Mount Magnet Water Reserve

drinking water source protection review

Mount Magnet town water supply
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Mount Magnet town water supply

Department of Water and Environmental Regulation
Water resource protection series
Report no. 182
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Summary

This drinking water source protection review considers changes that have occurred in and around the Mount Magnet Water Reserve since completion of the Mount Magnet Water Reserve drinking water source protection plan (DoE 2005). The plan still contains relevant information, so it is important that these documents are read in conjunction. Both are available on our website or by contacting us (see inside cover of this report for contact details).

Mount Magnet is a small town about 600 km north-east of Perth, in the Shire of Mount Magnet. It is a support centre for surrounding gold mining and pastoral stations.

There are 532 people living in the town of Mount Magnet (Australian Bureau of Statistics 2011). This number can vary depending on the mining activities in the area.

The Mount Magnet Water Reserve has two separate sections: Genga, which is south-west of the town of Mount Magnet; and Lennonville, which is north-west of the town.

There was previously a constituted Mount Magnet Catchment Area for a surface water dam, but as this was no longer used for public drinking water supply, it was abolished in 2007.

The Water Corporation supplies public drinking water to Mount Magnet from five production bores located in the Genga water reserve approximately 10 km south-west of the town. These bores draw water from an unconfined aquifer which makes the source vulnerable to contamination. Maintaining wellhead protection zones around the production bores, managing the key recharge area as priority 1 and managing the wider catchment as priority 2, will reduce the water quality contamination risks.

The Lennonville water reserve is a priority 1 area, to maintain protection for a future water source. There are no production bores here at this time.

The main changes since the 2005 plan are:

- the surface water dam catchment area was abolished in 2007
- two production bores in the eastern Genga borefield are no longer used
- new hydrological and hydrogeological assessments undertaken by DWER have determined that:
  - an area previously proposed to be included into the Genga water reserve is not required
  - the boundary should be amended to better reflect the recharge area for the current production bores.

We prepared this document in consultation with key stakeholders including the Water Corporation, the Shire of Mount Magnet and Ramelius Resources Ltd.
This review helps implement:

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

Important information about the Mount Magnet Water Reserve is in Table 1.

### Table 1 Key information about the Mount Magnet Water Reserve

<table>
<thead>
<tr>
<th>Mount Magnet Water Reserve</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Status of this report</strong></td>
<td>This report is based on information from the 2017–18 financial year. Public drinking water source area boundaries, priority areas, bore locations, wellhead protection zones and other data may be subject to change. For up-to-date information, please email <a href="mailto:drinkingwater@dwer.wa.gov.au">drinkingwater@dwer.wa.gov.au</a>.</td>
</tr>
<tr>
<td><strong>Local government authority</strong></td>
<td>Shire of Mount Magnet</td>
</tr>
<tr>
<td><strong>Location supplied</strong></td>
<td>Mount Magnet</td>
</tr>
<tr>
<td><strong>Water service provider</strong></td>
<td>Water Corporation</td>
</tr>
<tr>
<td><strong>Aquifer type</strong></td>
<td>Unconfined, alluvial and fractured rock aquifers (vulnerable to water quality contamination)</td>
</tr>
<tr>
<td><strong>Licensed abstraction</strong></td>
<td>350 ML/year</td>
</tr>
</tbody>
</table>
| **Number of bores** | 5 (as at 2017)  
The production bores are screened at depths ranging between 30 m and 72 m |
| **Bore names and GPS coordinates** | Western Genga borefield:  
  - 35/86 (E 573 440, N 6 887 491, zone 50)  
  - 36/86 (E 573 090, N 6 886 561, zone 50)  
  - 38/86 (E 572 728, N 6 888 334, zone 50)  
  - 40/86 (E 572 030, N 6 888 091, zone 50)  
  Eastern Genga borefield:  
  - 7/82 (E 575 957, N 6 888 598, zone 50) |
## Mount Magnet Water Reserve

<table>
<thead>
<tr>
<th>Water treatment</th>
<th>Calgon dosing to reduce the hardness. Chlorination to remove microbes</th>
</tr>
</thead>
</table>
| Dates of drinking water source protection reports | 2005 – *Mount Magnet Water Reserve drinking water source protection plan*  
2018 – *Mount Magnet Water Reserve drinking water source protection review* (this document) |
| Consultation             | 2000–2005: Public consultation occurred during development of the water source protection plan and included the Water Corporation, Department for Planning and Infrastructure (now Department of Planning, Lands and Heritage), Department of Land Information (now Landgate), Department of Industry and Resources (now Department of Mines, Industry Regulation and Safety), Midwest Development Commission, Shire of Mount Magnet, Main Roads, Harmony Gold (now Ramelius Resources Ltd), Aboriginal interests and other affected mining tenement owners and landowners.  
2017: While developing this drinking water source protection review, we consulted with key stakeholders. The Water Corporation, the Shire of Mount Magnet and Ramelius Resources Ltd. |
| Constitution history     | The Mount Magnet Catchment Area (town dam surface water catchment) was constituted in March 1985 under the *Country Areas Water Supply Act 1947*.  
The groundwater portion of the water reserve was constituted in August 1991 as the Mount Magnet Water Reserve under the *Country Areas Water Supply Act 1947*.  
Abolition of the Mount Magnet Catchment Area and constitution of the current Mount Magnet Water Reserve occurred on 29 June 2007 under the *Country Areas Water Supply Act 1947*.  
If supported, a new Mount Magnet Water Reserve boundary is proposed to be constituted in 2018–19 (see Figure A1). |
| Reference documents      | *Australian drinking water guidelines* (NHMRC & NRMMC 2011)  
State planning policy no. 2.7: *Public drinking water source policy* (WAPC 2003) |
1 Review of Mount Magnet’s drinking water source protection plan

1.1 Boundary, priority areas and protection zones

The existing Mount Magnet Water Reserve was constituted in 2007 under the *Country Areas Water Supply Act 1947*. The water reserve is made up of two parts: the Lennonville water reserve in the north, and the Genga water reserve in the south. Please refer to Figure A1 for the location of the water reserve.

The Lennonville water reserve is reserved for future drinking water supply and is managed as a priority 1 (P1) area. The *Mount Magnet Water Reserve drinking water source protection plan* (Department of Environment 2005) discussed the possibility of the Lennonville water reserve being used as a new source for a reverse osmosis plant. The Water Corporation has not yet established a reverse osmosis plant in Mount Magnet, but this review proposes to retain the Lennonville water reserve in the event that this occurs, or if a new water source with lower contamination risks is required.

The Genga water reserve reflects the recharge area for the existing production bores, based on topographical and hydrogeological information. The key recharge area is a P1 area, and the rest of the Genga water reserve, which represents the surface water catchment area of the borefield, is a priority 2 (P2) area. This is consistent with the decisions made in 2005 plan.

There was a third proposed part of the Genga water reserve discussed in the 2005 *Mount Magnet Water Reserve drinking water source protection plan*. This area was not constituted because several drainage diversions were thought to be excluding this area from contributing recharge to the water reserve. A recent hydrological and hydrogeological assessment has confirmed that most of this area does not contribute recharge to the production bores regardless of drainage diversions. Therefore this area is not included in the proposed Genga water reserve.

This hydrological assessment did define some boundary amendments that are required to more accurately depict the recharge area for the current production bores. This includes some expansion to the east, west and south-west in both the P1 and P2 areas and a reduction in the south-west. Please refer to Figure A4 for the new proposed boundary, priority areas and wellhead protection zones (WHPZs).

Since the 2005 plan, two bores (1/75 and 7/74) are now out of service and have been removed from the Water Corporation's groundwater allocation licence. This review recommends that production bores that are no longer used are appropriately decommissioned to avoid risks to groundwater. Decommissioning should be consistent with *Minimum construction requirements for water bores in Australia* (National Uniform Drillers Licensing Committee 2012).

The Genga water reserve contains five active drinking water production bores, all within the P1 area and each protected by a 500 m WHPZ (Figure A4).
The bores are divided into two different borefields within the Genga water reserve. There is an eastern borefield and a western borefield, which are thought to be separated by a basalt ridge groundwater divide. This suggests that there is a buffer between the two groundwater flow systems of each borefield and therefore they have separate catchment areas.

The two production bores that are out of service (1/75 and 7/74) are in the eastern Genga borefield, leaving only one active production bore (7/82) in that borefield. The majority of Mount Magnet’s public drinking water supply comes from the western side of Genga borefield, where the water quality risks are lower. This review recommends that, subject to water availability, any future production bores should be drilled in the western side of the Genga borefield or the Lennonville water reserve, to minimise water quality risks from neighbouring mining activities.

Future reviews should consider amending the boundary to remove the eastern side of the Genga borefield from the Mount Magnet Water Reserve if production bore 7/82 is no longer required and all three bores are appropriately decommissioned.

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

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

1.2 Update on water supply scheme

The Mount Magnet borefield consists of five active production bores (7/82, 35/86, 36/86, 38/86 and 40/86) which draw water from the unconfined alluvial and fractured rock aquifer. The production bores are screened at depths ranging between 30 m and 72 m.

Groundwater from the borefield is transported to treatment facilities where it undergoes Calgon dosing to reduce the hardness of the water. Chlorination is carried out to disinfect the water to ensure microbiological quality for consumers. The treated water is then pumped into storage tanks (Figure C3), approximately 500 m west of Mount Magnet, from where it is distributed via gravity to the town scheme.

Water Corporation’s groundwater allocation licence for Mount Magnet was last renewed in September 2016, and is due to expire in June 2026. The licence allows the Water Corporation to draw 350 000 kL of water from the alluvial and fractured rock aquifer (unconfined) to supply Mount Magnet’s drinking water from the five production bores.

It should be recognised that 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 Australian drinking water guidelines (ADWG; NHMRC & NRMMC 2011) and is based on preventive risk and multiple barriers for providing safe drinking water to consumers. This combination of catchment
protection and water treatment will deliver a more reliable, safer and lower cost drinking water to consumers than either approach could achieve individually.

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

1.3 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 protects 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 eight registered Aboriginal sites of significance within the Lennonville water reserve. These are: Couttes bore (P07946) and on the north-eastern tip of the water reserve is: Carved Cave Spring (P00742), Mirrawanni 1 (P05934), Mirrawanni 2 (P05935), Mirrawanni 3 (P05936), Mirrawanni 4 (P05937), Mirrawanni 5 (P05938), and Merawanee/Cave Well (P00307).

There are six registered Aboriginal sites of significance within the Genga water reserve. These are:

- Boogardi Road (S02757)
- Boogardi (S02790)
- Boogardie Camp (S03103)
- Jones Creek (S03101)
- Tula Rockshelter (S03106)
- Hughie King’s Camp (S03107).

Native title is the recognition in Australian law that some Aboriginal people continue to hold native title rights to lands and water arising from their traditional laws and customs. There is one native title claim within the Mount Magnet Water Reserve. This is the Badimia People’s claim (WAD6123/1998).

DWER is committed to working with Aboriginal people in its planning and management activities. The department recognises that native title is an important framework for water management.
1.4 Enforcing by-laws, surveying the area and maintenance

Water Corporation’s operators visit the borefield on a weekly basis and a catchment ranger conducts surveillance of the production bores and surrounding catchment on a six-monthly basis.

This review recommends that the Water Corporation continue by-law enforcement under the existing delegation arrangement (see section 2.2, recommendation no. 7). This includes:

- 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.

1.5 Other Department of Water and Environmental Regulation work

1.5.1 Mid West regional water supply strategy - A long-term outlook of water demand and supply, 2015

This strategy considers a range of water demand scenarios for mining, industry, agriculture and towns (including Mount Magnet) in the region. It identifies supply options to meet this demand.

1.5.2 Selection of future climate projections for Western Australia (DoW 2015)

This study aims to assist with providing climate scenarios for the consistent and transparent management of water resources. The report uses different scenarios, variables and regions (including Mount Magnet) to produce standard monthly climate anomalies for different time horizons.

1.5.3 Capacity of water resources in the Mid West to meet mining and industrial growth (DoW 2011)

This document is an addendum to Mid West Minerals Province – groundwater resource appraisal (DoW 2006) published as part of the Mid West regional minerals study. The report summarises current information on the availability of water resources in the Mid West, in the context of expected mining and industrial growth in the region.
1.6 Update on water quality risks

As part of this review, DWER has conducted an updated assessment of water quality contamination risks to Mount Magnet’s drinking water source, in accordance with the ADWG. Table 2 shows the risks that are new or have changed since the 2005 plan, and also includes risks that are still considered high.

Refer to Appendix D for information about typical contamination risks in PDWSAs. Refer to Appendix F to gain a greater understanding about the risk assessment process we use.

Land uses in the Mount Magnet Water Reserve have remained the same since the 2005 plan. Land uses include low-density sheep grazing (Figure C6) and exploration and mining activities (Figure C2).

Mining has continued to expand to the north-east and within the Genga water reserve. Proposals will be assessed through the state’s environmental approvals process, including consideration of the potential impacts on the Mount Magnet Water Reserve and whether the project poses an unacceptable risk to water quality and public health.

Illegal recreation such as off-road driving, camping and associated camp fires occurs within the water reserve (Figure C4).

Illegal rubbish dumping within the water reserve has been identified. There is an area where significant dumping has occurred and the rubbish has been previously collected and removed from the water reserve. However, this area continues to be used for illegal rubbish dumping (Figure C5).

The production bores are fenced, but some of them are only protected by low stock fencing (see Figure C1 low stock fencing around production bore 7/82) rather than the more effective and secure cyclone fencing.

There has been occasional vandalism to the bore compounds.

1.6.1 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 DWER’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.
There is one other licensed user in the Lennonville water reserve. There are no other licensed users in the Genga water reserve, but there are a number nearby.
<table>
<thead>
<tr>
<th>Land use/activity</th>
<th>Hazard</th>
<th>Management priority</th>
<th>Comments</th>
<th>Best management practice guidance¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roads and tracks</td>
<td>Hydrocarbons and other chemical spills</td>
<td>Low</td>
<td>Existing sealed roads are acceptable. Unsealed roads need to be managed to control access.</td>
<td>WQPN no. 44: <em>Roads near sensitive water resources</em>&lt;br&gt;WQPN no.10: <em>Contaminant spills – emergency response</em></td>
</tr>
<tr>
<td>Mining activities</td>
<td>Hydrocarbons from vehicles and machinery</td>
<td>Medium</td>
<td>Mining is primarily gold mining and processing. Best practice is implemented by mining companies.</td>
<td>Water quality protection guidelines 1–11: <em>Mining and mineral processing</em></td>
</tr>
<tr>
<td></td>
<td>Chemicals from mineral processing</td>
<td>Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pastoral lease</td>
<td>Pathogens from animal faeces</td>
<td>Medium</td>
<td>Stocking rates are low.</td>
<td>WQPN no. 35: <em>Pastoral activities within rangelands</em></td>
</tr>
<tr>
<td>Illegal recreation, off-road driving,</td>
<td>Pathogens from human access and rubbish</td>
<td>Medium</td>
<td>Illegal recreation numbers are low.</td>
<td>Operational policy 13: <em>Recreation within public drinking water source areas on Crown land</em></td>
</tr>
<tr>
<td>hunting and camping</td>
<td>Hydrocarbons from fuel leaks and spills</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use/activity</td>
<td>Hazard</td>
<td>Management priority</td>
<td>Comments</td>
<td>Best management practice guidance¹</td>
</tr>
<tr>
<td>--------------------------</td>
<td>---------------------------------------------</td>
<td>---------------------</td>
<td>-----------------------------------------------</td>
<td>------------------------------------</td>
</tr>
<tr>
<td>Illegal rubbish dumping</td>
<td>Pathogens from human access and rubbish</td>
<td>Medium</td>
<td>Rubbish dumping is illegal – penalties may apply.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Hydrocarbons from fuel leaks and rubbish</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Chemical leaching from rubbish</td>
<td>Low</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Water quality protection notes (WQPNs) are available at www.dwer.wa.gov.au or see Further reading.
1.7 Water quality information

The Water Corporation has provided updated water quality information for the Mount Magnet Water Reserve. The monitoring period was from August 2012 to July 2017. This is shown in Appendix B.

Raw water from the production bores is considered hard but has consistently been of good quality. With the exception of high levels of turbidity, nitrite and nitrates, the water has generally met the ADWG.

Hardness, turbidity and high nitrates are naturally occurring. Water hardness is treated before water is supplied to consumers. Nitrate levels are higher than the ADWG value for bottle-fed infants less than three months old. An exemption has been granted by the Department of Health for this source and the Water Corporation supplies bottled water for infants under three months. The water is within the guideline range for safe consumption by adults and infants over three months of age.

*Escherichia coli* was detected in two samples at low levels (below 20MPN/100mL) and no detections have occurred since 2013. The source of this 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 ADWG.
2 Implementing Mount Magnet’s drinking water source protection plan

2.1 Status of previous recommendations

Table 3 outlines recommendations from the 2005 plan and their current status.

Table 3 Implementation status of the 2005 Mount Magnet Water Reserve plan recommendations

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Constitution of modified water reserve and town dam catchment abolished.</td>
<td>Complete.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The water reserve was constituted and the town dam catchment was abolished in 2007 under the <em>Country Areas Water Supply Act 1947</em>.</td>
</tr>
<tr>
<td>2</td>
<td>Establish 500 m WHPZs around each production bore.</td>
<td>Complete.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>This occurred through the 2005 <em>Mount Magnet Water Reserve drinking water source protection plan</em>.</td>
</tr>
</tbody>
</table>
| 3   | Incorporation into land planning strategies, incorporating the management principles of WQPN no. 25: *Land use compatibility in PDWSAs* and reflecting P1 and P2 areas.                                                   | The water reserve has been partly incorporated into the Mount Magnet local planning scheme (LPS). The P2 northern part of the Genga water reserve has not been included. This review recommends that it is included into the LPS.
<p>| 4   | Referral of development proposals.                                                                                                                                                                                   | Ongoing. This recommendation will be carried forward.                                                                                                                                                         |
|     |                                                                                                                                                                                                                       | Development proposals within the water reserve are referred to the Mid West Gascoyne Region office of DWER.                                                                                                       |</p>
<table>
<thead>
<tr>
<th>5</th>
<th>A locality map and management priorities should be provided to Department of Industry and Resources (now Department of Mines, Industry Regulation and Safety), local shire and Water Corporation.</th>
<th>This information will again be sent to the Shire of Mount Magnet and Water Corporation as part of this review.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Erection of signs.</td>
<td>Signs exist on production bore compounds (Figure C1), storage and treatment compounds and at some locations in the water reserve. However, some additional catchment signage should also be installed in the Mount Magnet Water Reserve. All signs need to be maintained in accordance with the Water Corporation's <em>S111 Source protection signage</em> (2013).</td>
</tr>
<tr>
<td>7</td>
<td>Emergency response:</td>
<td>Emergency response protocols have changed since 2005 to the jurisdiction of HAZMAT and the local emergency management committee (LEMC). This review will be provided to the Shire of Mount Magnet, Water Corporation and the Mount Magnet LEMC.</td>
</tr>
<tr>
<td>8</td>
<td>Monitoring program for the production bores should be reviewed.</td>
<td>Water Corporation completed a Mount Magnet water monitoring review in 2010. Water Corporation continue to monitor the water quality of the water reserve as part of their requirement as a licensed water service provider.</td>
</tr>
<tr>
<td>9</td>
<td>Continue to advise residents and visitors of high nitrate levels in drinking water for infants under three months old.</td>
<td>Ongoing. This recommendation will be carried forward. The town's doctors and the hospital inform expecting and new mothers about the high nitrates in the drinking water and the hospital supplies bottled water to babies.</td>
</tr>
<tr>
<td>10</td>
<td>Shire of Mount Magnet and Main Roads should ensure measures to reduce risks of potential spills from traffic on the Geraldton to Mount Magnet road are considered and implemented where practicable.</td>
<td>The road has been widened near the petrol station and it is occasionally graded. Additional measures to increase road safety on the borefield stretch of road should be investigated and implemented.</td>
</tr>
</tbody>
</table>
2.2 Consolidated recommendations

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

1. After this report is published, the Department of Water and Environmental Regulation will arrange constitution of the amended boundary of the Mount Magnet Water Reserve under the *Country Areas Water Supply Act 1947*. (DWER)

2. Incorporate the findings of this review and location of the Mount Magnet Water Reserve (including its priority areas and protection zones) in the Shire of Mount Magnet local planning scheme in accordance with Western Australian Planning Commission’s State planning policy no. 2.7: *Public drinking water source policy*. (Shire of Mount Magnet)

3. Refer development proposals within the Mount Magnet Water Reserve that are inconsistent with the DWER’s WQPN no.25: *Land use compatibility tables for public drinking water source areas* or recommendations in this review to the DWER regional office for advice. (Department of Planning Lands and Heritage, Shire of Mount Magnet, proponents of proposals)

4. Investigate and implement practical additional measures to increase road safety on the borefield stretch of the Geraldton to Mount Magnet road. (Shire of Mount Magnet, Main Roads)

5. Ensure incidents covered by Westplan–HAZMAT in the Mount Magnet Water Reserve are addressed by ensuring that:
   - the Mount Magnet LEMC is aware of the location and purpose of the Mount Magnet Water Reserve
   - the locality plan for the Mount Magnet 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 Mount Magnet Water Reserve
• personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Mount Magnet Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality. (Water Corporation)

6. Erect additional signs along the boundary of the Mount Magnet Water Reserve including an emergency contact telephone number, in accordance with the Water Corporation’s S111 Source protection signage (2013). (Water Corporation)

7. Water Corporation should continue the current regime of water quality monitoring, maintenance of fencing, inspections and by-law enforcement. (Water Corporation)

8. Subject to the availability of water, any future production bores should be drilled into the western Genga borefield or the Lennonville water reserve to minimise water quality risks. (Water Corporation)

9. Appropriately decommission out of service bores that are no longer required in accordance with Minimum construction requirements for water bores in Australia (National Uniform Drillers Licensing Committee 2012). (Water Corporation/other licensed users)

10. If all production bores in the eastern side of the Genga borefield are decommissioned, amend the Mount Magnet Water Reserve boundary to exclude the catchment area for that side of the groundwater divide. (DWER)

11. Continue to advise residents and visitors of high nitrate levels in drinking water for infants under three months old, in particular expecting and new mothers. (Shire of Mount Magnet, hospital, local doctors, Department of Health)

12. This report will be reviewed in seven years or in response to changes in water quality contamination risks. (DWER)
Appendices

Appendix A – Figures
Mount Magnet Water Reserve drinking water source protection review

FIGURE A2 LAND USE AND TENURE IN AND AROUND MOUNT MAGNET RESERVE

SOURCE DATA
Department of Water acknowledges the following datasets and their custodians in the production of this map:
- Dataset Name - Custodian - Metadata Date
- Road Centrelines 2U - Landgate - 2016
- Spatial Catalogue Database (SCDB) - Landgate - 2017

LEGEND
- Existing Mount Magnet Water Reserve
- Proposed Mount Magnet Water Reserve
- Crown Reserve
- Freehold
- Public Roads
- Unallocated Crown Land

LOCATION
- Project officer: V. Caughten
- Drawn by: A. Watson
- Date: 19/02/2017
- File path: J:\\gi\\Projects\ProjectX\_Sols\_20170901\_4.01\Mount Magnet WRP\_mxd
- File name: FigA2.mxd
- Coordinate system: MGA94 Zone 50

Government of Western Australia
Department of Water

Department of Water and Environmental Regulation

15
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 Mount Magnet (Genga) Water Reserve in accordance with the requirements of the Australian drinking water guidelines (ADWG; NHMRC & NRMMC 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 Mount Magnet (Genga) Water Reserve. 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 July 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 requirements of the ADWG.

For more information on the quality of drinking water supplied to Mount Magnet 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 Mount Magnet (Genga) Water Reserve are summarised in the following table.

**Aesthetic detections for Mount Magnet (Genga) Water Reserve**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>ADWG aesthetic guideline value$^1$</th>
<th>Mount Magnet (Genga) Water Reserve (raw water)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Range</td>
</tr>
<tr>
<td>Hardness as CaCO$_3$</td>
<td>mg/L</td>
<td>200</td>
<td>230–300</td>
</tr>
<tr>
<td>Iron unfiltered</td>
<td>mg/L</td>
<td>0.3</td>
<td>0–0.008</td>
</tr>
<tr>
<td>Silicon as SiO$_2$</td>
<td>mg/L</td>
<td>80</td>
<td>70–80</td>
</tr>
<tr>
<td>Sodium</td>
<td>mg/L</td>
<td>180</td>
<td>145–200</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>250</td>
<td>53–74</td>
</tr>
<tr>
<td>Total filterable solids by summation</td>
<td>mg/L</td>
<td>600</td>
<td>854–1052</td>
</tr>
</tbody>
</table>

$^1$ 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 Mount Magnet (Genga) Water Reserve 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.
Health-related detections for Mount Magnet (Genga) Water Reserve

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>ADWG health guideline value&lt;sup&gt;2&lt;/sup&gt;</th>
<th>Mount Magnet (Genga) Water Reserve (raw water)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrite plus nitrate as N&lt;sup&gt;3, 4&lt;/sup&gt;</td>
<td>mg/L</td>
<td>11.29</td>
<td>14.1–17.2</td>
</tr>
<tr>
<td>Sulfate</td>
<td>mg/L</td>
<td>500</td>
<td>53–74</td>
</tr>
<tr>
<td>Arsenic</td>
<td>mg/L</td>
<td>0.01</td>
<td>0–0.002</td>
</tr>
<tr>
<td>Fluoride (lab measured)</td>
<td>mg/L</td>
<td>1.5</td>
<td>0.3–0.3</td>
</tr>
</tbody>
</table>

<sup>2</sup> 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).

<sup>3</sup> This is reported as nitrite plus nitrate as nitrogen, whereas the ADWG uses nitrate as nitrate, with a health guideline value of 50 mg/L. This has been converted to 11.29 mg/L so as to compare with the nitrite plus nitrate as nitrogen values that were sampled.

<sup>4</sup> 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 Mount Magnet (Genga) Water Reserve 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 2.9 per cent of samples (two samples). Of these, no samples had *E. coli* counts greater than 20 MPN/100mL. The highest detection was 4 MPN/100mL. There have been no *E. coli* detections in the raw water since August 2013.
Appendix C — Photographs

Photographs by V. Claughton, DWER

Figure C1  Fencing and signage around production bore 7/82 within the Mount Magnet Water Reserve

Figure C2  Mining activities east of the Mount Magnet Water Reserve
Figure C3  Mount Magnet water storage tanks

Figure C4  Evidence of a camp fire and recreation within the Mount Magnet Water Reserve near a bore
Figure C5  Evidence of rubbish dumping within the Mount Magnet Water Reserve

Figure C6  Stock watering trough and windmill within the Mount Magnet Water Reserve
Appendix D — Typical contamination risks in groundwater sources

Land development and land or water-based activities within a water reserve can directly affect the quality of drinking water and its treatment. Contaminants can reach drinking water sources through runoff over the ground and infiltration through the soil. A wide range of microbiological, chemical and physical contamination risks can impact on water quality and therefore affect the provision of reliable, safe, good quality drinking water to consumers.

Some contaminants in drinking water can affect human health, resulting in illness, hospitalisation or even death. Other impurities can affect the water’s aesthetic qualities, including its appearance, taste, smell and ‘feel’ but are not necessarily hazardous to human health. For example, cloudy water with a distinctive odour or strong taste may not be harmful to health, but clear, pleasant-tasting water may contain harmful microorganisms that are undetectable by sight, taste or smell (NHMRC & NRMMC 2011). Contaminants can also interfere with water treatment processes and damage infrastructure.

The Australian drinking water guidelines (ADWG; NHMRC & NRMMC 2011) outline criteria for acceptable drinking water quality to protect human health, manage aesthetics and maintain water supply infrastructure.

Some commonly seen contamination risks relevant to groundwater drinking water sources are described below.

**Microbiological risks**

Pathogens are types of microorganisms that are capable of causing illness and include bacteria, protozoa and viruses. When people consume drinking water that is contaminated with pathogens, the consequences vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and in some cases even death. For example, seven people died and about 2500 became ill in Walkerton, Canada, during 2000, because the town’s water supply was contaminated by a pathogenic strain of *Escherichia coli* and *Campylobacter* (NHMRC & NRMMC 2011).

The types of pathogens that are likely to cause harm to people are commonly found in the faeces of humans and domestic animals (such as dogs and cattle). These pathogens can enter drinking water supplies from faecal contamination in the catchment area, either directly or indirectly.

In groundwater sources this occurs indirectly. Faecal material can infiltrate through the soil and into the groundwater. For example, contamination can occur from septic tanks or grazing animals.

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (for example *Salmonella, Escherichia coli* and cholera), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses. Monitoring for
the presence of *E. coli* in water supplies provides an indication of the level of recent faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors including the existence of pathogen carriers (humans and domestic animals), the transfer to and movement of the pathogen in the water source and its ability to survive in the water.

The percentage of humans in the world that carry pathogens varies. For example, it is estimated that between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia* (Geldreich 1996).

The survival and movement of pathogens in groundwater is influenced by the characteristics of the pathogen (such as its size and inactivation rate) and the groundwater properties (including flow rate, porosity, amount of carbon in the soil, temperature and pH). Inactivation rate (the time it normally takes a pathogen to decay) is one of the most important factors governing how far pathogens may migrate. Typical half-lives of pathogens range from a few hours to a few weeks. For example, some reported migration distances of bacteria in groundwater are:

- 600 m in a sandy aquifer
- 1000–1600 m in channelled limestone
- 250–408 m in glacial silt-sand aquifers (Robertson & Edbery 1997).

Unlike chemicals, which dissipate and dilute when they enter a water source, pathogens can multiply under the right conditions, increasing the likelihood of contamination. Therefore it is important to understand both the surface water and groundwater systems to be able to protect the drinking water source from pathogens.

Given the wide variety of pathogens, their behaviour in the environment and the potential consequences of consuming contaminated water, the most effective way to protect public health and reduce water treatment costs is to avoid the introduction of pathogens into a water source.

**Physical risks**

Turbidity is the result of soil or organic particles becoming suspended in water. Increased turbidity can result in cloudy or muddy-looking water, which is not aesthetically appealing to consumers. Turbidity can also reduce the effectiveness of treatment processes (such as disinfection). This is because pathogens and chemicals can attach onto soil particles, make them more difficult to remove during disinfection and treatment processes.

Other physical properties of water can affect water supply infrastructure, or the aesthetics of the drinking water. For example, pH can contribute to the corrosion and encrustation of pipes; iron and dissolved organic matter can affect the colour and smell of water; and salinity levels can affect its taste. Although not necessarily harmful to human health, water with properties like this will be less appealing to customers.
Chemical risks

Chemicals can occur in drinking water as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMMC 2011). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

Pesticides include agricultural chemicals used to control:

- weeds (herbicides)
- pests (insecticides, rodenticides)
- worms (nematicides)
- mites (miticides).

Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills, incorrect use or leakage from storage areas. In these cases, the relevant authorities should be notified promptly and the spill cleaned up to prevent contamination of the drinking water source.

Hydrocarbons such as fuels and oils are potentially toxic to humans. Harmful chemical by-products may be formed when hydrocarbons are combined with chlorine during the water treatment process. Hydrocarbons can occur in water supplies as a result of spills and leaks from vehicles and machinery.

Drinking water sources can also be contaminated by nutrients such as nitrogen and phosphorus. Nutrients can be introduced into a catchment via the application of fertiliser, from septic systems, and from animal faecal matter that washes through soil and into the groundwater. Nitrate and nitrite are two forms of nitrogen that can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMMC 2011).

Other chemicals and heavy metals can be associated with land uses such as industry and landfill. These may enter groundwater and could be harmful to human health if consumed.
Appendix E — How do we protect public drinking water source areas?

The *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 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](http://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 the Department of Water and Environmental Regulation) 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 and read our Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016). 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

<table>
<thead>
<tr>
<th>Drinking water source protection report</th>
<th>Scope and outcome</th>
<th>Consultation</th>
<th>Time to prepare</th>
<th>Implementation table</th>
<th>Gazettel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drinking water source protection assessment (DWSPA)</td>
<td>Desktop assessment of readily available information</td>
<td>Preliminary</td>
<td>Up to 3 months</td>
<td>No</td>
<td>Arrange for the constitution and gazettal of the source under legislation. This helps protect water quality and guides land use planning. All types of consulted drinking water source protection reports can recommend to constitute a source’s boundary under legislation.</td>
</tr>
<tr>
<td>Drinking water source protection plan (DWSPP)</td>
<td>Full investigation of risks to water quality building on information in the DWSPA</td>
<td>Public</td>
<td>6–12 months</td>
<td>Prepared from recommendations in the DWSPA and/or information from public consultation</td>
<td></td>
</tr>
<tr>
<td>Drinking water source protection review (DWSPR)</td>
<td>Review changes in land and water factors and implementation of previous recommendations. Sometimes prepared to consider specific issues in a PDWSA</td>
<td>Key stakeholders</td>
<td>3–6 months</td>
<td>Prepared from recommendations in the DWSPA or DWSPP</td>
<td></td>
</tr>
</tbody>
</table>
Appendix F – 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: Gnangara 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 an assessment based on preventive risk that considers both the maximum and residual risks 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)*

<table>
<thead>
<tr>
<th>Likelihood</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Insignificant</td>
</tr>
<tr>
<td>Almost certain</td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Likely</strong></td>
<td>Moderate</td>
</tr>
<tr>
<td><strong>Possible</strong></td>
<td>Low</td>
</tr>
<tr>
<td><strong>Unlikely</strong></td>
<td>Low</td>
</tr>
<tr>
<td><strong>Rare</strong></td>
<td>Low</td>
</tr>
</tbody>
</table>
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**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ADWG</strong></td>
<td><em>Australian drinking water guidelines</em></td>
</tr>
<tr>
<td><strong>ANZECC</strong></td>
<td><em>Australian and New Zealand Environment Conservation Council</em></td>
</tr>
<tr>
<td><strong>DBCA</strong></td>
<td><em>Department of Biodiversity, Conservation and Attractions</em></td>
</tr>
<tr>
<td><strong>DoE</strong></td>
<td><em>Department of Environment</em></td>
</tr>
<tr>
<td><strong>DoW</strong></td>
<td><em>Department of Water</em></td>
</tr>
<tr>
<td><strong>DWER</strong></td>
<td><em>Department of Water and Environmental Regulation</em></td>
</tr>
<tr>
<td><strong>HAZMAT</strong></td>
<td><em>hazardous materials</em></td>
</tr>
<tr>
<td><strong>LEMC</strong></td>
<td><em>local emergency management committee</em></td>
</tr>
<tr>
<td><strong>LPS</strong></td>
<td><em>local planning scheme</em></td>
</tr>
<tr>
<td><strong>NHMRC</strong></td>
<td><em>National Health and Medical Research Council</em></td>
</tr>
<tr>
<td><strong>NRMMC</strong></td>
<td><em>Natural Resource Management Ministerial Council</em></td>
</tr>
<tr>
<td><strong>P1, P2, P3</strong></td>
<td><em>priority 1, priority 2, priority 3</em></td>
</tr>
<tr>
<td><strong>PDWSA</strong></td>
<td><em>public drinking water source area</em></td>
</tr>
<tr>
<td><strong>SPP</strong></td>
<td><em>state planning policy</em></td>
</tr>
<tr>
<td><strong>WAPC</strong></td>
<td><em>Western Australian Planning Commission</em></td>
</tr>
<tr>
<td><strong>Westplan–HAZMAT</strong></td>
<td><em>Western Australian plan for hazardous materials</em></td>
</tr>
<tr>
<td><strong>WHPZ</strong></td>
<td><em>wellhead protection zone</em></td>
</tr>
<tr>
<td><strong>WQPN</strong></td>
<td><em>water quality protection note</em></td>
</tr>
</tbody>
</table>
## Units of measurement

<table>
<thead>
<tr>
<th>Unit Abbreviation</th>
<th>Unit Description</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>km</td>
<td>kilometres</td>
<td>A measure of distance, 1 km equals 1000 m.</td>
</tr>
<tr>
<td>mg/L</td>
<td>milligrams per litre</td>
<td>A measure of concentration of a substance in a solution.</td>
</tr>
<tr>
<td>MPN</td>
<td>most probable number</td>
<td>A method used to measure the occurrence of microbes in a sample of water. The procedure uses tubes or microtitre plates and presence/absence tests (WHO 2011).</td>
</tr>
<tr>
<td>pH</td>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>TDS</td>
<td>total dissolved solids</td>
<td>Consists of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometre filter membrane can also contribute to TDS. TDS comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC &amp; NRMMC 2011).</td>
</tr>
</tbody>
</table>

## Volumes of water

<table>
<thead>
<tr>
<th>Volume Description</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>One millilitre</td>
<td>0.001 litre</td>
</tr>
<tr>
<td>One litre</td>
<td>1 litre</td>
</tr>
<tr>
<td>One thousand litres</td>
<td>1000 litres</td>
</tr>
<tr>
<td>One million litres</td>
<td>1 000 000 litres</td>
</tr>
<tr>
<td>One thousand million litres</td>
<td>1 000 000 000 litres</td>
</tr>
</tbody>
</table>

(mL)  (L)  (kL)  (ML)  (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 & NRMMC 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 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).

**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 wellfield).

**Catchment**
The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.

**Constitute**
Define the boundaries of any catchment area or water reserve by Order in Council under the Country Areas Water Supply Act 1947 or by Proclamation under the Metropolitan Water Supply, Sewerage and Drainage Act 1909.

**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.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fractured rock aquifer</td>
<td>An aquifer where groundwater is present in the fractures, joints, solution cavities, bedding planes and zones of rocks. Fractured rock aquifers are highly susceptible to contamination from land uses when aquifers crop-out or sub-crop close to the land surface.</td>
</tr>
<tr>
<td>Health guideline value</td>
<td>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 &amp; NRMMC 2011).</td>
</tr>
<tr>
<td>Hydrocarbons</td>
<td>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.</td>
</tr>
<tr>
<td>Leaching/leachate</td>
<td>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.</td>
</tr>
<tr>
<td>Maximum risk</td>
<td>This is the level of risk in the absence of any preventive measures 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 &amp; NRMMC 2011).</td>
</tr>
<tr>
<td>Nutrients</td>
<td>Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.</td>
</tr>
<tr>
<td>Pathogen</td>
<td>A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <em>Escherichia coli</em>), protozoa (such as <em>Cryptosporidium</em> and <em>Giardia</em>) and viruses.</td>
</tr>
<tr>
<td>Pesticides</td>
<td>Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.</td>
</tr>
<tr>
<td>Public drinking water source area</td>
<td>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.</td>
</tr>
</tbody>
</table>
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 1 (P2) areas is risk minimisation and priority 3 (P3) areas is risk management.

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.

Residual risk

This is the level of risk after considering preventive measures 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.

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 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 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.

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.
References


—— 2009, WQPN no. 36: *Protecting public drinking water source areas*

—— 2016b, WQPN no. 25: *Land use compatibility tables for public drinking water source areas*.


Further reading


Board M (MLA Member for Jandakot and Chairman of the Select Committee) 1994, *The Select Committee on Metropolitan Development and Groundwater Supplies – Report*, Legislative Assembly, Perth.


— 2004, WQPN 25: *Land use compatibility in public drinking water source areas*

— 2006, WQPN no. 10: *Contaminant spills: emergency response*

— 2006, WQPN no. 44: *Roads near sensitive water resources*

— 2006, WQPN no. 76: *Land use planning in Public Drinking Water Source Areas*

— 2009, WQPN no. 36: *Protecting public drinking water source areas*

— 2016b, WQPN no. 25: *Land use compatibility tables for public drinking water source areas*


