction rates to minimise increases in salinity.

Positive *Escherichia coli* counts were recorded in raw (untreated) water samples from the Allanooka and Mount Hill bore fields. This could be attributed to pathogens from livestock. This is a potential high risk to the drinking water source and the cause of these results has been investigated to find and remove the source(s) of contamination. Mitigation measures are being implemented (see section 1.8.9).The bores with ongoing *E. coli* detections are currently not used for drinking water supply.

Water undergoes testing and treatment prior to supplying to the public to ensure it is safe to drink. It is important to appreciate that the raw-water data presented does not represent the quality of drinking water distributed to the public. The treated water meets the requirements of the ADWG.

2 Consultation

In 2014, the department circulated the *Draft Allanooka and Dongara Water Reserve drinking water source protection review* (DoW unpublished) to stakeholders for comment. It was developed with input from the Shire of Irwin, Water Corporation, Department of Health, the former Department of Mines and Petroleum, the former Department of Planning, Main Roads WA and other relevant land managers.

The 2014 draft was not finalised or released on our website, due to ongoing issues that were raised by a number of stakeholders, relating to:

- potential impacts on proposed new production bores located in P2 areas
- potential land use restrictions on mining tenements
- risks to the quality of the drinking water source
- land management responsibilities
- long-term water planning matters.

Since then, the department has investigated and considered options to address these concerns (see section 3, recommendations).

As part of this 2019 review, the department consulted with the following stakeholders:

- Department of Planning, Lands and Heritage
- Department of Mines, Industry Regulation and Safety
- Water Corporation
- National Native Title Tribunal
- Yamatji Marlpa Aboriginal Corporation.

The department considered all feedback and incorporated it in this report, where appropriate.

3 Implementation of the 2002 water source protection plan

3.1 Status of previous recommendations

Table 2 outlines recommendations from the 2002 *Allanooka and Dongara–Denison water reserves water source protection plan* and their current status as they apply to the Allanooka–Dongara Water Reserve.

Table 2 Implementation status of the 2002 plan

No.	Recommendation	Comments
1	The existing Allanooka Water Reserve and Dongara–Denison Water Reserve should be de-proclaimed and replaced by the proposed Allanooka–Dongara Water Reserve under the *Country Areas Water Supply Act 1947.*	In 2004, the Allanooka Water Reserve and Dongara–Denison Water Reserve were abolished and replaced by the Allanooka–Dongara Water Reserve under the *Country Areas Water Supply Act 1947.*
2	Land planning strategies, including the Geraldton Region Plan and the Shire of Irwin Town Planning Scheme should incorporate the Allanooka–Dongara Water Reserve and management principles outlined in this plan and reflect the priority 1 and 2 classifications given to the water reserve.	The Shire of Irwin supports the plan and will ensure this is addressed in its planning strategy review process. This recommendation will be carried forward in this review (recommendation no. 2).
3	All development proposals within the Allanooka–Dongara Water Reserve that are likely to impact on water quality should be referred to the Water and Rivers Commission for advice and recommendation.	Development proposals within the Allanooka–Dongara Water Reserve are referred to DWER's Mid-West Gascoyne Region office. Guidelines have been provided through DWER's WQPN series. This recommendation is ongoing and will be carried forward in this review (recommendation no. 3).

No.	Recommendation	Comments
4	Signs should be erected along the boundaries of the water reserve to define the reserve and promote public awareness of the need to protect water quality.	The Allanooka–Dongara Water Reserve is located on agricultural land and has limited public access points. A map showing current and future sign locations was provided by the Water Corporation. All existing signs need to be maintained and replaced, where necessary (recommendation no. 5).
5	Incidents covered by WESTPLAN–HAZMAT in the Allanooka–Dongara Water Reserve should be addressed through the following measures: *(see 2002 plan for further details).*	Emergency response in the catchment area is an ongoing requirement and the recommendation will be carried forward (recommendation no. 9).
6	A surveillance program should be established to identify and respond to any incompatible land uses or potential contaminant threats within the Allanooka–Dongara Water Reserve. Consideration should be given to delegation of surveillance and by-law enforcement responsibilities in the proposed Allanooka–Dongara Water Reserve to the Water Corporation.	Delegation of the Allanooka–Dongara Water Reserve to the Water Corporation has been completed. Water Corporation continues to undertake surveillance and by-law enforcement and this recommendation will be carried forward (recommendation no. 6).
7	Review monitoring program to ensure water quality risks identified in this plan are addressed. Routinely review water quality analysis results to detect any adverse trends or results and initiate appropriate action.	Water Corporation continually monitors water quality in accordance with the ADWG (see Appendix B). This occurs through its requirements as a licenced water service provider. The current water quality monitoring program will continue (recommendation no. 6).
8	A detailed hydrogeological investigation should be conducted to further define the recharge processes for the water source.	DWER carried out a comprehensive groundwater investigation in the Allanooka and Casuarinas groundwater subareas between 2007 and 2011. Additional hydrogeological work is recommended (recommendation no. 10).

No.	Recommendation	Comments
9	Adopt strategies detailed in Section 8.6 Table 1 ‘Land use, potential water quality risks and recommended strategies’ *(see 2002 plan for further details).*	An implementation strategy was included in the 2002 plan. DWER no longer prepares implementation strategies for these reports.
10	Implementation of these recommendations should be reviewed annually after this plan is endorsed. A full review of this protection plan should be undertaken after five years.	This review document meets the intent of this recommendation. A seven-year review period is DWER’s current policy and this recommendation will be carried forward (recommendation 11).

3.2 Consolidated recommendations

Based on the findings of this review, the following recommendations will now be applied to the Allanooka–Dongara Water Reserve. The bracketed stakeholders are those expected to have a responsibility for, or an interest in, the implementation of that recommendation.

1. The lease and annual farm operation plan for the Department of Water and Environmental Regulation's land in the Allanooka-Dongara Water Reserve should be updated in accordance with recommendations in section 1.8.9. (Department of Water and Environmental Regulation and lessee)
2. Incorporate the findings of this review and location of the Allanooka–Dongara Water Reserve (including its priority areas and protection zones) in the Shire of Irwin's local planning scheme in accordance with the Western Australian Planning Commission's State planning policy no. 2.7: *Public drinking water source policy*. (Shire of Irwin)
3. Refer development proposals within the Allanooka–Dongara Water Reserve that are inconsistent with the Department of Water and Environmental Regulation's WQPN no.25: *Land use compatibility tables for public drinking water source areas* or recommendations in this plan to the Department of Water and Environmental Regulation regional office for advice. (Department of Planning, Lands and Heritage, Shire of Irwin, proponents of proposals.)
4. Undertake a risk assessment in accordance with the *Australian drinking water guidelines* (NHMRC & NRMMC 2011, August 2018 update) prior to constructing the proposed production bores. (Water Corporation.)
5. Maintain signs along the boundary of the Allanooka–Dongara Water Reserve and bore compounds to promote protection of the drinking water source, including an emergency contact telephone number. (Water Corporation.)
6. Water Corporation should continue water quality monitoring, maintenance of bore compound fencing, inspections, surveillance and by-law enforcement. (Water Corporation.)
7. Abandoned production and monitoring bores that will no longer be used should be decommissioned in accordance with the *Minimum construction requirements for water bores in Australia*. (Water Corporation.)
8. Ensure incidents covered by Westplan–HAZMAT in the Allanooka–Dongara Water Reserve are addressed by ensuring that:
    - the Shire of Irwin local emergency management committee (LEMC) is aware of the location and purpose of the Allanooka–Dongara Water Reserve
    - the locality plan for the Allanooka–Dongara Water Reserve is provided to the Department of Fire and Emergency Services headquarters for the HAZMAT emergency advisory team

- the Water Corporation acts in an advisory role during incidents in the Allanooka–Dongara Water Reserve
- personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Allanooka–Dongara Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality. (Water Corporation.)

9. Review the Allanooka–Dongara Water Reserve boundary based on hydrogeological modelling of the recharge area for existing and future production bores. (Department of Water and Environmental Regulation.)
10. A review of this report should be undertaken within seven years or as required to address water quality contamination risks. (Department of Water and Environmental Regulation.)

Appendices

Appendix A – Figures

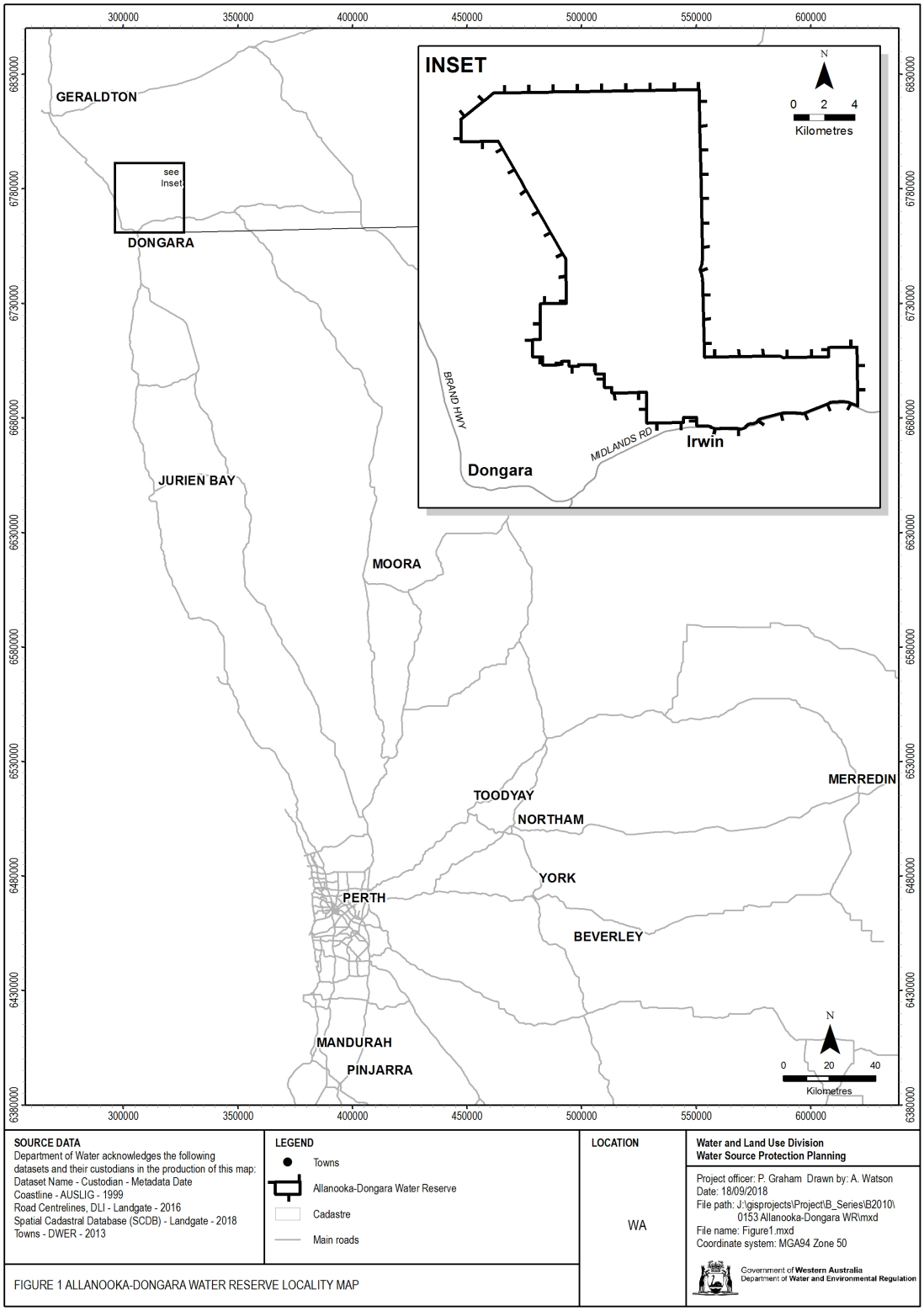

Figure A1 Allanooka–Dongara Water Reserve locality map

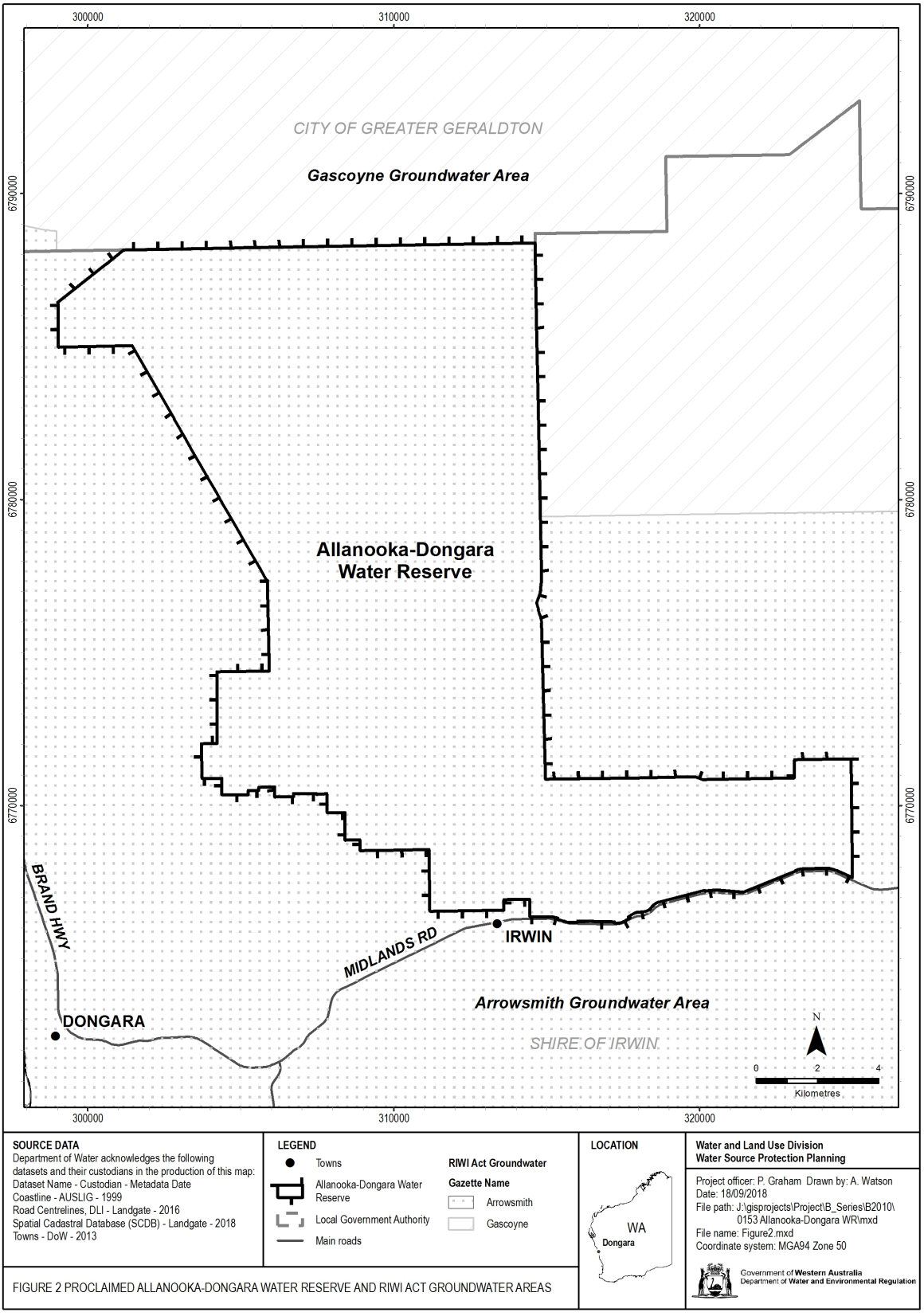

Figure A2 Allanooka–Dongara Water Reserve and Rights in Water and Irrigation (RIWI) Act 1914 groundwater areas

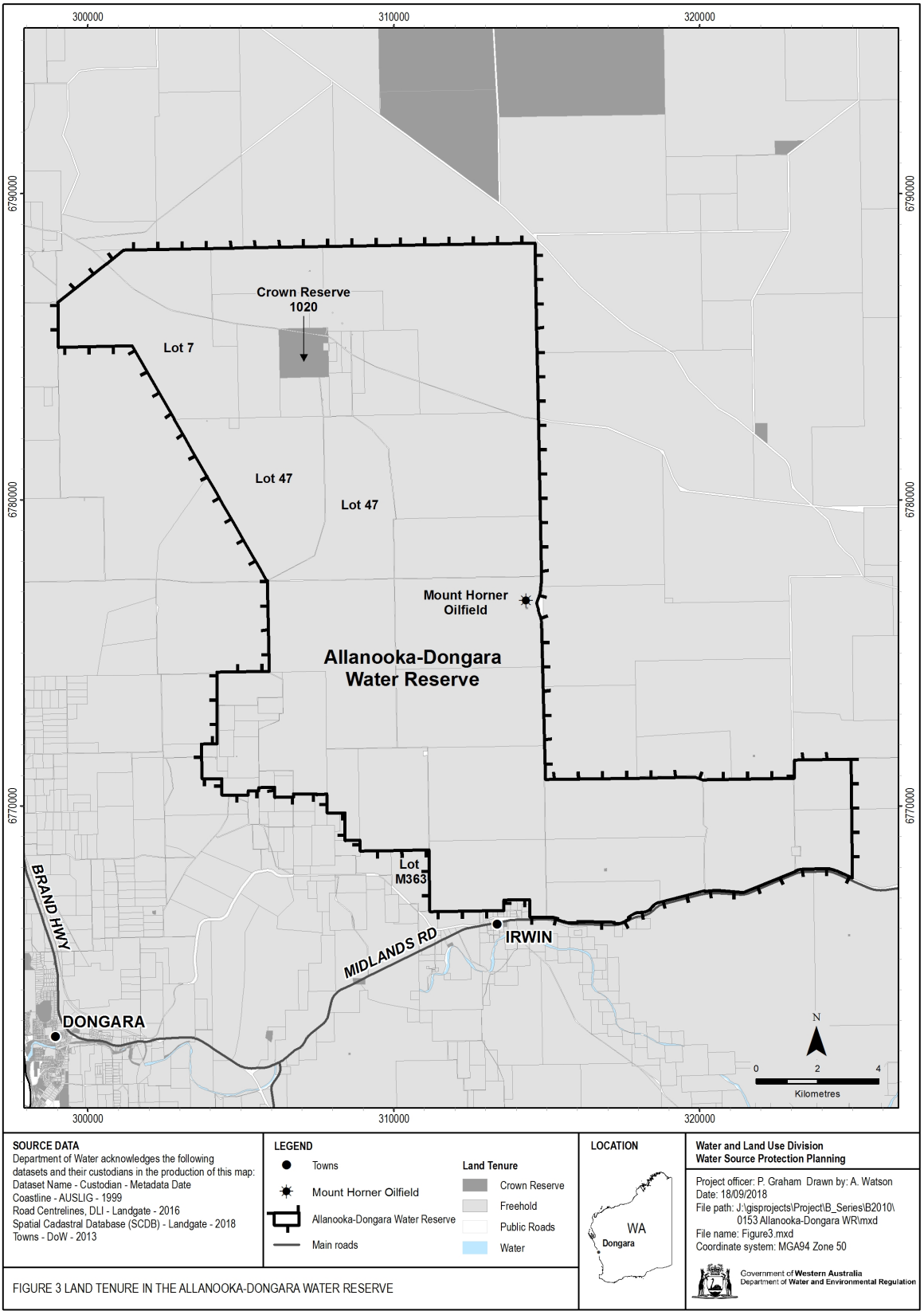

Figure A3 Land tenure in the Allanooka–Dongara Water Reserve

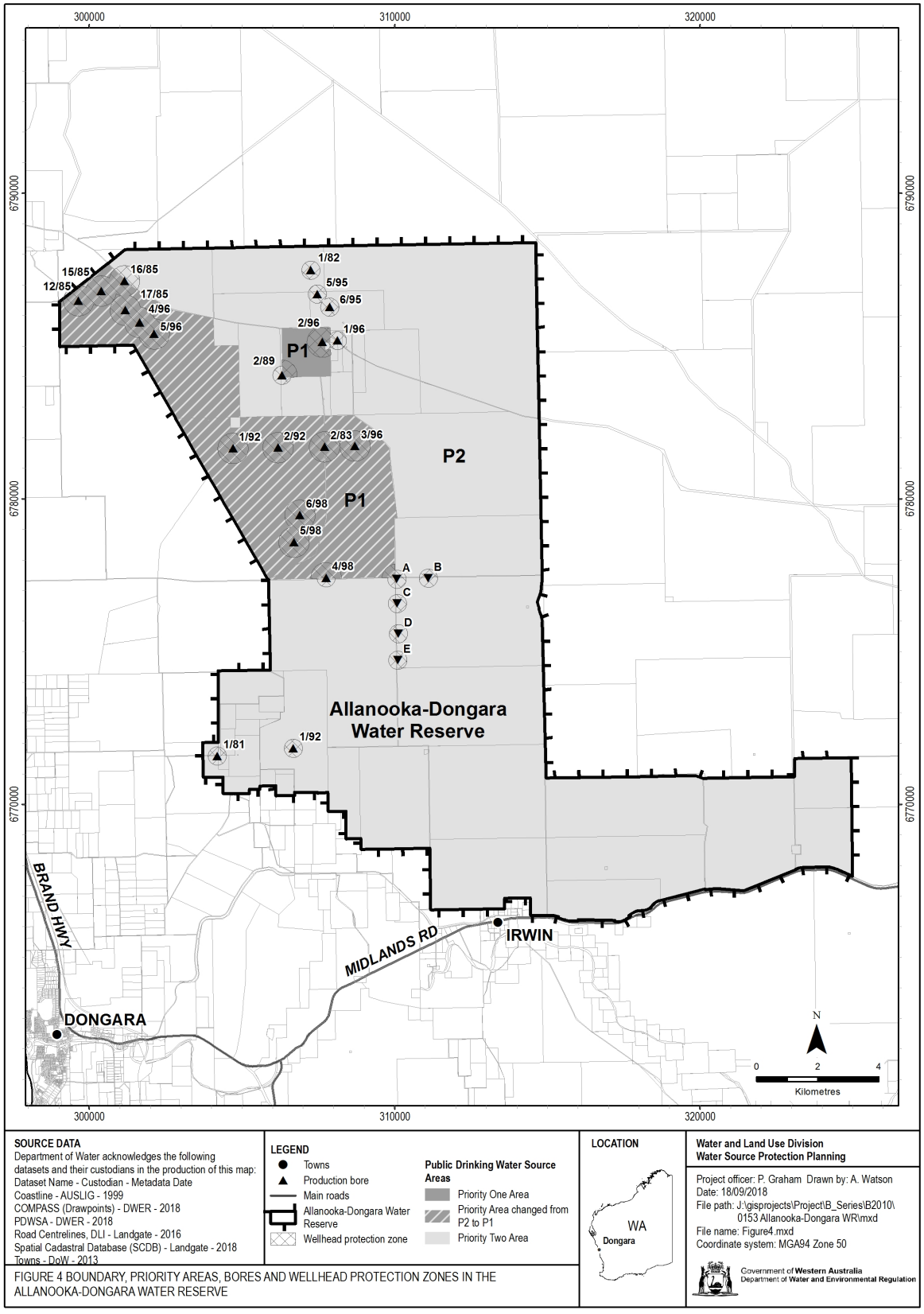

Figure A4 Priority areas, bores and wellhead protection zones in the Allanooka–Dongara Water Reserve

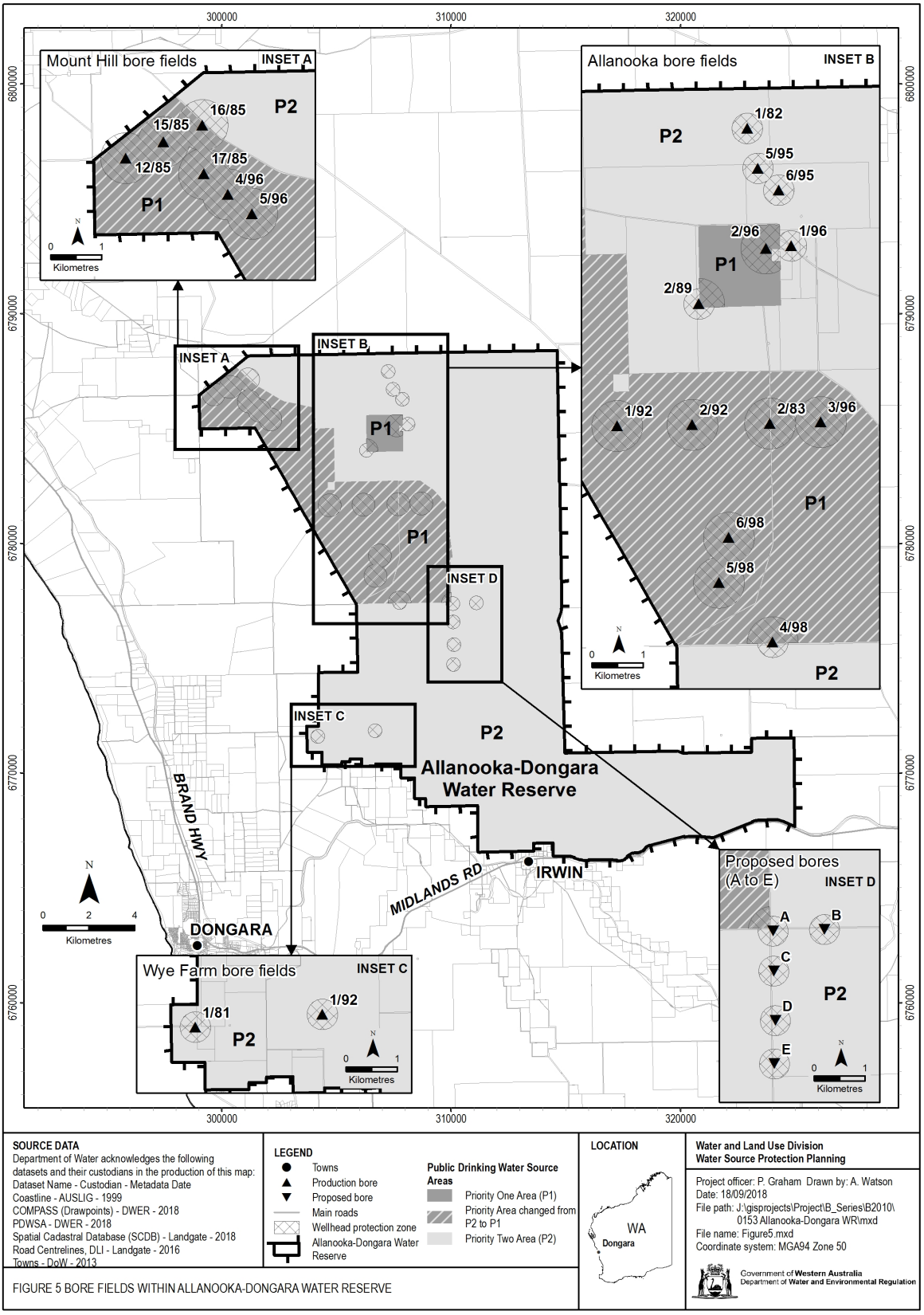

Figure A5 Bore fields and bores within the Allanooka–Dongara Water Reserve

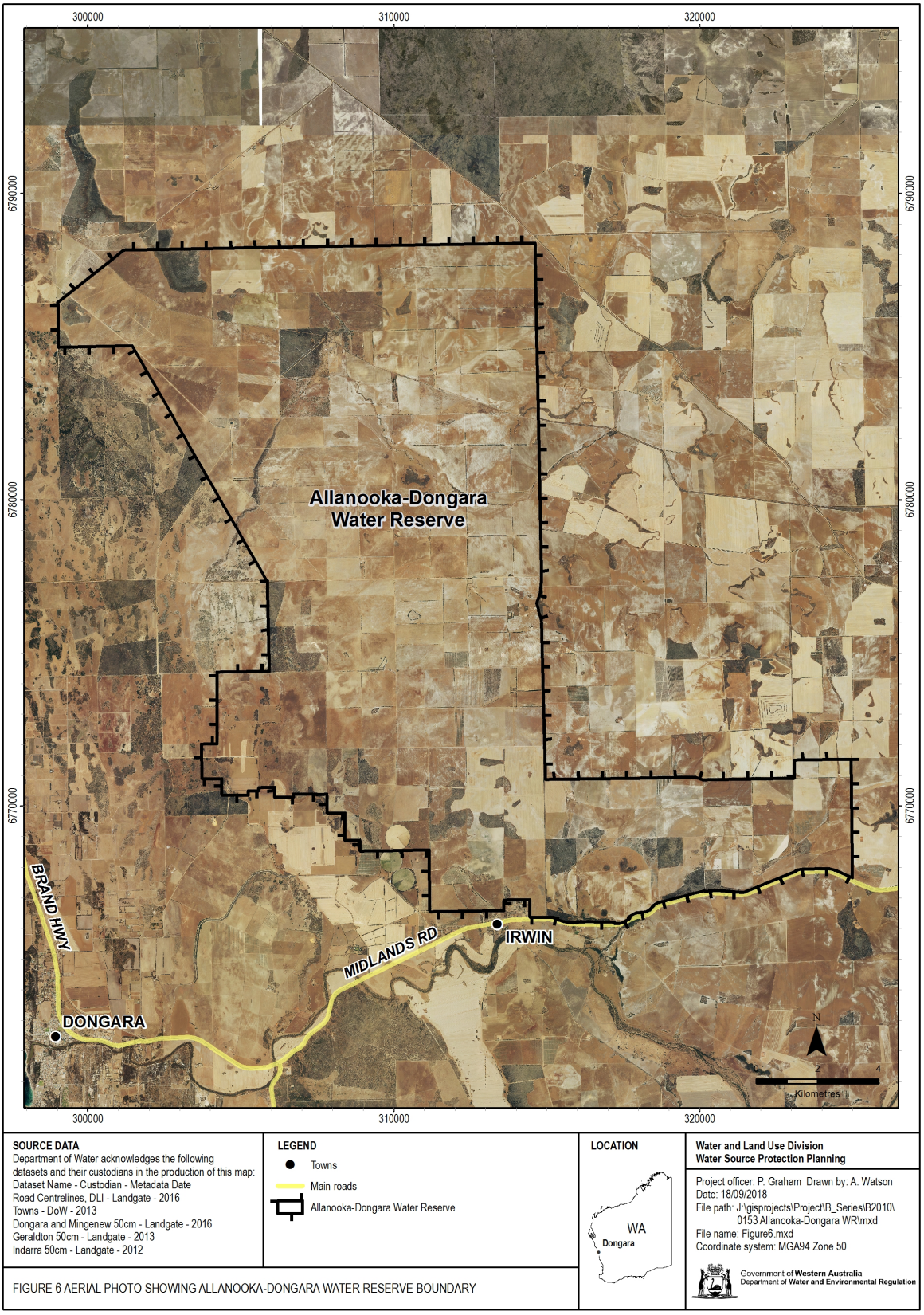

Figure A6 Aerial photo of the Allanooka–Dongara Water Reserve

Appendix B – Water quality data

The information provided in this appendix has been supplied by the Water Corporation.

The Water Corporation has monitored the raw (source) water quality from Allanooka, Mount Hill and Wye Farm bore fields in accordance with the requirements of the Australian drinking water guidelines (ADWG; NHMRC & NRMMC 2011, August 2018 update) and interpretations agreed to with the Department of Health. This data shows the quality of water in the public drinking water source area (PDWSA). The raw water is monitored regularly for:

- aesthetic characteristics (non-health-related)
- health-related characteristics including:
  - health-related chemicals
  - microbiological contaminants.

The following data represents the quality of raw water from Allanooka, Mount Hill and Wye Farm bore fields. In the absence of specific guidelines for raw-water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customer's tap. Any water quality parameters that have been detected are reported; those that on occasion have exceeded the ADWG are in ***bold and italics*** to give an indication of potential raw-water quality issues associated with this source. The values are taken from ongoing monitoring for the period August 2012 to August 2019.

It is important to appreciate that the raw-water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of the ADWG.

For more information on the quality of drinking water supplied to Midwest Region refer to the most recent Water Corporation drinking water quality annual report at www.watercorporation.com.au.

Aesthetic characteristics

The aesthetic quality analyses for raw water from Allanooka, Mount Hill and Wye Farm bore fields are summarised in the following table. Results in ***bold and italics*** indicate that the guideline level has been exceeded.

Table B1 Aesthetic detections for Allanooka, Mount Hill and Wye Farm bore fields raw water samples

Parameter	Units	ADWG aesthetic guideline value[1]	Allanooka bore field		Mount Hill bore field		Wye Farm bore field	
			Range	Mean	Range	Mean	Range	Mean
Aluminium (acid soluble)	mg/L	0.2	<0.008–0.01	<0.01	<0.008–0.015	<0.008	<0.008–0.01	<0.008
Chloride	mg/L	250	***360–395***	***375***	***280–495***	***353***	***315–400***	***350***
Colour (true)	TCU	15	<1–<1	<1	<1–<1	<1	<1–<1	<1
Conductivity	mS/m	–	145–157	150	115–190	143	141–156	146
Hardness as $CaCO_3$	mg/L	200	96–120	109	52–*130*	77	98–130	77
Iron unfiltered	mg/L	0.3	<0.003–*0.14*	<0.003	0.003–**1.8**	0.003	0.008–***0.94***	0.084
Manganese unfiltered	mg/L	0.1	<0.002–0.004	<0.002	<0.002–0.065	<0.002	<0.002–0.18	<0.002
Sodium	mg/L	180	***225–255***	***237***	***200–320***	***246***	***225–255***	***237***

Parameter	Units	ADWG aesthetic guideline value[1]	Allanooka bore field		Mount Hill bore field		Wye Farm bore field	
			Range	Mean	Range	Mean	Range	Mean
Sulfate	mg/L	250	48–58	51	40–80	64	48–57	51
Total filterable solids by summation	mg/L	500	***769–884***	***808***	***653–1029***	***797***	***777–857***	***821***
Turbidity	NTU	5	<0.4–*0.6*	0.4	<0.4–***17***	<0.4	<0.4–1.2	<0.4
pH measured in laboratory	no units	6.5–8.5	6.04–6.87	6.46	6.04–6.74	6.38	6.39–7.42	6.99

[1] An aesthetic guideline value is the concentration or measure of a water quality characteristic that is associated with good quality water.

Health-related chemicals

Raw water from Allanooka, Mount Hill and Wye Farm bore fields is analysed for chemicals that are potentially harmful to human health, including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that have been detected in the source are summarised in the following table. Results in ***bold and italics*** indicate that the guideline level has been exceeded.

Table B2 Health-related detections for Allanooka, Mount Hill and Wye Farm bore fields

Parameter	Units	ADWG health guideline value[2]	Allanooka bore field		Mount Hill bore field		Wye Farm bore field	
			Range	Mean	Range	Mean	Range	Mean
Manganese unfiltered	mg/L	0.5	<0.002–0.004	<0.002	<0.002–0.065	<0.002	<0.002–0.018	<0.002
Nitrate as nitrate	mg/L	50	1.771–3.853	2.998	<0.002–3.45	<0.002	2.347–17.273	7.684

[2] A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2011, August 2018 update).

Microbiological contaminants

Microbiological testing of raw-water samples from the bore fields is currently conducted on a monthly basis. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water from warm-blooded animals.

A detection of *E. coli* in raw water may indicate contamination of faecal material.

During the review period, positive *E. coli* counts were recorded in 4.7 per cent of raw water samples (three samples) at the Allanooka bore field. Of these three samples, one had an *E. coli* count greater than 20 MPN/100mL (26 MPN/100mL).

Also, positive *E. coli* counts were recorded in 6.6 per cent of samples (10 samples) at the Mount Hill bore field. None of these 10 samples had an *E. coli* count greater than 20 MPN/100mL.

There were no positive *E. coli* counts at Wye Farm bore field.

Appendix C – Photographs

Photo C1 Secure bore compound and scouring pipe at Allanooka–Dongara Water Reserve

Photo C2 Water Corporation's Allanooka chemical dosing plant

Photo C3 Soil erosion and pooling of water from a leaky reservoir outside the water treatment plant

Photo C4 Unsealed bores in Mount Hill bore field

Photo C5 Cattle within wellhead protection zone near bore scouring pipe outlet (photo by M. Sawyer, Water Corporation, 2014)

Photo C6 Parts of Hunt Gully at Allanooka-Dongara Water Reserve (Water Valley Farm)

Photo C7 Stock watering troughs in the Allanooka-Dongara Water Reserve

Photo C8 Mount Horner oilfield

Shortened forms

List of shortened forms

ADWG	*Australian drinking water guidelines*
DoW	Department of Water (former)
DWER	Department of Water and Environmental Regulation
HAZMAT	hazardous materials
LEMC	local emergency management committee
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
P1, P2, P3	priority 1, priority 2, priority 3
PSC 88	Public sector circular number 88
PDWSA	public drinking water source area
WAPC	Western Australian Planning Commission
Westplan–HAZMAT	Western Australian plan for hazardous materials
WHPZ	wellhead protection zone
WQPN	water quality protection note

Units of measurement

ha	hectares	A measure of area, 1 ha equals 10 000 m^2.
km	kilometres	A measure of distance, 1 km equals 1000 m.
km^2	square kilometres	A measure of area.
mS/m	millisiemens per metre	Electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
m	metres	A measure of distance.
m^2	square metres	A measure of area.
mg/L	milligrams per litre	A measure of concentration of a substance in a solution.
NTU	nephelometric turbidity units	A measure of turbidity in water.
pH		A logarithmic scale for expressing the acidity or alkalinity of a solution; a pH below 7 indicates an acidic solution and above 7 indicates an alkaline solution.
TCU	**true colour units**	A measure of degree of colour in water.
yr	**year**	A measure of time.

Volumes of water

One millilitre	0.001 litre	1 millilitre	(mL)
One litre	1 litre	1 litre	(L)
One thousand litres	1000 litres	1 kilolitre	(kL)
One million litres	1 000 000 litres	1 megalitre	(ML)
One thousand million litres	1 000 000 000 litres	1 gigalitre	(GL)

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Adsorb	Adsorb means to accumulate on the surface of something.
Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, for example appearance, taste and odour (NHMRC & NRMMC 2011).
Allocation	Is the volume of water that a licensee is permitted to abstract, usually specified in kilolitres per year (kL/y).
Aquifer	A geological formation or group or formations able to receive, store and transmit significant quantities of water.
Australian drinking water guidelines	The *National water quality management strategy: Australian drinking water guidelines 6* (ADWG; NHMRC & NRMMC 2011) outlines acceptable criteria for the quality of drinking water in Australia (see *References*).
Augment	To increase the available water supply, for example, pumping back water from a secondary storage/reservoir dam.
Backflow	The unintended flow of water from a potentially polluted source back into a clean water supply, which can be caused by siphoning when the pressure in the water supply system is low.
Bore	A narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
Bore field	A group of bores to monitor or withdraw groundwater.
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Contamination	A substance present at concentrations exceeding background levels that presents – or has the potential to present – a risk of harm to human health, the environment, water resources or any environmental value.
Drinking water source protection report	A report on water quality hazards and risk levels within a public drinking water source area; includes recommendations to avoid, minimise, or manage those risks for the protection of the water supply in the provision of safe drinking water supply.

Gazette	Publication within the Government Gazette of Western Australia of the Order in Council or proclamation defining the boundaries of any catchment area or water reserve.
Groundwater	The water that occurs in pore spaces and fractures in rocks beneath the ground surface. Also see aquifer and unconfined aquifer.
Groundwater area	An area proclaimed under the *Rights in Water and Irrigation Act 1914* for the purposes of licensing and managing water use.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2011).
Hydraulic gradient	The change in hydraulic head per unit of distance, which determines the rate of groundwater flow.
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The branch of geology that deals with the occurrence, distribution and effects of groundwater. It is the study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
Licence	A formal authorisation which entitles the licence holder to ‘take’ water from a watercourse, wetland or underground source for a specified quantity and period of time.
Maximum risk	This is the level of risk in the absence of any preventive measures (barriers) being installed in the system, or assuming that preventive measures have failed. Assessing maximum risk is useful for identifying high priority risks, determining where attention should be focused and preparing for emergencies (NHRMC & NRMMC 2011).
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.

Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Order in Council	Made under the Governor of Executive Council and published in the Government Gazette to constitute or abolish a catchment area or water reserve under section 9 of the *Country Areas Water Supply Act 1947.*
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses.
Permeability	Also referred to as hydraulic conductivity, this is the ability of a rock or soil unit to transmit fluids. Its magnitude depends on the size of the pore spaces (see porosity) and the degree to which they are interconnected.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Pollution	Water pollution occurs when waste products change the physical, chemical or biological properties of the water, adversely affecting water quality, the ecosystem and beneficial uses of the water.
Porosity	The ratio of water (or air) filled pore spaces to the total volume of the rock or soil, expressed as a percentage or fraction.
Priority 1, 2 and 3	Three different priority areas are assigned within PDWSAs to guide land use decisions. The objective of priority 1 (P1) areas is *risk avoidance*, priority 2 (P2) areas is *risk minimisation* and priority 3 (P3) areas is *risk management*.
Public drinking water source area	The area from which water is captured to supply drinking water. It includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.

Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Residual risk	This is the level of risk after considering preventive measures (barriers) that are applied in the drinking water supply system, such as fencing to keep cattle away from drinking water bores, or surveillance to identify people accessing protected areas. Residual risk provides an indication of how effective preventive strategies are, or the need for additional preventive measures (NHRMC & NRMMC 2011).
Runoff	Water that flows over the surface from a catchment area, including streams.
Scheme supply	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
Semi-confined aquifer	A semi-confined aquifer or leaky aquifer is saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.
Sole supply	The only source of drinking water for a given town or community. These sources are important to protect as there are no other current options to supply drinking water for that location.
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.
Superficial aquifer	Shallow (near to the surface) aquifers which are easily recharged and can be readily accessed by bores.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Unconfined aquifer	An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the watertable. This is also known as a superficial aquifer.

Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water quality	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	An area constituted under the *Country Areas Water Supply Act 1947* or the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater
Wellhead	The top of a well (or bore) used to draw groundwater
Wellhead protection zone	Usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination risks.
Westplan–HAZMAT	State emergency management plan for hazardous materials emergencies.

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