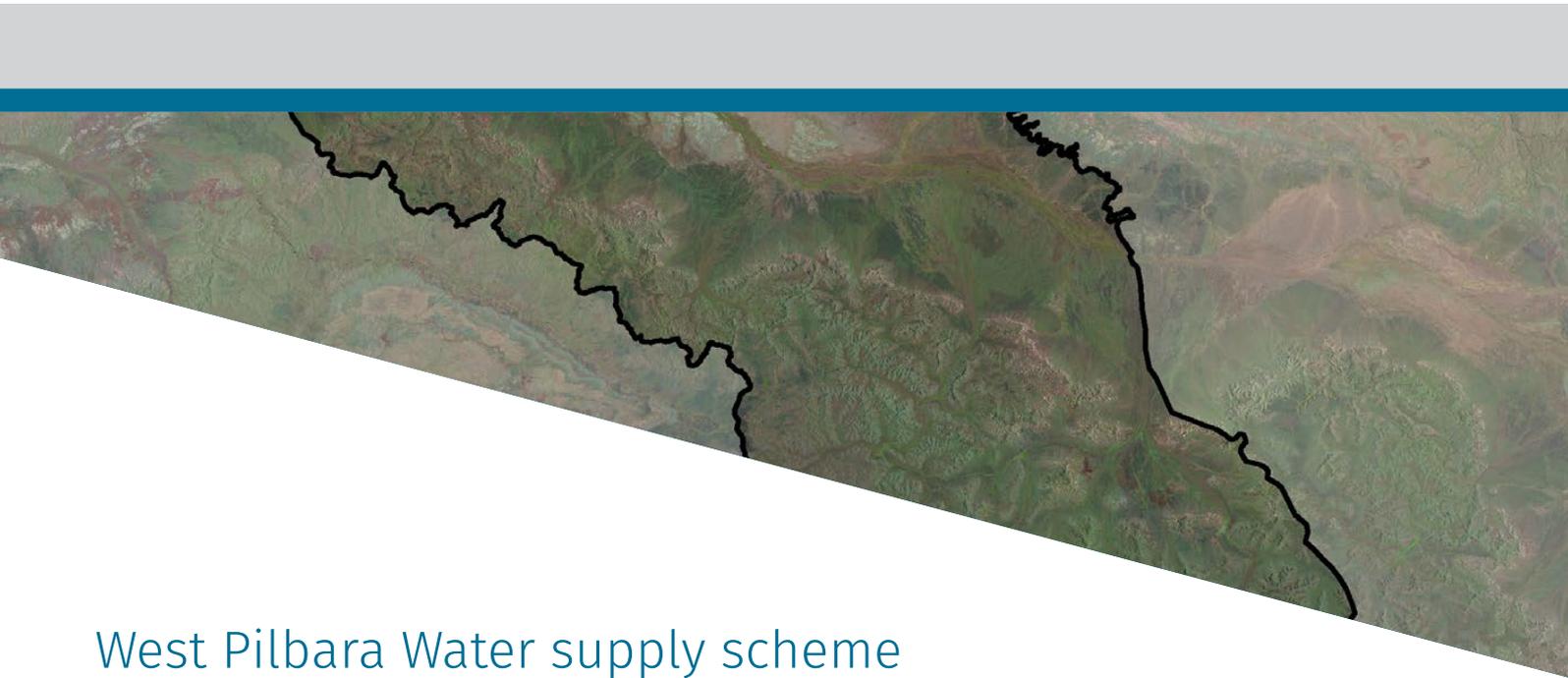




Millstream Water Reserve

drinking water source protection review



West Pilbara Water supply scheme

Millstream Water Reserve drinking water source protection review

West Pilbara Water Supply Scheme

Department of Water and Environmental Regulation

Water resource protection series

Report no. 178

November 2018

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Cover photograph: Aerial photo of Millstream Water Reserve

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The Department of Water and Environmental Regulation was established by the Government of Western Australia on 1 July 2017. It is a result of the amalgamation of the Department of Environment Regulation, Department of Water and the Office of the Environmental Protection Authority. This publication may contain references to previous government departments and programs. Please email the Department of Water and Environmental Regulation to clarify any specific information.

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 report was prepared by the former Department of Water (DoW). On 1 July 2017, the Government of Western Australia established the Department of Water and Environmental Regulation (DWER), resulting from the amalgamation of DoW, the Department of Environmental Regulation, and the Office of the Environmental Protection Authority. As such, this publication contains references to previous government departments and programs.

This drinking water source protection review updates and amends parts of the *Millstream Water Reserve drinking water source protection plan* (DoW 2010b). It considers updated hydrogeological information for the Millstream Water Reserve since the plan was released. The 2010 plan still contains other relevant information, so it is important that these documents are read in conjunction. Both are available on our website or by contacting us.

The Millstream wellfield is approximately 100 km south of Karratha. Along with water from Harding Dam and the Bungaroo Creek Water Reserve, it supplies the West Pilbara Water Supply Scheme.

The Millstream area is a complex system of permanent pools and wetlands, which is predominantly fed by groundwater discharge from the Millstream Dolomite, along with seasonal flows in the Fortescue River. The bores at Millstream are drilled into the Millstream Dolomite, which is an unconfined and highly transmissive aquifer, making the wellfield vulnerable to contamination from inappropriate land uses.

The Department of Water and Environmental Regulation (DWER) prepared this document in consultation with key stakeholders, including former Department of Parks and Wildlife (now the Department of Biodiversity, Conservation and Attractions), relevant pastoral lease managers, the Yindjibarndi Aboriginal Corporation and the Water Corporation.

The main changes since the 2010 plan are:

- The existing Millstream Water Reserve boundary is being reduced to reflect an updated hydrogeological assessment of the northern section of the water reserve boundary.
- Two previous production bores (9 and 10) will be decommissioned due to salinity issues.

This review helps implement:

- the *Australian drinking water guidelines* (ADWG; NHMRC & NRMCC 2011)
- State planning policy no. 2.7: *Public drinking water source policy* (Western Australian Planning Commission 2003)
- Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a).

Important information about the Millstream Water Reserve is in Table 1.

Table 1 Key information about the Millstream Water Reserve

Millstream Water Reserve	
Local government authority	Shire of Ashburton
Locations supplied	<p>West Pilbara Water Supply Scheme: Karratha, Dampier, Roebourne, Wickham, Point Samson, Cape Lambert, Burrup Peninsula.</p> <p>The scheme is sourced from Millstream Water Reserve (this report), Harding Dam Catchment Area and the Bungaroo Creek Water Reserve. For other reports see www.dwer.wa.gov.au.</p>
Water service provider	Water Corporation
Aquifer type	Unconfined, highly transmissive aquifer vulnerable to contamination from surface activities
Licensed abstraction	15 GL per year (when combined with a surface water allocation from Harding Dam)
Number of bores	Eight
Bore names and GPS coordinates	<p>Bore 1 (E 506 880, N 7 612 178, zone 50)</p> <p>Bore 2 (E 506 864, N 7 611 970, zone 50)</p> <p>Bore 3 (E 506 831, N 7 611 524, zone 50)</p> <p>Bore 4 (E 507 079, N 7 611 723, zone 50)</p> <p>Bore 5 (E 507 051, N 7 611 934, zone 50)</p> <p>Bore 6 (E 506 804, N 7 611 157, zone 50)</p> <p>Bore 7 (E 508 856, N 7 610 230, zone 50) – currently unequipped due to asset deterioration and salinity</p> <p>Bore 8 (E 509 142, N 7 609 949, zone 50) – currently unequipped due to asset deterioration and salinity</p> <p>Bore 9 (E 509 428, N 7 609 666, zone 50) – unequipped and proposed to be decommissioned</p> <p>Bore 10 (E 509 736, N 7 609 363, zone 50) – unequipped and proposed to be decommissioned</p> <p>Bore 11 (E 510 088, N 7 609 056, zone 50) – unequipped and proposed to be decommissioned</p>

Millstream Water Reserve	
	Bore 12 (E 510 488, N 7 608 706, zone 50) – unequipped and proposed to be decommissioned
Dates of drinking water source protection reports	<p>1999 – <i>Millstream Water Reserve water source protection plan</i> (Water and Rivers Commission)</p> <p>2010 – <i>Millstream Water Reserve drinking water source protection plan</i> (DoW)</p> <p>2017 – <i>Millstream Water Reserve drinking water source protection review</i> (this document)</p>
Consultation	<p>1999 – targeted stakeholder consultation as part of the water source protection plan</p> <p>2009 – targeted stakeholder consultation as part of the drinking water source protection plan</p> <p>2017/18 – targeted stakeholder consultation as part of this review</p>
Constitution history	<p>Constituted in the Government Gazette on 2 March 2001 under the <i>Country Areas Water Supply Act 1947</i></p> <p>Amendment will need to be progressed under the <i>Country Areas Water Supply Act 1947</i> when this report is finalised</p>
Reference documents	<p><i>Australian drinking water guidelines</i> (NHMRC & NRMCC 2011)</p> <p>State planning policy no. 2.7: <i>Public drinking water source policy</i> (Western Australian Planning Commission 2003)</p> <p>Allocation planning series no. 42: <i>Millstream aquifer – determination of a long-term sustainable yield and long-term reliable allocation</i> (DoW 2010a)</p> <p>Water resource allocation and planning report series no. 55: <i>Pilbara groundwater allocation plan</i> (DoW 2013)</p> <p><i>WAter resources inventory 2014 water availability, quality and trends</i> (DoW 2014)</p> <p><i>Hydrogeology of the Fortescue Valley</i> (Barnett et al. 1986)</p> <p><i>The Pilbara Coast water study</i> (Haig 2009)</p> <p><i>Millstream model calibration</i> (Sinclair Knight Merz 2009)</p> <p><i>A local scale groundwater model of the Millstream aquifer</i> (URS 2007)</p>

1 Review of Millstream Water Reserve drinking water source protection plan

1.1 Boundary, priority areas and protection zones

This drinking water source protection review updates and amends parts of the *Millstream Water Reserve drinking water source protection plan* (DoW 2010). It complements the information in the 2010 plan and therefore needs to be read alongside it.

Since 2010, the Department of Water and Environmental Regulation (DWER) has conducted further hydrogeological investigations of the northern area of the Millstream Water Reserve, meaning that the boundary in this area can be reduced.

We have reviewed and assessed the geology, hydrogeology and hydrology in the north and found that an original geological interpretation that was used to create the existing boundary could be improved in accuracy. A wide, impermeable barrier (including the Proterozoic Marra Mamba Iron Formation) was identified between the wellfield and the existing northern boundary. The hydrogeological model was updated with the new information and a thorough surface water assessment was also undertaken.

These assessments confirmed that a new, reduced boundary was appropriate. Figure A1 shows the current constituted boundary and Figure A2 shows the proposed boundary. DWER recommends that it should be constituted as the Millstream Water Reserve, via an amendment to the boundary under the *Country Areas Water Supply Act 1947* (see section 2.2, recommendation 1). The department will arrange this once the review is published.

The proposed Millstream Water Reserve boundary still ensures that the recharge area of this important drinking water supply will be constituted and mapped to ensure it is considered in future land use decisions or development of other bores. This means the water reserve will continue to protect water quality and ensure the availability of a reliable and safe drinking water to consumers of the West Pilbara Water Supply Scheme now and in the future.

The boundary, priority areas and protection zones have been determined in accordance with our Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a). The existing priority areas remain unchanged in this review (see Figure A5).

Please read Appendix C for more information about how we protect drinking water sources.

1.2 Update on water supply scheme

In 2014, the department renewed the Water Corporation's licence to draw 15 GL per year from Harding Dam and the Millstream aquifer. This licence expires in 2024.

Previously the wellfield consisted of 12 production bores. However, four of these (9, 10, 11 and 12) are now unequipped due to salinity issues, and it is unlikely that they will be used again (the 2010 report stated they were active).

Additionally there are two production bores (7 and 8) which are currently unequipped due to severe deterioration (pumps/columns/casings/motors) and moderate salinity, however they may be required and be re-equipped in the future. Therefore, currently there are six active production bores.

DWER recommends that production bores that are no longer used and are not likely to be re-equipped should be appropriately decommissioned consistent with *Minimum construction requirements for water bores in Australia* (National Uniform Drillers Licensing Committee 2012) (see section 2.2, recommendation 9).

For more information on why it is so important to protect our catchments, and DWER's approach based on preventive risk, read Appendix D.

1.3 Enforcing by-laws, surveying the area and maintenance

This review recommends that the Water Corporation continue by-law enforcement under the existing delegation arrangement (see section 2.2, recommendations 3 and 6)

- erecting and maintaining signs in accordance with *S111 Source protection signage* (Water Corporation 2013)
- maintaining security and fencing surrounding the bores and treatment compound
- ongoing regular surveillance and inspections.

1.4 Other departmental work

These are other reports the former Department of Water (DoW) (now DWER) published that are related to the Pilbara region including Millstream. They are not directly linked to this report but provide context and background for water-related issues in the locality of the Millstream Water Reserve.

1.4.1 Water resources inventory

In 2014, the *Water resources inventory – Water availability, quality and trends* (DoW) was released. It describes water resources in the Pilbara, stating that there is no further water available from the shallow Millstream aquifer as it is fully allocated. It states that the long-term reliable allocation for the Millstream aquifer as a standalone source is 6000 ML per year.

1.4.2 Pilbara groundwater allocation plan, 2013

In 2013, the *Pilbara groundwater allocation plan* (DoW) was released. It sets out how the department will manage groundwater in the Pilbara through allocation limits, water licensing and ongoing monitoring and evaluation over seven years (or longer).

It discusses the sources for the West Pilbara Water Supply Scheme. The plan sets allocation limits for Millstream and Harding Dam: *“The combined reliable yield for the scheme, between Harding Dam and the Millstream aquifer, is 10 GL/yr with 94 per cent reliability.”*

The plan details the high ecological, social and cultural values of Millstream and commits to protecting them.

1.4.3 Millstream aquifer - determination of a long-term sustainable yield and long-term reliable allocation, 2010

In 2010, the *Millstream aquifer – determination of a long-term sustainable yield and long-term reliable allocation* (DoW) report was released.

This report assesses the long-term sustainable yield for Millstream explaining that the long-term sustainable yield is relatively low due to the variability of recharge from cyclones.

This report describes that the Millstream aquifer already has an allocation which is greater than its sustainable yield and discusses how this will be managed through criteria placed on the operation of the borefield.

1.4.4 Pilbara regional water plan, 2010-2030

In 2010, the *Pilbara Regional water plan – Statement of response* (DoW) was released. It provided the department’s response to the comments received on the *Draft Pilbara regional water plan* in 2009.

Later that same year, the *Pilbara regional water plan 2010–2030* (DoW) was released. The plan sets strategic directions for the Pilbara region’s water resources, including Millstream, to be managed and developed in a sustainable manner. The plan has a long-term view to 2030.

1.4.5 Millstream status report, 2009

In 2009, the *Millstream status report – A review of management and consolidation of current understanding* (DoW) was released. This report reviewed and updated resource management decisions that were previously based on assumptions or uncertainties.

The review consolidated understanding of the aquifer and the environment, reviewed the management to date and identified assumptions and information gaps.

1.5 Update on water quality risks

There have been no significant changes in land uses since the 2010 *Millstream Water Reserve drinking water source protection plan*. Please refer to Appendix C of the 2010 plan for a summary of land uses, potential water quality risks and recommended protection strategies within the Millstream Water Reserve.

Refer to Appendix D to gain a greater understanding about the risk assessment process we use.

1.5.1 Existing and proposed land uses and activities

The Millstream Water Reserve consists of Crown land under various forms of reserves or leases. The main uses are national park, water supply, pastoral leases and mining tenements. An update on current land uses and activities is outlined below.

National park

The Millstream Water Reserve sits within a portion of the Millstream–Chichester National Park. The Department of Biodiversity, Conservation and Attractions (DBCA) manages the park in accordance with:

- *Policy statement no. 18 – Recreation, tourism and visitor services* (Department of Environment and Conservation 2006)
- *Millstream-Chichester National Park and Mungaroona Range Nature Reserve management plan* (Department of Environment and Conservation 2011).

Operational policy no. 13: Recreation within public drinking water source areas on Crown land (DoW 2012) was updated after the 2010 Millstream plan was released. This policy applies to recreation in the Millstream Water Reserve.

The Department of Justice work camp – which was located within the national park – has now been closed. This means that water quality risks are now reduced. This land use and its risks detailed in the 2010 Millstream Water Reserve drinking water source protection plan are no longer relevant.

The *Millstream–Chichester National Park and Mungaroona Range Nature Reserve management plan* (DEC 2011) proposed the expansion of various types of accommodation facilities in the national park. The plan discussed developing new accommodation, expanding existing camping facilities and creating new camp sites.

In 2016, the department supported some new camp sites and improved recreational facilities at Miliyanha and Stargazers as a replacement for a number of sites at Crossing Pool that were closed in 2013.

Tourism WA, through its Naturebank project, has identified the Millstream area as a possible location for commercial eco and nature-based tourism, including accommodation. Negotiation with DWER and the Water Corporation has identified a preferred site for this proposal that will be outside of the new proposed Millstream

Water Reserve, thereby eliminating the risk to the Millstream drinking water source from this proposal.

Where possible, future proposals should be located outside of the Millstream Water Reserve to ensure consistency with the state's water source protection policies and procedures, and protect drinking water quality and public health.

Pastoral leases

There are two pastoral leases covering parts of the water reserve. Further information on these is available in the 2010 plan.

Mining tenements

Mining tenements are held across the majority of the Millstream Water Reserve. There are ten operating gravel pits currently supplying gravel for the Robe Rail, in addition to the handling, loading and storage sites associated with the Robe Rail. There are no operating iron ore mines but there is the potential for new mining operations in the future. Currently there are three major iron ore project proposals within the Millstream Water Reserve.

Proposals will be assessed through the state's environmental approvals process, including consideration of the potential impacts on the Millstream Water Reserve and whether the project poses an unacceptable risk to water quality.

Aboriginal sites of significance and native title

The Millstream area is one of the most significant cultural and mythological sites of importance for Aboriginal people in northern Western Australia. Consequently, there are many sites of significance and native title claims within the water reserve. Please refer to the 2010 plan for more information.

There are currently 129 sites of significance within the Millstream Water Reserve. The new proposed boundary will result in 59 of those sites no longer being within the water reserve.

1.5.2 Other groundwater bores

There are 48 currently licensed groundwater bores for six different users within the Millstream Water Reserve.

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's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914*. All bores should be constructed 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.

1.6 Department of Water and Environmental Regulation land

There is a *Land Administration Act 1997* reserve in the Millstream Water Reserve jointly vested with DWER and the Water Corporation for the purpose of water supply. Reserve 38991 covers much of the Priority 1 (P1) area of the Millstream Water Reserve and extends beyond the water reserve boundary to the west. The department recommends that a land management strategy be developed with Water Corporation, ensuring that the priority purpose for management of this land is drinking water protection (see section 2.2, recommendation 11). Refer to the 2010 plan for further information.

1.7 Water quality information

The Water Corporation has provided updated water quality information for the Millstream Water Reserve. This is shown in Appendix B.

There are high levels of naturally occurring hardness and turbidity, which is treated before supply to consumers.

There have been occasional *Escherichia coli* detections which were low level and non-reoccurring. Follow up samples after each event detected no *E. coli*. The source of contamination was unknown.

It is important to appreciate that this raw water data 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 Australian drinking water guidelines before it is supplied to consumers.

2 Implementing Millstream Water Reserve's drinking water source protection plan

2.1 Status of previous recommendations

Table 2 outlines recommendations from the 2010 plan and their current status.

Table

Table 2 *Implementation status for Millstream Water Reserve*

No.	Recommendation	Comments
1	The boundary of the Millstream Water Reserve should be amended under the <i>Country Areas Water Supply Act 1947</i> .	The current boundary was constituted in 2001. This review recommends to amend the boundary (section 2.2, recommendation no. 1).
2	Develop an implementation strategy for this plan's recommendations.	Implementation plans are no longer required as the status of recommendations are captured in drinking water source protection reviews (e.g. this table in this review).
3	Incorporation into land planning strategies.	<p>The water reserve has not been incorporated into the Shire of Ashburton's town planning scheme (no.7) as a special control area.</p> <p>However, a significant proportion of the P1 area of the Millstream water reserve is a local scheme reserve, zoned as <i>public purposes, water and drainage</i> in the town planning scheme.</p> <p>Consistent with the Western Australian Planning Commission's State planning policy no. 2.7: <i>Public drinking water source policy</i>, this review recommends including the proposed water reserve and wellhead protection zones into the next update of the scheme (section 2.2, recommendation no. 2).</p>

No.	Recommendation	Comments
4	All development proposals within the Millstream Water Reserve inconsistent with Water quality protection note no. 25 or recommendations in this plan should be referred to DWER for advice and recommendations.	Development proposals within the water reserve are referred to the department's North West Region. This has been continued as a recommendation of this review (section 2.2, recommendation no. 4).
5	Incidents covered by Westplan–HAZMAT in the Millstream Water Reserve.	This has been continued as a recommendation of this review (section 2.2, recommendation no. 5).
6	DWER should consider delegating responsibility for monitoring and enforcement measures within the Millstream Water Reserve to the Water Corporation.	This has been delegated to the Water Corporation. This review recommends that Water Corporation continue monitoring and enforcement on the department's behalf (section 2.2, recommendation no. 6).
8	Additional signs should be erected along the boundary of the Millstream Water Reserve to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number.	There are signs on some entry roads and around production bore compounds. Additional signs should be installed and maintained in accordance with <i>S111 Source protection signage</i> (Water Corporation 2013). This has been continued as a recommendation of this review (section 2.2, recommendation no. 3).
9	A review of this plan should be undertaken after seven years.	This has been undertaken through the preparation of this review document. Future reviews are expected to occur every seven years, subject to resources and risk priorities.

No.	Recommendation	Comments
10	The <i>Millstream-Chichester National Park and Mungarooona Range Nature Reserve management plan</i> (DEC 2011) should ensure that source protection objectives are adequately addressed.	The 2011 management plan appropriately identified risks of contamination to the aquifer associated with recreation sites and activities, and detailed strategies to address these threats. This review proposes an amendment of the boundary that will further reduce the area of the Millstream Chichester National Park that is within the water reserve. This new boundary should be reflected in the next update of the management plan.
11	New ablution facilities within the water reserve should be sited away from the Millstream Dolomite.	Proposals for new facilities have been referred to the department. This has been continued as a recommendation of this review (section 2.2, recommendation no. 8).
12	DWER continue to work with the Yindjibarndi Aboriginal Corporation on planning and management activities related to the management of water at Millstream.	This has occurred and will continue as a recommendation of this review (section 2.2, recommendation no. 7).

2.2 Consolidated recommendations

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

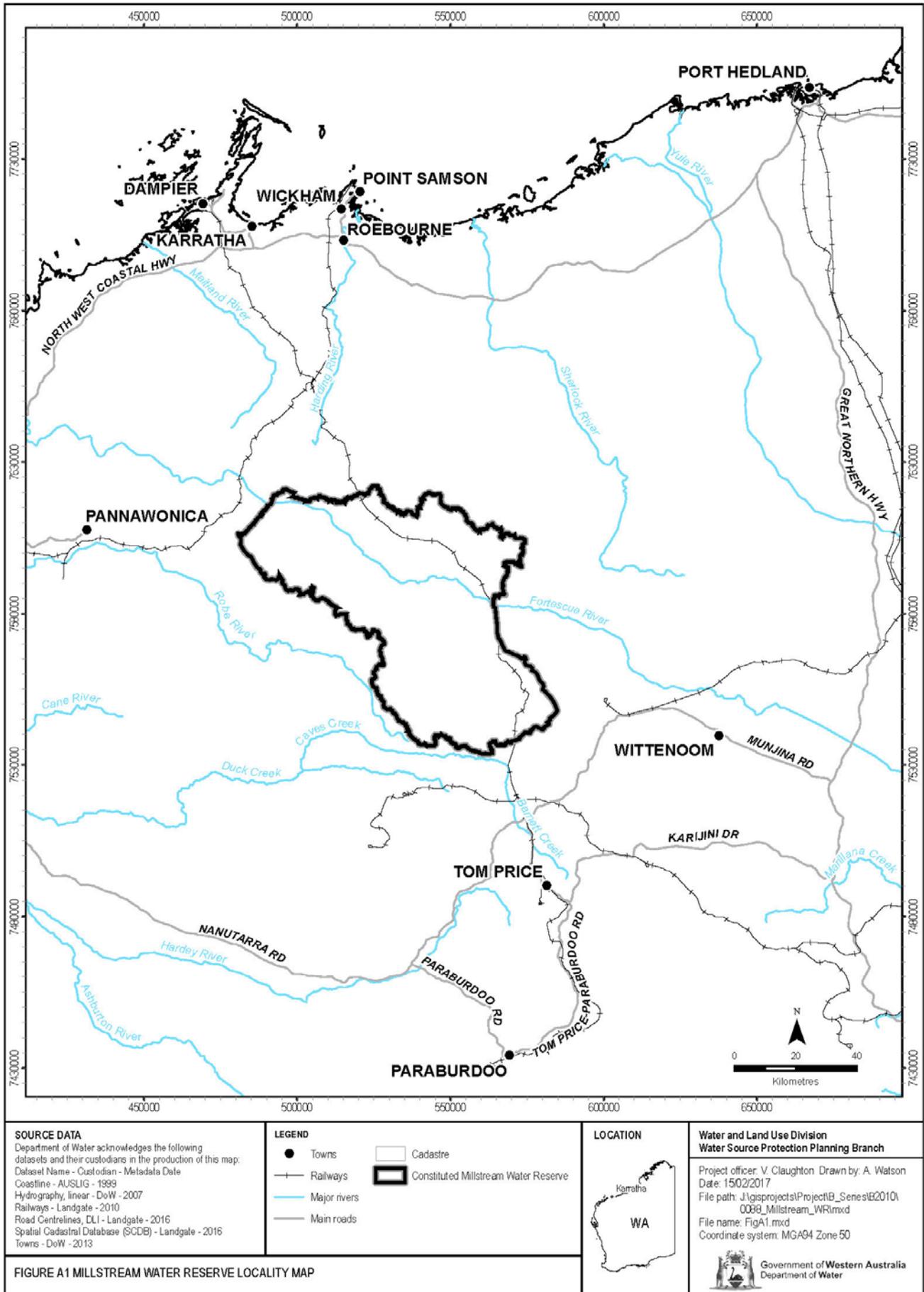
1. Amend the boundary of the Millstream Water Reserve under the *Country Areas Water Supply Act 1947* as shown in Figure A2. (DWER)
2. Incorporate the findings of this review and the amended boundary of the Millstream Water Reserve in the Ashburton local planning scheme in accordance with the Western Australian Planning Commission's State planning policy no. 2.7: *Public drinking water source policy*. (Shire of Ashburton)
3. Erect and maintain signs along the new boundary of the Millstream Water Reserve including an emergency contact telephone number, in accordance with the Water Corporation's *S111 Source protection signage* (2013). (Water Corporation)
4. Refer development proposals within the amended Millstream Water Reserve that are inconsistent with the department's WQPN no.25: *Land use compatibility*

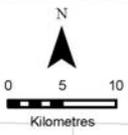
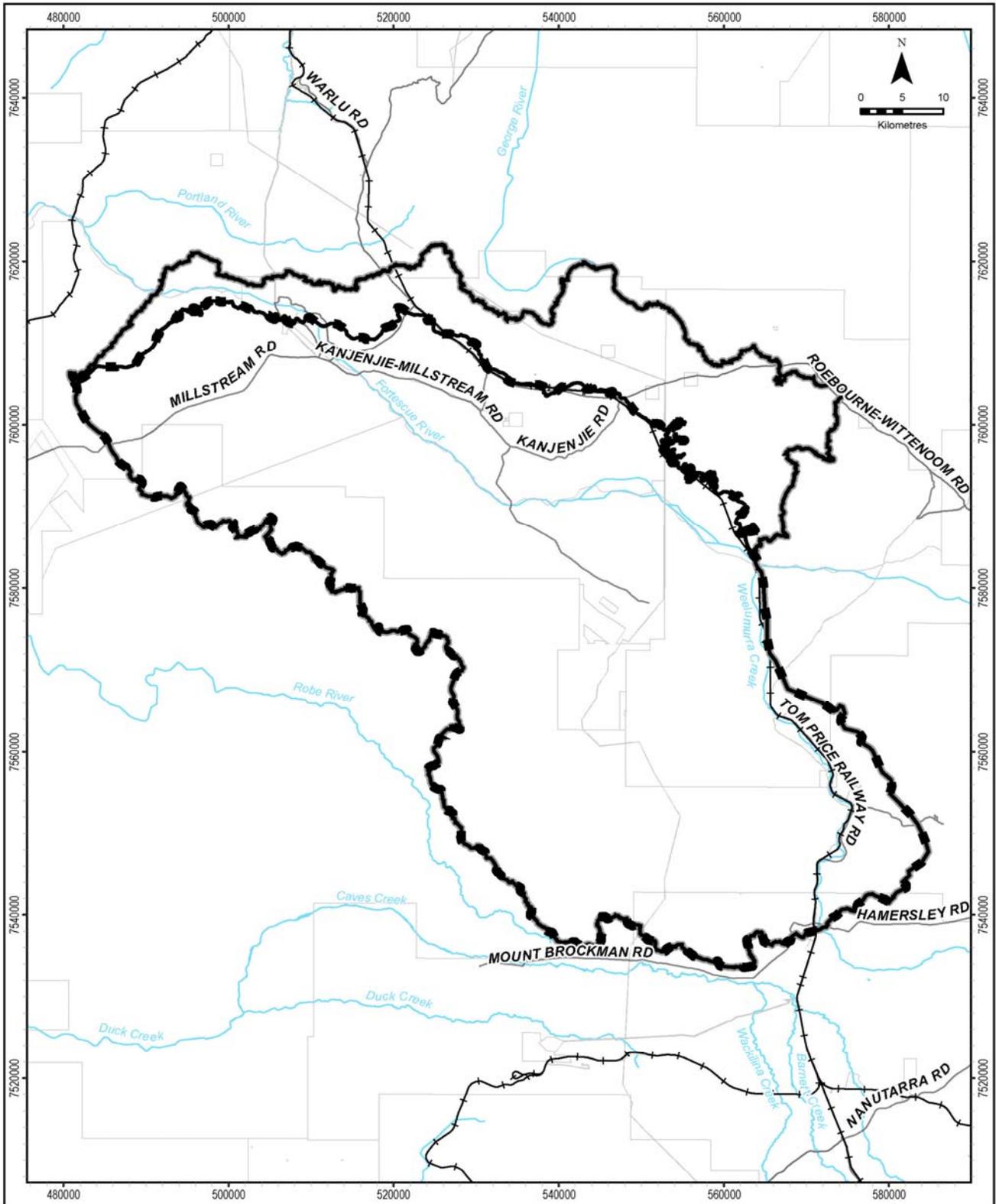
tables for public drinking water source areas or recommendations in this review to DWER's regional office for advice. (Department of Planning, Lands and Heritage, Shire of Ashburton, proponents of proposals)

5. Ensure incidents covered by Westplan–HAZMAT in the amended Millstream Water Reserve are addressed by ensuring that:
 - the Pilbara local emergency management committee is aware of the amended boundary and purpose of the Millstream Water Reserve
 - the updated locality plan for the Millstream 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 amended Millstream Water Reserve
 - personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the amended Millstream Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality.
6. Water Corporation should continue the current regime of water quality monitoring, maintenance of fencing, inspections and by-law enforcement. (Water Corporation)
7. Continue to work with the Yindjibarndi Aboriginal Corporation on planning and management activities related to the management of water at Millstream. (DWER)
8. New ablution facilities within the water reserve should be sited away from the Millstream Dolomite. (Department of Biodiversity, Conservation and Attractions, DWER)
9. Production bores no longer in use and not proposed to be re-equipped should be appropriately decommissioned, consistent with National Uniform Drillers Licensing Committee 2012, *Minimum construction requirements for water bores in Australia*. (Water Corporation)
10. The next update of the *Millstream-Chichester National Park and Mungarooona Range Nature Reserve management plan* should reflect the proposed reduced boundary of the Millstream Water Reserve. (Department of Biodiversity, Conservation and Attractions)
11. A land management strategy should be developed for the jointly-vested reserve 38991 to ensure that the priority for management is drinking water protection. (DWER and Water Corporation)
12. This report will be reviewed in seven years or in response to changes in water quality contamination risks. (DWER)

Appendices

Appendix A – Figures





SOURCE DATA

Department of Water acknowledges the following datasets and their custodians in the production of this map:
 Dataset Name - Custodian - Metadata Date
 Coastline - AUSLIG - 1999
 Hydrography, linear - DoW - 2007
 Railways - Landgate - 2010
 Road Centrelines, DLI - Landgate - 2016
 Spatial Cadastral Database (SCDB) - Landgate - 2016
 Towns - DoW - 2013

LEGEND

- Proposed Millstream Water Reserve
- Constituted Millstream Water Reserve
- Cadastre
- Railways
- Rivers
- Roads

LOCATION



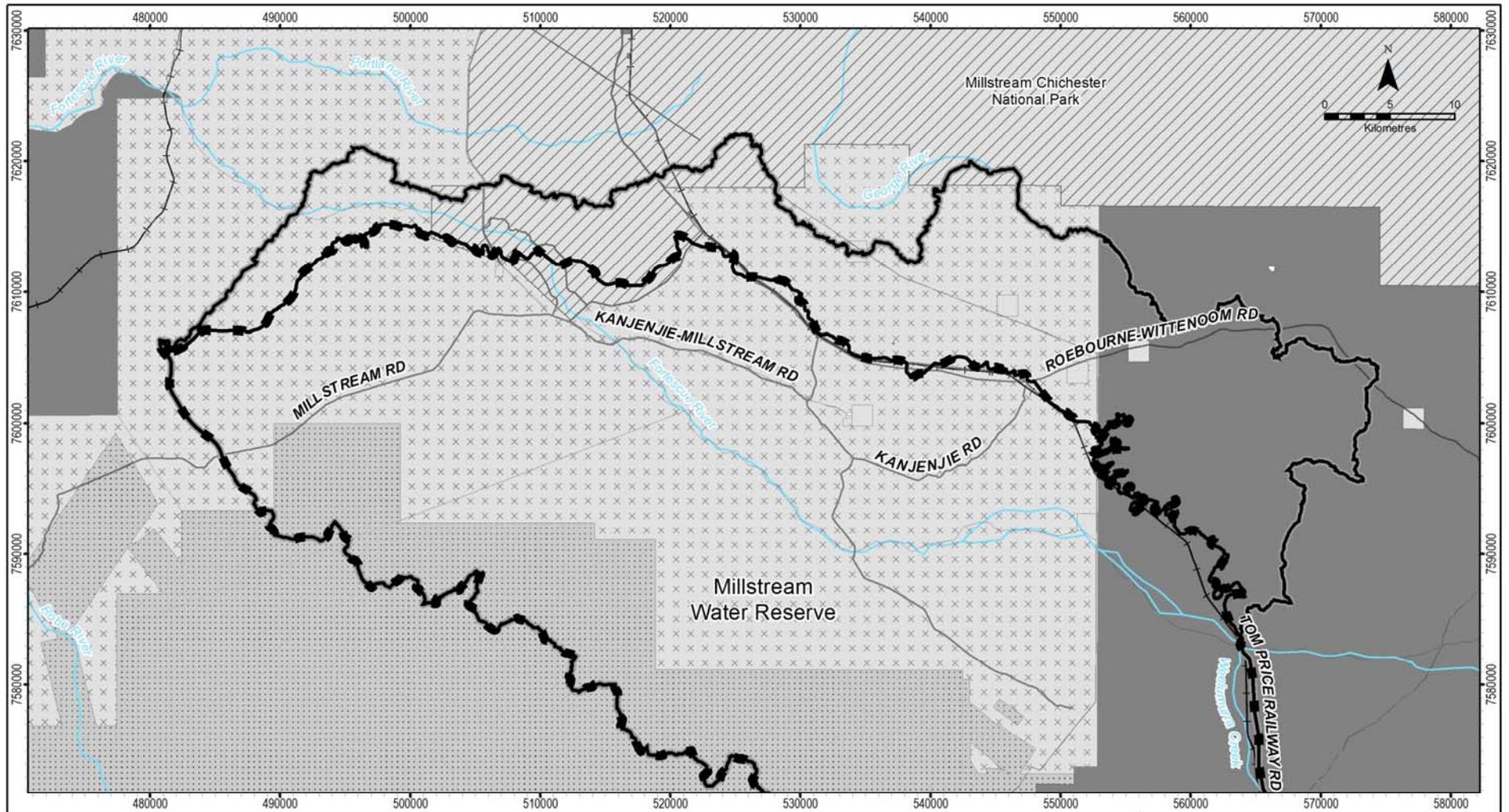
**Water and Land Use Division
Water Source Protection Planning Branch**

Project officer: V. Cloughton Drawn by: A. Watson
 Date: 15/02/2017
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 File name: FigA2.mxd
 Coordinate system: MGA94 Zone 50



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Department of Water

FIGURE A2 EXISTING AND PROPOSED MILLSTREAM WATER RESERVE BOUNDARY



SOURCE DATA

Department of Water acknowledges the following datasets and their custodians in the production of this map:
 Dataset Name - Custodian - Metadata Date
 Coastline - AUSLIG - 1999
 DPaW Managed Lands and Waters - DPaW - 2015
 Hydrography, linear - Landgate - 2007
 Railways - Landgate - 2010
 Road Centrelines, DLI - Landgate - 2016
 Spatial Cadastral Database (SCDB) - Landgate - 2016
 Towns - DoW - 2013

LEGEND

- | | | | | | |
|--|--------------------------------------|--|------------------------|--|----------|
| | Proposed Millstream Water Reserve | | Crown Lease | | Railways |
| | Constituted Millstream Water Reserve | | Crown Reserve | | Rivers |
| | Millstream Chichester National Park | | Freehold | | Roads |
| | Water Corporation | | Unallocated Crown Land | | |

LOCATION



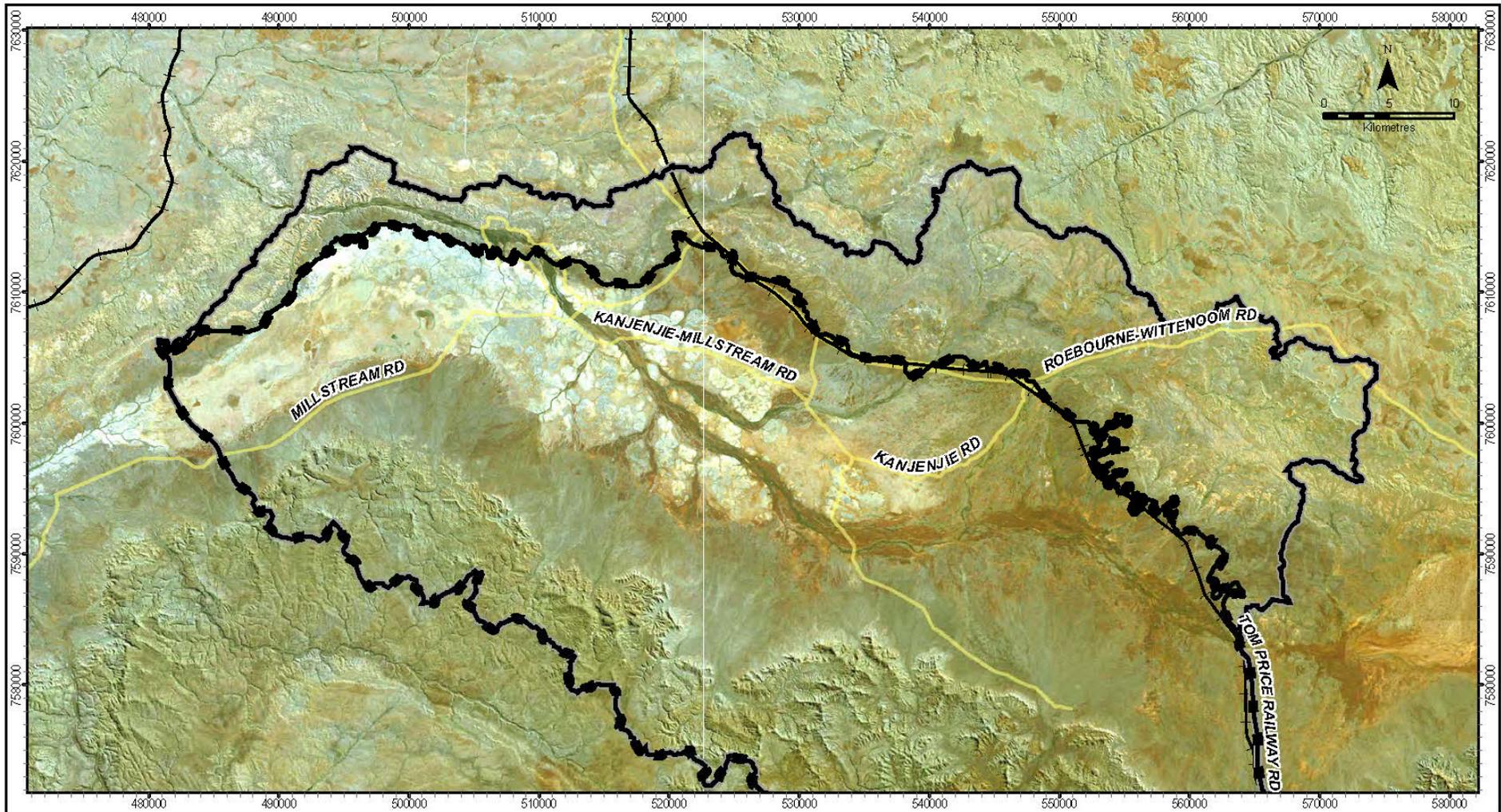
**Water and Land Use Division
Water Source Protection Planning Branch**

Project officer: V. Cloughton Drawn by: A. Watson
 Date: 15/02/2017
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 File name: FigA3.mxd
 Coordinate system: MGA94 Zone 50



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Department of Water

FIGURE A3 NORTHERN AREA OF EXISTING AND PROPOSED MILLSTREAM WATER RESERVE BOUNDARY



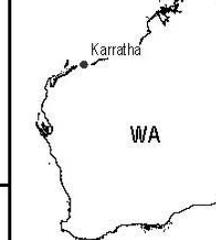
SOURCE DATA

Department of Water acknowledges the following datasets and their custodians in the production of this map:
 Dataset Name - Custodian - Metadata Date
 Coastline - AUSLIG - 1999
 Railways - Landgate - 2010
 Road Centrelines, DLI - Landgate - 2016
 Towns - DoW - 2013
 Pilbara 97 25m 321 ll.ecw - Landgate - 1997

LEGEND

-  Proposed Millstream Water Reserve
-  Constituted Millstream Water Reserve
-  Railways
-  Roads

LOCATION



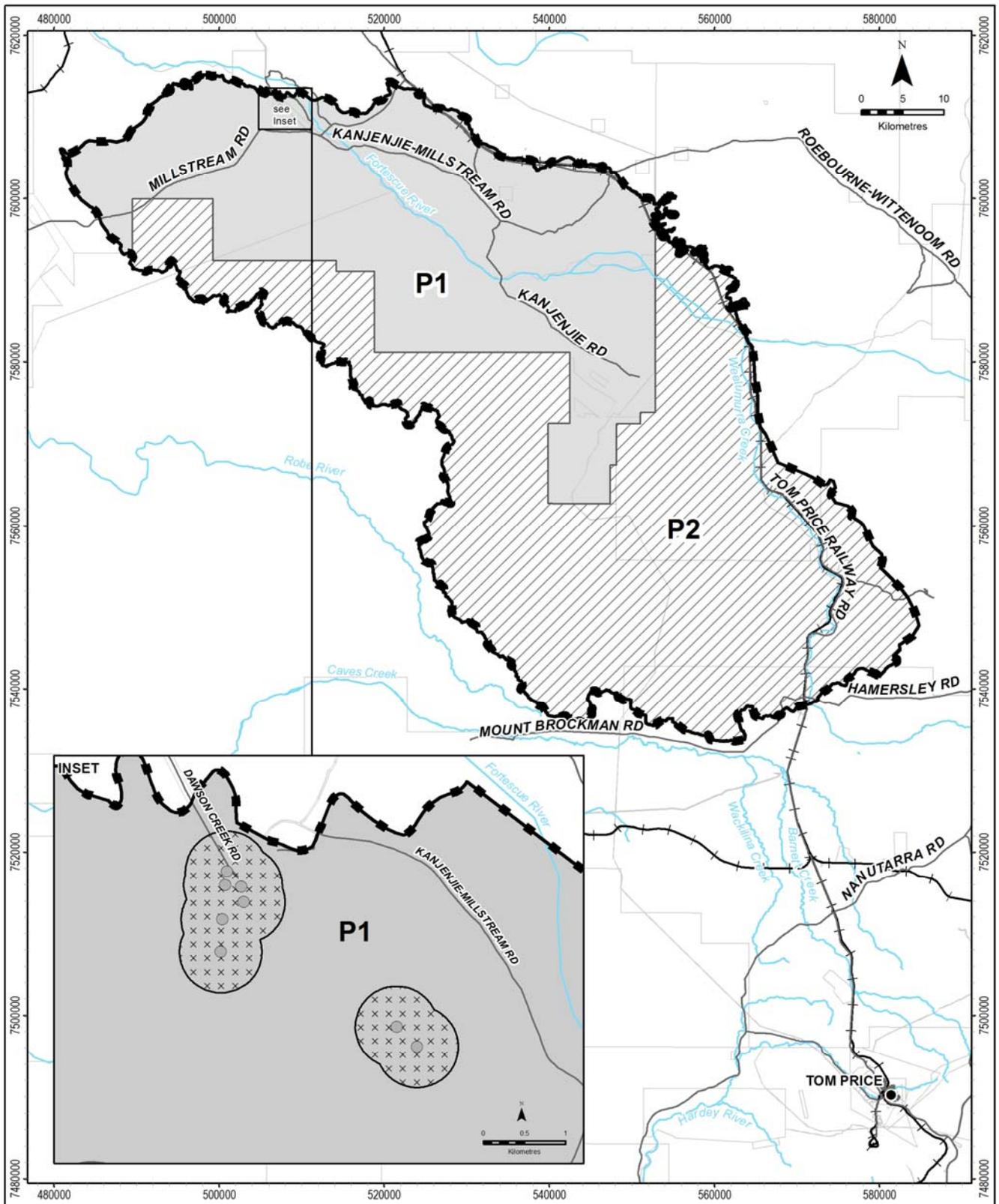
**Water and Land Use Division
 Water Source Protection Planning Branch**

Project officer: V. Cloughton Drawn by: A. Watson
 Date: 15/02/2017
 File path: J:\gisprojects\Project\B_Series\B2010\0088_Millstream_WR\mxd
 File name: FigA4.mxd
 Coordinate system: MGA94 Zone 50



Government of Western Australia
 Department of Water

FIGURE A4 AERIAL PHOTOGRAPHY OF THE NORTHERN PROPOSED MILLSTREAM WATER RESERVE BOUNDARY



SOURCE DATA
 Department of Water acknowledges the following datasets and their custodians in the production of this map:
 Dataset Name - Custodian - Metadata Date
 Coastline - AUSLIG - 1999
 Hydrography, linear - DoW - 2007
 Railways - Landgate - 2010
 Road Centrelines, DLI - Landgate - 2016
 Spatial Cadastral Database (SCDB) - Landgate - 2016
 Towns - DoW - 2013

LEGEND	
	Proposed Millstream Water Reserve
	Priority One Area (P1)
	Priority Two Area (P2)
	Wellhead Protection Zone
	Cadastral
	Bores
	Towns
	Rivers
	Railways
	Roads



**Water and Land Use Division
 Water Source Protection Planning Branch**
 Project officer: V. Cloughton Drawn by: A. Watson
 Date: 15/02/2017
 File path: J:\gis\projects\Project\B_Series\B2010\0088_Millstream_Water_Reserve\mxd
 File name: FigA5.mxd
 Coordinate system: MGA94 Zone 50

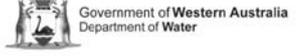


FIGURE A5 PROPOSED BOUNDARY, PRIORITY AREAS AND WELLHEAD PROTECTION ZONES IN THE MILLSTREAM WATER RESERVE

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 Millstream borefield in accordance with the requirements of the *Australian drinking water guidelines* (ADWG; NHMRC & NRMCC 2011) 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 Millstream borefield. 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 February 2012 to January 2017.

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 health guideline values of the ADWG.

For more information on the quality of drinking water supplied to the West Pilbara Water Supply Scheme 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 Millstream borefield are summarised in the following table.

Aesthetic detections for Millstream borefield

Parameter	Units	ADWG aesthetic guideline value ¹	Millstream borefield (raw water sample point)	
			Range	Median
Chloride	mg/L	250	46–185	135
Hardness as CaCO ₃	mg/L	200	140– 460	365
Iron unfiltered	mg/L	0.3	<0.003–0.07	<0.003
Silicon as SiO ₂	mg/L	80	55–65	60
Sodium	mg/L	180	31–99	68.5
Sulfate	mg/L	250	16–92	62.5
Total filterable solids by summation	mg/L	600	362– 1010	819
Turbidity	NTU	5	<0.1–0.3	<0.1
pH measured in laboratory	no units	6.5–8.5	7.1–7.85	7.42

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 Millstream borefield is analysed for chemicals that are harmful to human health, including inorganics, heavy metals, industrial hydrocarbons and pesticides. Those that have been detected in the source are summarised in the following table.

Health-related detections for Millstream borefield

Parameter	Units	ADWG health guideline value ²	Millstream borefield (raw water sample point)	
			Range	Median
Nitrite plus nitrate as N	mg/L	11.29 ³	1.2–2.1	1.65
Sulfate	mg/L	500	16–92	62.5
Fluoride (lab measured)	mg/L	1.5	0.6–0.7	0.65

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 & NRMCC 2011).

³ A guideline value of 11.29 mg/L (as nitrogen) has been set to protect bottle-fed infants less than three months of age. Up to 22.58 mg/L (as nitrogen) can be safely consumed by adults and children over three months of age.

Microbiological contaminants

Microbiological testing of raw water samples from Millstream borefield 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 reviewed period, positive *E. coli* counts were recorded in 4.8 per cent of samples. Of these, the maximum positive count of *E. coli* was 4 MPN/100mL.

These *E. coli* detections represent three individual events. Follow-up samples after each event detected no *E. coli*. The source of contamination is unknown.

Appendix C – How do we protect public drinking water source areas?

The *Australian drinking water guidelines* (ADWG; NHMRC & NRMCC 2011) outline how we should protect drinking water in Australia. The ADWG recommends a 'catchment to consumer' framework that uses an approach based on preventive risk and multiple barriers. A similar approach is recommended by the World Health Organization.

The catchment to consumer framework applies across the entire drinking water supply system – from the water source to the taps in your home. It ensures a holistic assessment of water quality risks and solutions to ensure the delivery of a reliable and safe drinking water to supply your home.

An approach based on preventive risk means that we look at all the different risks to water quality. We determine what risks can reasonably be avoided and what risks need to be minimised or managed to protect public health. This approach means that the inherent risks to water quality are as low as possible. A risk-based approach is often suggested as a way to address risks to water quality in a public drinking water source area (PDWSA) - the area from which water is captured to supply drinking water. However, a risk-based approach is not the same as an approach based on preventive risk. A risk-based approach is inadequate for addressing risks to public health, and is not recommended by the ADWG.

A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system. The first and most important barrier is protecting PDWSA. If we get this barrier right, it has a flow-on effect that can result in a lower cost, safer drinking water supply. Other barriers against contamination include storage of water to help reduce contaminant levels, disinfecting the water (for example chlorination to inactivate pathogens), maintenance of pipes and testing of water quality.

Research and experience shows that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. That's why this drinking water source protection report is important. We should not forget that ultimately it's about safeguarding your health by protecting water quality now and for the future.

An additional benefit from PDWSA protection is that it complements the state's conservation initiatives.

In Western Australia, DWER protects PDWSAs by implementing the ADWG, writing reports, policies and guidelines, and providing input into land use planning.

This drinking water protection report achieves elements 2 and 3 of the 12 elements in the ADWG recommended for protecting drinking water. It shows the PDWSA's location, its characteristics, existing and potential water quality contamination risks, and makes recommendations to deal with those risks.

The *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* and the *Country Areas Water Supply Act 1947* provide us with legislative tools to protect water quality for PDWSAs. These Acts and the associated by-laws allow us to assess and manage the water quality contamination risks from different land uses and activities. The department works cooperatively with other agencies and the community to implement this legislation and develop drinking water source protection reports. For example, the Western Australian Planning Commission (WAPC) has developed a number of state planning policies to help guide development in PDWSAs.

An important step in maximising the protection of water quality in PDWSAs is to define their boundaries, priority areas and protection zones to help guide land use planning and to identify where legislation applies. Our Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a) describes how we do this. It is available www.dwer.wa.gov.au.

There are three different priority areas:

- The objective of priority 1 (P1) areas is risk avoidance – ensuring there is no degradation of the water quality (for example over Crown land).
- The objective of priority 2 (P2) areas is risk minimisation – maintaining or improving water quality (for example over rural-zoned land).
- The objective of priority 3 (P3) areas is risk management – maintaining the water quality for as long as possible (for example, urban- or commercial-zoned land).

Protection zones surround drinking water abstraction bores and surface water reservoirs so that the most vulnerable areas are protected from contamination.

Our Water quality protection note (WQPN) no. 25: *Land use compatibility tables for public drinking water source areas* (DoW 2016b) outlines appropriate development and activities within each of the priority areas (P1, P2 and P3).

With more than 120 constituted PDWSAs across Western Australia, the department prioritises the update of drinking water source protection reports (such as this document). Our aim is to update each report every seven years. In some locations, more frequent updates may be required to address changing water quality risks and land uses. These updates allow us to make changes to the PDWSA boundary, priority areas and protection zones if required. They also allow solutions to new water quality risks to be considered.

There are three different types of drinking water source protection reports – each providing for different needs. The following table shows the differences between the types of reports.

There is also a fourth type of report – Land use and water management strategy – that performs the same functions as a drinking water source protection report. However, these strategies are prepared by the WAPC (with input from DWER) and are strategic documents that integrate land use planning with water management. There are currently land use and water management strategies for Gnangara, Jandakot and Middle Helena.

If you would like more information about the ADWG and how we protect drinking water in Western Australia, visit www.dwer.wa.gov.au or read our Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a). You can also contact DWER's Water source protection planning branch on +61 8 6364 7600 or email drinkingwater@dwer.wa.gov.au.

Drinking water source protection reports produced by DWER

Drinking water source protection report	Scope and outcome	Consultation	Time to prepare	Implementation table	Gazettal
Drinking water source protection assessment (DWSPA)	Desktop assessment of readily available information	Preliminary	Up to 3 months	No	<p>Arrange for the constitution and gazettal of the source under legislation. This helps protect water quality and guides land use planning.</p> <p>All types of consulted drinking water source protection reports can recommend to constitute a source's boundary under legislation.</p>
Drinking water source protection plan (DWSPP)	Full investigation of risks to water quality building on information in the DWSPA	Public	6–12 months	Prepared from recommendations in the DWSPA and/or information from public consultation	
Drinking water source protection review (DWSPR)	Review changes in land and water factors and implementation of previous recommendations. Sometimes prepared to consider specific issues in a PDWSA	Key stakeholders	3–6 months	Prepared from recommendations in the DWSPA or DWSPP	

Appendix D – Understanding risks to drinking water quality

The existing integrated land use planning and public drinking water source area (PDWSA) protection program is based on the findings of three parliamentary committee reports in 1994, 2000 and 2010 (see *Further reading*). Since 1995, this program has resulted in the development of four Western Australian Planning Commission state planning policies (SPPs), recognising the importance of PDWSAs for the protection of water quality and public health:

- SPP no. 2.2: Gnamara groundwater protection
- SPP no. 2.3: Jandakot groundwater protection
- SPP no. 2.7: Public drinking water source policy
- SPP no. 2.9: Water resources.

This integrated program relies upon a risk assessment process based on preventive risk in each PDWSA through the development of drinking water source protection reports. It is important to understand how risks are assessed to appreciate the impact of development within PDWSAs.

Risk-based assessments normally focus on the acceptability of risks after mitigation (residual risks). For drinking water sources residual risk is required. This means that in some cases, the maximum risks from land uses will still be considered unacceptable, even after mitigation has reduced the risk. This is a more conservative approach needed to protect the health of consumers.

Water quality risks are evaluated by considering the type and scale of a potential contamination event (consequence), together with the probability/frequency of that event occurring (likelihood). An understanding of this relationship will prevent the common misunderstanding that probability equals risk (see risk matrix below).

Risk matrix: Level of risk (from the Australian drinking water guidelines 2011)

Likelihood	Consequences				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Moderate	High	Very high	Very high	Very high
Likely	Moderate	High	High	Very high	Very high
Possible	Low	Moderate	High	Very high	Very high
Unlikely	Low	Low	Moderate	High	Very high
Rare	Low	Low	Moderate	High	High

For example, just because a drinking water contamination incident has not occurred for many years (low likelihood) does not mean that the risk is low - we also need to consider the consequence of that contamination when determining risk. Furthermore, no previous detection of contamination is not proof that the risk is acceptable.

Shortened forms

List of shortened forms

ADWG	<i>Australian drinking water guidelines</i>
ANZECC	Australian and New Zealand Environment Conservation Council
DBCA	Department of Biodiversity, Conservation and Attractions
DoW	Department of Water
DWER	Department of Water and Environmental Regulation
HAZMAT	hazardous materials
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
P1, P2, P3	priority 1, priority 2, priority 3
PDWSA	public drinking water source area
Westplan–HAZMAT	Western Australian plan for hazardous materials
WAPC	Western Australian Planning Commission
WHPZ	wellhead protection zone
WQPN	water quality protection note

Units of measurement

MPN	most probable number	Used to estimate the number of viable bacteria in a sample.
km	kilometres	A measure of distance, 1 km equals 1000 m.
m	metres	A measure of distance.
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.

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.
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 & NRMCC 2011).
Allocation	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 of formations able to receive, store and transmit significant quantities of water.
Australian drinking water guidelines	The <i>National water quality management strategy: Australian drinking water guidelines 6</i> (ADWG; NHMRC & NRMCC 2011) outlines acceptable criteria for the quality of drinking water in Australia (see <i>References</i>).
Bore	A narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
Borefield	A group of bores to monitor or withdraw groundwater (also see <i>wellfield</i>).
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Catchment area	An area constituted under the <i>Country Areas Water Supply Act 1947</i> or the <i>Metropolitan Water Supply, Sewerage, and Drainage Act 1909</i> for the purposes of protecting a drinking water supply.
Constitute	Define the boundaries of any catchment area or water reserve by Order in Council under the <i>Country Areas Water Supply Act 1947</i> or by Proclamation under the <i>Metropolitan Water Supply, Sewerage and Drainage Act 1909</i> .
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.
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 & NRMCC 2011).
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.
Hydrology	The science dealing with water on the land, including such things as its properties, laws and geographical distribution.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i>), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i>) and viruses.
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 <i>Metropolitan Water Supply, Sewerage, and Drainage Act 1909</i> or the <i>Country Areas Water Supply Act 1947</i> .
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 <i>risk avoidance</i> , priority 2 (P2) areas is <i>risk minimisation</i> and priority 3 (P3) areas is <i>risk management</i> .
Recharge	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.
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.

Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Unconfined aquifer	An aquifer where the upper boundary is the watertable and therefore is in contact with the atmosphere through the pore spaces in the unsaturated zone. Typically (but not always) it is the shallowest aquifer at a given location.
Water quality	Collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	An area constituted under the <i>Country Areas Water Supply Act 1947</i> or the <i>Metropolitan Water Supply, Sewerage, and Drainage Act 1909</i> for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater.
Wellfield	A group of bores located in the same area used to monitor or withdraw 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.

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