Government of Western Australia
Department of Water and Environmental Regulation

Dandaragan Water Reserve

drinking water source protection review

Dandaragan town water supply

Water resource protection series
Report WRP 167
October 2017

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Cover photograph: Aerial photograph of the proposed Dandaragan Water Reserve

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

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Summary

Dandaragan is a small town in the Wheatbelt region of Western Australia. It is about 160 km north of Perth in the Shire of Dandaragan (see Figure A1). The town provides the service centre for a thriving rural community, broadacre farming and tourism. In 2011 the population of Dandaragan was 401 with 188 private dwellings (Australian Bureau of Statistics 2011).

The Dandaragan Water Reserve covers approximately 16 km^2 (see Figure A2). The Water Corporation supplies drinking water to Dandaragan via the Dandaragan Town Water Supply (TWS) scheme. In 2013/14, there were 90 properties connected to the Dandaragan TWS scheme (Water Corporation 2014).

The Water Corporation draws water from one production bore to supply the Dandaragan TWS scheme. This bore, 1/81, is located in a secure compound owned by the Water Corporation, within Crown Reserve 36020 (see Figure A3). It draws water from the Leederville–Parmelia aquifer, which is semi-confined in this area. The geophysical logs indicate that the Leederville Formation is fairly shaly at this location and provides a barrier against contaminants from entering the groundwater. This means that the potential risk of groundwater contamination in the Dandaragan Water Reserve from human activity is lower than in an unconfined aquifer because of the low permeability and transmissivity of the Leederville–Parmelia aquifer.

This drinking water source protection review considers changes that have occurred in and around the Dandaragan Water Reserve since completion of the *Dandaragan Water Reserve water source protection plan* (Water and Rivers Commission 1999). 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.

We prepared this document in consultation with key stakeholders, including the Water Corporation and the Shire of Dandaragan.

The main changes since the 1999 plan are:

- Production bore 1/82 failed and has been retained as a monitoring bore.
- The series of spears that drew water from the superficial aquifer to augment the public water supply during times of peak demand are no longer used.
- Raw groundwater is now dosed with sodium carbonate (soda ash) to correct the pH prior to supplying to consumers.
- Recommendations from the 1999 plan have been completed or require ongoing implementation. A consolidated list of recommendations has been provided in this review (see section 2.2).

The former Department of Water conducted a hydrogeological assessment of the Dandaragan Water Reserve, which helped us to determine that the size of the existing reserve can be reduced (Figure A2). This means that fewer privately-owned lots will be affected by the water reserve. This is explained in section 1.1.1.

We discovered an anomaly in the 1999 plan; rural land was assigned a priority 3 (P3) area. This is inconsistent with other public drinking water source areas (PDWSAs) in the state where rural land is generally assigned as priority 2 (P2).

This review consolidates the ongoing recommendations from the 1999 plan with the following new recommendations:

- Reduce the boundary of the Dandaragan Water Reserve.
- Consult with landowners to determine if rural land can be changed from P3 to P2 to be consistent with other PDWSAs in the state. This will not prevent the water reserve boundary from being reduced.

This review is consistent with the *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 2011), State planning policy no. 2.7: *Public drinking water source policy* (Western Australian Planning Commission 2003) and Strategic policy: *Protecting public drinking water source areas in Western Australia* (Department of Water 2016).

Important information about the Dandaragan Water Reserve is shown in Table 1.

Table 1 Key information for the Dandaragan Water Reserve

Dandaragan Water Reserve	
Local government authority	Shire of Dandaragan
Location supplied	Dandaragan (90 properties)
Water service provider	Water Corporation
Aquifer type	Semi-confined groundwater
Aquifer name	Leederville–Parmelia
Licence number	GWL65046(7)
Licensed abstraction	70 000 kL per year
Number of production bores	1
Bore name	1/81
MGA co-ordinates of bore	Easting 376 274, Northing 6 606 611, Zone 50
Date drilled	10 February 1982
Date pump installed	27 August 1993

Dandaragan Water Reserve	
Bore depth	114 m below top of casing
Bore screen interval	105.8–114 m below top of casing
Dates of drinking water source protection reports	1999 – *Dandaragan Water Reserve water source protection plan* (Water and Rivers Commission 1999) 2016 – *Dandaragan Water Reserve drinking water source protection review* (this document)
Consultation	1999 – extensive public consultation occurred during the development of the *Dandaragan Water Reserve water source protection plan* and the draft plan was released for public comment. 2016 – consultation with the Water Corporation and Shire of Dandaragan
Proclamation status/history	Proclaimed in June 1970 under the *Country Areas Water Supply Act 1947* Amended water reserve boundary proclaimed in November 1999 under the *Country Areas Water Supply Act 1947* Amendment (reduction) of the boundary will be progressed under the *Country Areas Water Supply Act 1947* when this report is finalised
Reference documents	*Australian drinking water guidelines* (NHMRC & NRMMC 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* (Department of Water 2016) *Gingin groundwater allocation plan* (Department of Water 2015a)

1 Review of Dandaragan's water source protection plan

Dandaragan is a small town in the Wheatbelt region of Western Australia. It is located about 29 km west of Moora and about 160 km north of Perth in the Shire of Dandaragan. The townsite services local rural industries that are predominantly based on wheat and sheep farming. In 2011 the population of Dandaragan was 401 with 188 private dwellings (Australian Bureau of Statistics 2011).

The Dandaragan Water Reserve covers approximately 16 km^2 and is located immediately to the north of Dandaragan. The Water Corporation supplies drinking water to Dandaragan via the Dandaragan Town Water Supply (TWS) scheme. In 2013/14 there were 90 properties, including 70 residential properties, connected to the Dandaragan TWS scheme (Water Corporation 2014).

The Water Corporation abstracts water for the Dandaragan TWS scheme from one production bore which draws water from the Leederville Formation component of the Leederville–Parmelia aquifer. This bore, 1/81, is 114 m deep and is located within Crown Reserve 36020 in a secure compound owned by the Water Corporation. Refer to Figure A3 and Figure C1.

The Department of Water and Environmental Regulation conducted a hydrogeological assessment of the Dandaragan Water Reserve which confirmed that the Leederville–Parmelia aquifer is semi-confined in the Dandaragan Water Reserve. In this area, the groundwater in the Leederville flows south-easterly while the deeper groundwater flows in a southerly direction. The semi-confined nature of the aquifer means that the potential risk of groundwater contamination in the Dandaragan Water Reserve from surface-based land uses is low.

1.1 Boundary

The Dandaragan Water Reserve was originally proclaimed in June 1970 under *Country Areas Water Supply Act 1947*. It covered what was considered at the time to be a large portion of the probable recharge area, which included the town.

To protect the bores from contamination by surrounding land uses, the *Dandaragan Water Reserve water source protection plan* (Water and Rivers Commission 1999) recommended amending the 1970 boundary to cover more of the probable recharge area. This recommendation was based on the information we had available at the time, and the amended boundary was proclaimed in 1999 under the *Country Areas Water Supply Act 1947* (Figure A2).

Our recent hydrogeological assessment of the Dandaragan Water Reserve has confirmed that the existing boundary could be reduced and still provide a safe distance from the production bore to protect it from contamination. We determined that the groundwater in the Dandaragan Water Reserve travels 1.46 km in 50 years. Our current approach to protect drinking water from contaminants is to achieve a minimum of 50 years groundwater flow travel time from the boundary to a production

bore. Therefore, the Dandaragan Water Reserve boundary could be reduced to a safe distance of 1.5 km upgradient of the production bore.

On that basis, this review recommends amending the Dandaragan Water Reserve from 16 km^2 to about 4 km^2 under the *Country Areas Water Supply Act 1947* (see section 2.2, recommendation no. 1 and Figure A2). This will provide the added benefit of removing restrictions from land use and development on the excluded land, because the land can be removed from the local planning scheme's special control area.

1.2 Priority areas

In 1999, Crown Reserve 36020, where the bores are located, was assigned a priority 1 (P1) area to protect the groundwater source. The remaining land, including reserves and freehold land (residential, rural residential, rural and industrial) was assigned a priority 3 (P3) area.

1.2.1 Rural land

Our current policy for protecting PDWSAs is that rural-zoned land is assigned a priority 2 (P2) area. P2 areas are defined and managed to maintain or improve the quality of the drinking water source with the objective of *risk minimisation*. P2 areas occur within PDWSAs where the risks need to be minimised. Low levels of development, consistent with the rural zoning, are considered appropriate in P2 areas.

Existing rural land in the proposed Dandaragan Water Reserve is currently assigned a P3 area. This is contrary to current policy applied across the state. This anomaly was discussed with the Shire of Dandaragan during the preparation of this review.

Reassigning rural land from P3 to P2 has not been undertaken in this review due to the need for consultation with landowners. Consulting properly with landowners takes considerable time and resources, which are not available at this time. This review recommends consulting with landholders in the future to determine if this reassignment can occur (see section 2.2, recommendation no. 8). The consultation can occur at any time before the next review of this water reserve.

Rural land uses in the proposed Dandaragan Water Reserve include stock grazing and broad hectare cropping. Reassigning land from P3 to P2 will not impact upon the operation of rural land as the existing land uses are already consistent with Water quality protection note (WQPN) no. 25: *Land use compatibility tables for public drinking water source areas* (Department of Water 2016). We recommend that best management practices are undertaken to minimise risks to water quality. Any pre-existing, approved, non-conforming land uses are also allowed to continue with best management practices.

Guidance on best management practices is provided in:

- WQPN no. 1: *Agriculture – dryland crops near sensitive water resources*

- WQPN no. 53: *Dam construction and operation in rural areas*
- WQPN no. 70: *Wastewater treatment and disposal – domestic systems*
- WQPN no. 80: *Stockyards*
- WQPN no. 96: *Pest animal management in PDWSAs*
- WQPN no. 104*: Aerial spraying of crops with pesticides*
- Rural water note (RWN) no. 1: *Water quality in broadacre farming*.

1.2.2 Reserves

Our current policy for protecting PDWSAs is that reserves are assigned as either P1 or P2 areas, depending on the existing land use and ownership.

Land uses on P3 area reserves within the Dandaragan Water Reserve include:

- a landfill on Reserve 26950
- recreation grounds, including a golf course, on Reserve 28121
- sports grounds on Reserve 24385
- community club premises on Reserve 34709.

Apart from the landfill, these recreation and community uses are listed in WQPN no. 25 as *compatible with conditions* or *acceptable* in P3 areas.

P3 areas are defined and managed to maintain the quality of the drinking water source for as long as possible with the objective of *risk management*. P3 areas generally occur within PDWSAs where the land is zoned for urban, commercial or light industrial purposes. Within P3 areas, drinking water sources need to co-exist with higher intensity land uses (compared to P1 and P2 areas). A key element in the protection of P3 areas is implementing best management practices.

As the land uses and activities in the reserves currently assigned as P3 areas are consistent with P3 areas, and given the pre-existing, approved status of the landfill site, the P3 areas will remain unchanged.

Guidance on best management practices is provided in:

- *A guide to the use of pesticides in Western Australia* (Department of Health 2013)
- Circular no. PSC88: *Use of herbicides in water catchment areas* (Department of Health 2007)
- *Western Australian environmental guidelines for the establishment and maintenance of turf grass areas*
- WQPN no. 70: *Wastewater treatment and disposal – domestic systems*
- WQPN no. 24: *Landfilling with inert materials*
- WQPN no. 111: *Landfills for disposal of putrescible materials*

1.2.3 Light industrial and commercial areas

The light industrial area on lots 5, 9, 100 and part of lot 1144, which includes a motor vehicle repair workshop, will remain as a P3 area. WQPN no. 25 states that light industrial land uses are *compatible with conditions* in P3 areas.

Guidance on best management practices is provided in:

- WQPN no. 28: *Mechanical servicing and workshops*
- WQPN no. 42: *Radiator repair and reconditioning*
- WQPN no. 51: *Industrial wastewater management and disposal*
- WQPN no. 52: *Stormwater management at industrial sites*
- WQPN no. 56: *Tanks for elevated chemical storage*
- WQPN no. 61: *Tanks for ground level chemical storage*
- WQPN no. 93: *Light industry near sensitive waters*.

1.2.4 Roads

Road reserves are *compatible with conditions* in P2 areas and *acceptable* in P3 areas. In the Dandaragan Water Reserve, roads will be assigned the same priority as the surrounding land.

Guidance on best management practices for roads is provided in WQPN no. 44: *Roads near sensitive water resources.*

1.3 Protection zones

Wellhead protection zones (WHPZs) protect underground sources of drinking water from contamination within the immediate vicinity of drinking water production bores. In these zones, groundwater can moves more rapidly towards bores due to the depressurisation of the aquifer caused by groundwater pumping. Irrespective of the groundwater flow direction, any contamination within a WHPZ is likely to migrate rapidly into the bore. In these zones, extra protection measures are necessary for the following reasons:

- There is little opportunity for natural groundwater processes such as soil microbes to degrade contaminants before they enter the production bore.
- There may be insufficient response time (or buffer distance) for effective clean-up of fuel or other chemical spills before they enter production bores.
- The placement of other bores in these zones could interfere with the efficient operation of the public water supply pump.

The current WHPZ in the Dandaragan Water Reserve is centred around bore 1/82, which is no longer in operation. This review recommends realigning the WHPZ to centre around production bore 1/81 (see section 2.2, recommendation no. 2).

The proposed Dandaragan Water Reserve boundary, priority areas and protection zones discussed in sections 1.1, 1.2 and 1.3 have been determined in accordance with current departmental policy.

If you require more information about how we protect drinking water sources, please read Appendix E.

1.4 Update on water supply scheme

1.4.1 Licensing

Groundwater resource use and conservation in Western Australia is administrated by this department in accordance with the *Rights in Water and Irrigation Act 1914*. Under this act, a licence is required to draw water from surface water and groundwater areas.

The former Department of Water renewed the Water Corporation's groundwater allocation licence in August 2015. This allows the Water Corporation to draw 70 000 kL of water from one production bore in the Leederville–Parmelia aquifer to supply Dandaragan's drinking water. This licence expires in August 2025. The current entitlement is sufficient to meet expected demands for the duration of the licence. A licence amendment can be requested if the forecast annual abstraction is likely to exceed the annual water entitlement.

1.4.2 Water supply and treatment

The Dandaragan bore field currently consists of one production bore (1/81) and three monitoring bores (1/82, 1/77 and 2/77). Refer to figures C2 to C5 in Appendix C.

Groundwater is dosed with sodium carbonate (soda ash) for pH correction and undergoes aeration and filtration to remove iron and manganese. The water is disinfected by chlorination to ensure microbiological quality for consumers. After treatment, the water is stored in a 225 kL low-level tank. Transfer pumps then distribute the water to the town's reticulation system and to a 225 kL mid-level ground tank, and a 90 kL high-level tank for distribution to elevated parts of the town.

It should be recognised that although treatment and disinfection are essential barriers against contamination, PDWSA management is the first step in protecting water quality and ensuring a safe drinking water supply. This approach is endorsed by the ADWG (NHMRC & NRMMC 2011) and reflects an approach 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 drinking water sources, please read Appendix E.

1.5 Native title claims and Aboriginal sites of significance

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.

The Department of Water and Environmental Regulation 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.

There are two native title claims within the Dandaragan Water Reserve:

- Yued claim (WC1997/071) represented by the South West Aboriginal Land and Sea Council – accepted for registration
- Single Noongar Claim (Area 1) (WC2003/006) – not accepted for registration.

The State Government of Western Australia and the Noongar native title claimants negotiated an agreement called an Indigenous Land Use Agreement (ILUA). Six ILUAs were executed on the 8 June 2015 by the State Government of Western Australia. This agreement recognises the Noongar people as the traditional owners of land in the South West Settlement Area, which extends from a point south of Dongara on the west coast, approximately east to a point north of Moora and then south-easterly to a point midway between Albany and Esperance (see Figure A5). It will enable some types of land-based customary activities to be undertaken by Noongar people in PDWSAs within the South West Settlement Area.

The ILUA is available via the Department of Premier and Cabinet, see www.dpc.wa.gov.au/lantu/Claims/Pages/SouthWestSettlement.aspx.

1.6 Enforcing by-laws, surveying the area and maintenance

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

- maintaining signs in accordance with *S111 Source protection signage* (Water Corporation 2013)
- maintaining security and fencing surrounding the bore
- ongoing regular surveillance which currently includes six-monthly inspections and monthly monitoring for aesthetic characteristics, health-related chemicals, microbiological contaminants and water levels
- raising water quality incidents through the Advisory Committee for the Purity of Water.

1.7 Other departmental work

1.7.1 Mid West regional water supply strategy

The Department of Water and Environmental Regulation developed the *Mid West regional water supply strategy* (Department of Water 2015) to provide a long-term outlook of water demand and supply. It informs long-term planning and regional development and will help ensure investment in water supply is aligned with state development objectives and land-use planning at a regional scale. It will also provide the foundation for more detailed planning at local and site scales.

Five strategies within the document guide how government, industry and the community can work together to ensure that water is available to meet future demand in the Mid West region.

The *Mid West regional water supply strategy* is available on the department's website.

1.7.2 Gingin groundwater allocation plan

The Gingin groundwater area was proclaimed in 1975 under the *Rights in Water and Irrigation Act 1914*. This means that water users require a water licence to abstract groundwater under section 5C of the act (unless exemptions apply).

The Dandaragan Water Reserve falls within the Cowalla groundwater subarea of the Gingin groundwater area.

The department published the *Gingin groundwater allocation plan* in 2015. The plan covers the proclaimed Gingin groundwater area north of Gingin Brook. It sets out how we will manage groundwater in the Gingin plan area through allocation limits, water licensing and ongoing monitoring and evaluation until at least 2020.

The plan was developed to manage groundwater resources in the Gingin plan area in the context of a drying climate and high demand for water. The allocation limits and licensing rules in the plan will maintain the reliability of groundwater for productive use and reduce the risks to the groundwater-dependent environment. The plan supports further development in the area by indicating the amount of water that can reliably be abstracted and by establishing new water trading zones.

The *Gingin groundwater allocation plan* is available on the department's website.

1.7.3 Gingin groundwater allocation methods report

The *Gingin groundwater allocation plan methods report* was published in March 2015. This report explains how we developed the allocation limits for each of the 35 groundwater resources covered in the *Gingin groundwater allocation plan* (Department of Water 2015a). The report summarises the hydrogeological, environmental (including potential impacts from a drying climate), cultural and social information available for the aquifers, reviews subarea boundaries and describes the method we used to set allocation limits.

The main change to the way we determine allocation limits is that we reduced the rainfall figures that were used to calculate recharge.

The *Gingin groundwater allocation methods report* is available on the department's website.

1.8 Update on water quality risks

As part of this review, the department conducted a new assessment of water quality contamination risks to the Dandaragan drinking water source, in accordance with the ADWG. For more information on understanding risks in PDWSAs, please read Appendix F.

This section only discusses risks to Dandaragan's drinking water quality that have changed since the 1999 plan. Please refer to the *Dandaragan Water Reserve water source protection plan* (Water and Rivers Commission 1999) for information about the unchanged risks that still apply. Table 2 (at the end of this section) summarises the risks, which are also described in the following sections.

When the 1999 plan was published, we considered that the portion of the Leederville Formation where the bore drew water from was unconfined. This meant that we thought the aquifer was highly vulnerable to contamination.

However, our recent hydrogeological assessment shows that the Leederville–Parmelia aquifer is semi-confined at this location, meaning that the potential risk of groundwater contamination is actually low. This is because the interbedded silty sandstone and clayey siltstone in the unsaturated zone provide a buffer against potential contamination. This means that most of the potential risks identified in the 1999 plan are no longer applicable.

Land uses surrounding the Dandaragan Water Reserve are shown in an aerial photo in Figure A4.

The public drinking water supply bore is in a secure compound that is owned by the Water Corporation. There has been no evidence of problems from vandalism.

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.

1.8.1 Extensive agricultural activities and stock grazing

The Dandaragan Water Reserve bore field is surrounded by private farming land which is mainly used for extensive agricultural activities including broadacre cropping and sheep grazing. The main risks to Dandaragan's drinking water source from these land uses include pathogens from grazing animals, nutrients from animals and fertilisers, pesticides from farm practices and hydrocarbons from farm machinery and vehicles. However, these risks are low.

Extensive stock grazing and broad hectare cropping are listed in WQPN no. 25 as *compatible* in P3 areas and *compatible with conditions* in P2 areas. Conditions apply

to fertiliser and pesticide application and animal stocking rates to ensure they are consistent with the objectives for P2 areas.

Some agricultural land is within the WHPZ. By-laws and conditions apply to storage and use of chemicals in WHPZs. Refer to section 1.3 for guidance.

1.8.2 Dandaragan townsite

Dandaragan and its surrounding urban area was within the 1970 water reserve and identified as a risk to water quality in the 1999 plan. It is not within either the current (1999) or proposed boundary and is downgradient of the production bore. This means that septic tanks in the town are no longer considered to be a risk to Dandaragan's drinking water quality.

1.8.3 Landfill site

The landfill site (Reserve 26950) is located approximately 1.3 km west of the production bore. It is licensed by the Department of Water and Environment Regulation as a class II putrescible landfill site. It is used for solid waste disposal and accepts household, agricultural and construction waste including clean fill, inert waste and some putrescible wastes. It is unlined and has a clay base. Contaminants have the potential to leach into the groundwater. The potential risk of groundwater contamination from the landfill site is considered to be lower than that assessed in 1999.

Class II landfill sites are listed in our WQPN no. 25 as *incompatible* in P3 areas. However, as a pre-existing, approved, non-conforming land use it is allowed to continue with best management practices. Refer to section 1.2.2 for guidance.

1.8.4 Golf course and sports grounds

The golf course (Reserve 28121) and sports grounds (reserves 24385 and 34709) provide a potential source of contamination from pesticides (chemicals), fertilisers (nurtrients) and septic systems (pathogens and nutrients). These are located west of the water supply bore.

Golf courses and recreational parks/ovals are listed in our WQPN no. 25 as *compatible with conditions* and sporting and recreation club rooms are listed as *acceptable* in P3 areas. Refer to section 1.2.2 for guidance.

A small area of the sports grounds is within the WHPZ. By-laws and conditions apply to storage and use of chemicals in WHPZs.

The risk of contamination from these land uses is low.

1.8.5 Light industrial area

The light industrial area – lots 5, 9 and 100 and a small portion of Lot 1144 – is located 300 m west of and immediately upstream from the production bore. The area has not been developed since the 1999 plan when the risks of water quality contamination were unknown.

The potential risk of groundwater contamination from the light industrial area is low. Refer to section 1.2.3 for guidance.

A small area in the south-eastern corner of the industrial area, part of lot 1144, is in the WHPZ. By-laws and condition apply to storage and use of chemicals in WHPZs.

Mechanical workshop

The mechanical workshop on lot 100 is about 425 m upstream from the water supply bore. The main risks to Dandaragan's drinking water source from this land use include hydrocarbons and other chemicals from machinery and vehicles. Best practices are recommended. Guidance is provided in our WQPN no. 28: *Mechanical servicing and workshops*.

The potential risk of groundwater contamination from the mechanical workshop is lower than estimated in the 1999 plan.

1.8.6 Future development

There are no indications that land uses within the proposed Dandaragan Water Reserve will be intensified. However, four rural lots within the proposed boundary (881, 871, 313 and 62) were identified in the Shire of Dandaragan's *Local planning strategy 2012* for future rezoning and subdivision. The Shire of Dandaragan is currently updating the local planning strategy, which proposes to change these lots to a rural zoning. The new strategy should include a special control area that protects the proposed Dandaragan Water Reserve. The Shire of Dandaragan should refer the draft strategy to the Department of Water and Environmental Regulation for comment.

Further, the Shire of Dandaragan's *Town Planning Scheme No. 7* (Department of Planning 2006) should be amended to reflect the proposed Dandaragan Water Reserve (see section 2.2, recommendation no. 4).

1.8.7 Groundwater bores

Production bore 1/81 is 114 m deep and is within a secure compound owned and managed by the Water Corporation. There have been no reported problems of vandalism at the compound and the Water Corporation conducts regular inspections of the compound and the surrounding water reserve. The potential risk of contaminants entering the groundwater via the public drinking water supply bore is low due to the depth of the bore and the semi-confined nature of the aquifer.

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 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).

In addition to the Water Corporation bore there are three other licensed users within the proposed water reserve boundary, this included the Shire of Dandaragan and two private bores.

1.8.8 Mining, petroleum and unconventional gas

One mining tenement (E 7004609) and one petroleum exploration permit pending renewal (EP 407 R1) cover the proposed Dandaragan Water Reserve. Mining and petroleum activities are regulated by the Department of Mines, Industry Regulation and Safety.

The Dandaragan Water Reserve is within an area that has potential shale and tight gas resources trapped within rock formations. In Western Australia, shale gas activities are regulated by the Department of Mines, Industry Regulation and Safety under the *Petroleum and Geothermal Energy Resources Act 1967*. Projects cannot proceed until the Department of Mines, Industry Regulation and Safety approves an environmental plan and any other associated plans as required under the current regulations.

The Legislative Council Standing Committee on Environment and Public Affairs recently released its report on the parliamentary inquiry into the implications of hydraulic fracturing for unconventional gas for Western Australia. Oil or gas exploration and production are managed in accordance with government's response to this report (Report no. 42: *Implications for Western Australia of hydraulic fracturing for unconventional gas* (2015)), the *Administrative agreement between the Department of Mines and Petroleum and Department of Water for onshore petroleum and geothermal activities in Western Australia* (2015) and *Guide to the regulatory framework for shale and tight gas in Western Australia: A whole-of-government approach* (2015).

In accordance with the administrative agreement, proposals for the extraction of shale or tight gas within the Dandaragan Water Reserve will be referred to this department for advice. The agreement also requires that proposals within 5 km of bore 1/81 are referred to this department for advice.

Table 2 Summary of potential water quality risks and best management practices

Land use/activity	**Hazard**	**Management priority[1]**	**Best management practice guidance[2]**
Cropping and grazing	Pathogens from livestock and human activity	Low	WQPN no. 1: *Agriculture: dryland crops near sensitive water resources* WQPN no. 53: *Dam construction and operation in rural areas* WQPN no. 96: *Pest animal management in PDWSAs* WQPN no. 104*: Aerial spraying of crops with pesticides* RWN no. 1: *Water quality in broadacre farming* Public sector circular number 88: *Use of herbicides in water catchment areas* Stocking rate guidelines for rural small holdings
	Nutrients from livestock excrement and fertilisers	Low	
	Pesticides, herbicides and chemicals	Low	
	Hydrocarbon contamination caused by fuel spills and oil leaks from vehicles and machinery	Low	
Residential	Nutrients and pathogens from septic systems	Low	WQPN no. 70: *Wastewater treatment and disposal – domestic systems*
Roads and tracks	Hydrocarbon and chemicals contamination caused by spills and leaks from vehicles and machinery Pesticides from weed-spraying along edges of roads Nutrients from accidents or leaks	Low	WQPN no. 44: *Roads near sensitive water resources*
Landfill	Nutrient, heavy metal, chemical, organic waste and hydrocarbon	Low	WQPN no. 24: *Landfilling with inert materials*

Land use/activity	Hazard	Management priority[1]	Best management practice guidance[2]
	contamination via leachate and surface water contamination from runoff from household, agricultural, construction and waste		WQPN 111: *Landfills for disposal of putrescible materials*
Golf course and sports grounds	Nutrients (such as nitrogen) from fertiliser Pesticides, herbicides and chemicals contamination Nutrients and pathogens from the septic systems	Low	*Western Australian environmental guidelines for the establishment and maintenance of turf grass areas* *A guide to the use of pesticides in Western Australia* Circular no. PSC88: *Use of herbicides in water catchment areas* WQPN no. 70: *Wastewater treatment and disposal – domestic systems*
Light industrial area including mechanical workshop	Nutrient, heavy metal, chemical and hydrocarbon contamination from spills, vehicles and machinery	Low	WQPN no. 28: *Mechanical servicing and workshops* WQPN no. 42: *Radiator repair and reconditioning* WQPN no. 51: *Industrial wastewater management and disposal* WQPN no. 52: *Stormwater management at industrial sites* WQPN no. 56: *Tanks for elevated chemical storage* WQPN no. 61: *Tanks for ground level chemical storage* WQPN no. 93: *Light industry near sensitive waters*

[1] The management priority of these land uses/activities reflect the semi-confined nature of this water reserve's aquifer.

[2] Water quality protection notes (WQPNs) are available at www.dwer.wa.gov.au.

1.9 Water quality information

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

Generally, the groundwater quality in the Dandaragan Water Reserve is good. Most chemical parameters are within the aesthetic and health guidelines in the ADWG (NHMRC & NRMMC 2011), with the exception of iron and manganese which are elevated, causing high turbidity, and pH, which is just below the aesthetic guideline level. These are naturally occurring in the local groundwater.

It should be noted that the Water Corporation treats and disinfects the raw groundwater from this source before supplying it to consumers (see section 1.4.2).

2 Implementation of Dandaragan's drinking water source protection plan

2.1 Status of previous recommendations

Table 3 outlines recommendations from the 1999 plan and their current status.

Table 3 Implementation status for Dandaragan Water Reserve water source protection plan

No.	Recommendation	Comments
1	The proposed Dandaragan Water Reserve should be gazetted under the *Country Areas Water Supply Act 1947*.	The amended Dandaragan Water Reserve was gazetted in 1999 under the *Country Areas Water Supply Act 1947.*
2	Planning strategies should incorporate the management principles outlined in the former Water and Rivers Commission's *Land use compatibility in public drinking water source areas* and reflect the priority 1 and priority 3 classifications given to the water reserve.	The Dandaragan Water Reserve and priority areas are incorporated in the Shire of Dandaragan's local planning strategy (2012). Section 5.22 of the *Shire of Dandaragan's local planning scheme no. 7* includes the Dandaragan Water Reserve but it is not shown in the scheme maps. It states that 'water source protection plans are prepared by the former Water and Rivers Commission (now the Department of Water and Environmental Regulation). This review recommends that the Shire of Dandaragan's local planning strategy and scheme, including maps, should be updated to incorporate the proposed Dandaragan Water Reserve boundary, priority areas and protection zone (section 2.2, recommendation no. 3). Status: completed with proposed changes due to water reserve boundary change

No.	Recommendation	Comments
3	All development proposals in the proposed water reserve which are likely to impact on water quality should be referred to the Water and Rivers Commission. This particularly would apply to the light industrial subdivision to the north-west of the wellfield.	Development proposals within the Dandaragan Water Reserve are referred to the Mid West Region office of the Department of Water and Environmental Regulation. Guidance is provided through the WQPN series. This recommendation is ongoing and will be carried forward in this review (section 2.2, recommendation no. 4).
4	Signs should be erected along the boundaries of the Water Reserve to define the reserve and promote public awareness of the need to protect water quality.	Signs advising on the location of the location of the Dandaragan Water Reserve have been erected. This recommendation is ongoing and will be carried forward in this review (section 2.2, recommendation no. 6).
5	A process should be put in place to address any spillage of pollutants within the water reserve.	Emergency response protocols have changed to Westplan–HAZMAT and the local emergency management committee (LEMC). This has been continued as a new recommendation of this review (section 2.2, recommendation no. 5).
6	A surveillance program should be established to identify any incompatible land uses or potential contaminant threats within the water reserve.	Water Corporation continues to undertake surveillance and by-law enforcement within the Dandaragan Water Reserve. This recommendation is ongoing and will be carried forward in this review (section 2.2, recommendation no. 7)
7	Implementation of these recommendations should be reviewed one year after this plan is endorsed. A full review of this protection plan should be undertaken approximately every five years.	This was completed in 2016 through the preparation of this review document. This recommendation is ongoing and will be carried forward in this review (section 2.2, recommendation no. 9).

2.2 Consolidated recommendations

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

1. Amend the Dandaragan Water Reserve existing boundary to the proposed reduced boundary, including priority areas and realigned protection zone, under the *Country Areas Water Supply Act 1947*. (Department of Water and Environmental Regulation)
2. Realign the 300 m radius wellhead protection zone around bore 1/81. (Department of Water and Environmental Regulation)
3. Incorporate the findings of this review and the location of the proposed Dandaragan Water Reserve (including its priority areas and protection zone) in the Shire of Dandaragan local planning scheme in accordance with the Western Australian Planning Commission's State planning policy no. 2.7: *Public drinking water source policy*. The Shire of Dandaragan should refer the draft strategy to the Department of Water and Environmental Regulation for comment. (Shire of Dandaragan)
4. Refer development proposals within the amended Dandaragan Water Reserve that are inconsistent with the Department of Water and Environmental Regulation's WQPN no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this review to the department's regional office for advice. (Department of Planning, Shire of Dandaragan and development proposal proponents)
5. Ensure incidents covered by Westplan–HAZMAT in the Dandaragan Water Reserve are addressed by ensuring that:
    - the Dandaragan LEMC and the Wheatbelt Emergency Management District are aware of the location and purpose of the Dandaragan Water Reserve
    - the locality plan for the Dandaragan 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 Dandaragan Water Reserve
    - personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Dandaragan Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality. (Water Corporation)
6. Maintain signs along the boundary of the Dandaragan 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. Consult land holders regarding reassigning rural land within the proposed Dandaragan Water Reserve from P3 to P2 areas prior to the next review of this water reserve. (Department of Water and Environmental Regulation)
9. Update this review within seven years or as appropriate to address changes in water quality risks. (Department of Water and Environmental Regulation)

Appendices

Appendix A — Figures

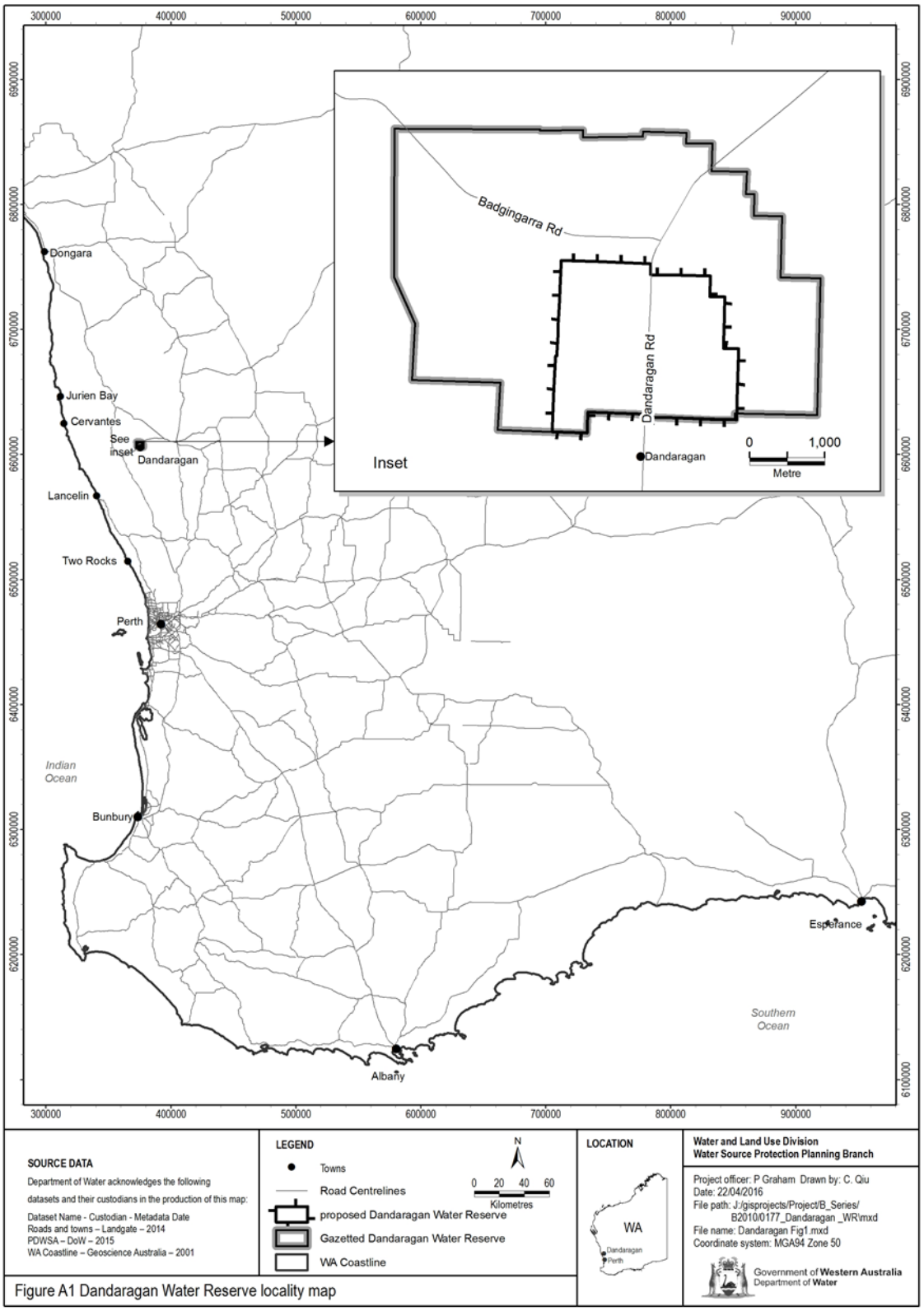

Figure A1 Dandaragan Water Reserve – locality map

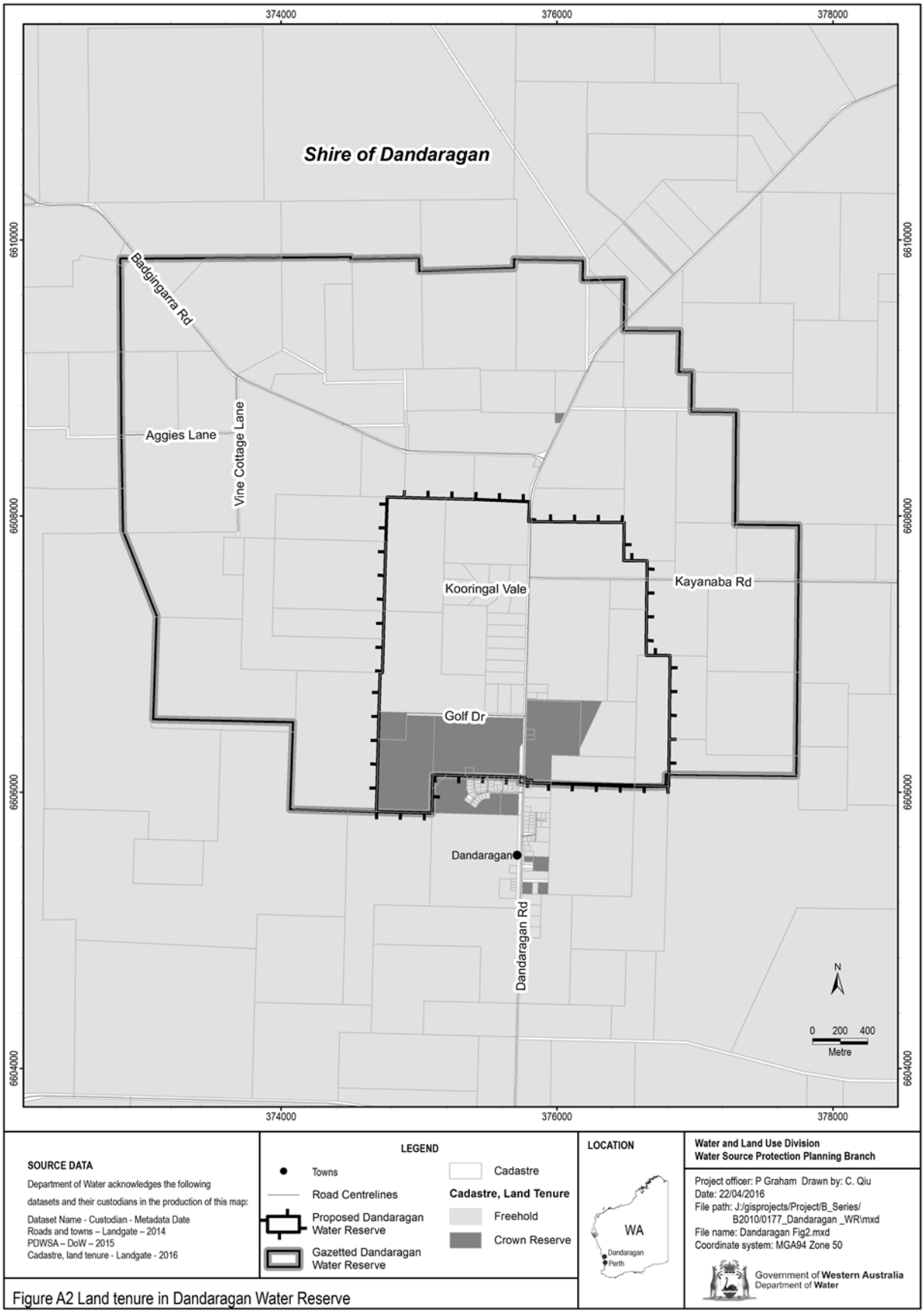

Figure A2 Dandaragan Water Reserve – land tenure

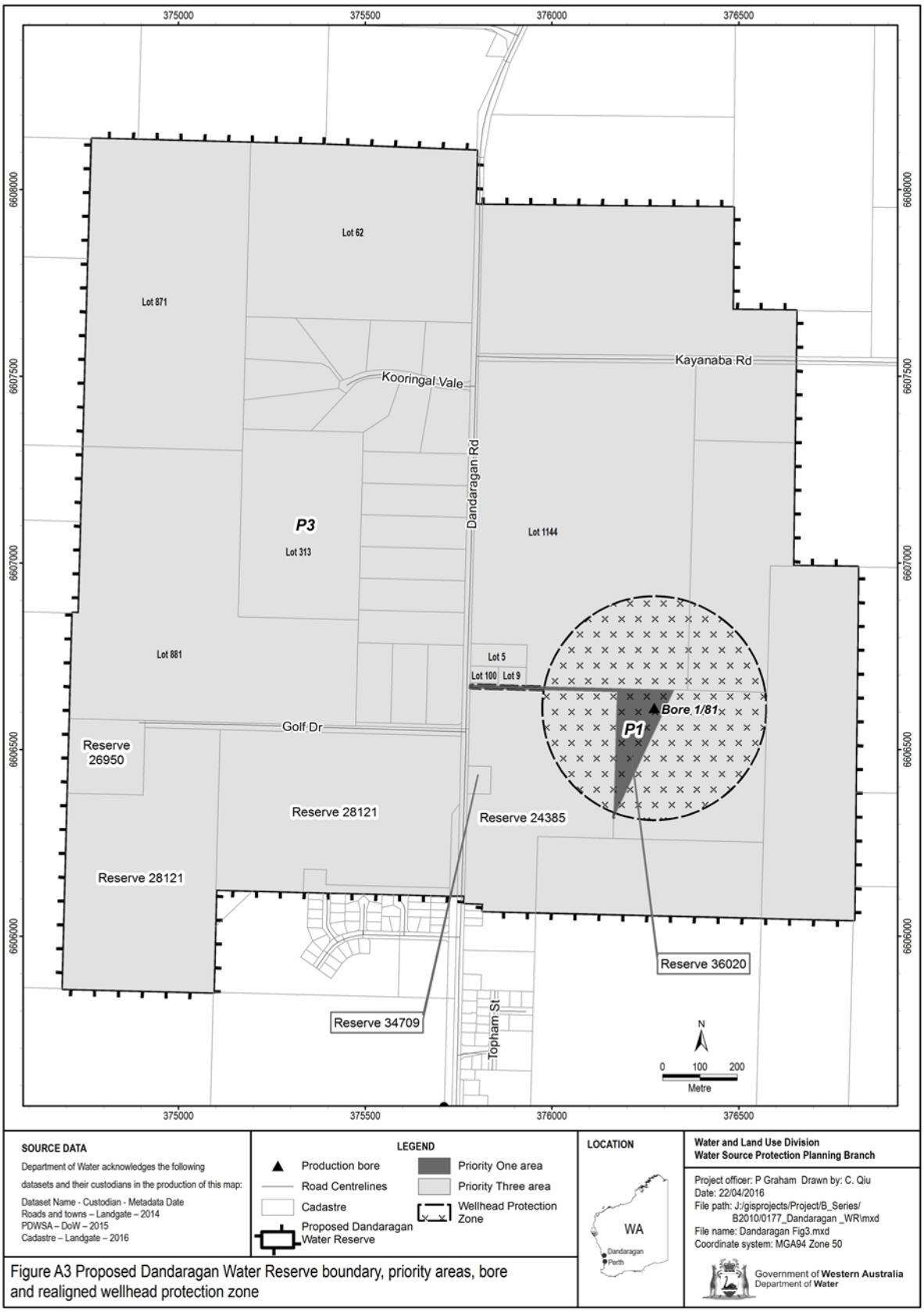

Figure A3 Proposed Dandaragan Water Reserve boundary, priority areas, bore and realigned wellhead protection zone

Figure A3 Dandaragan Water Reserve – proposed boundary, priority areas and protection zones and realigned wellhead protection zone

Figure A4 Proposed Dandaragan Water Reserve – aerial photo

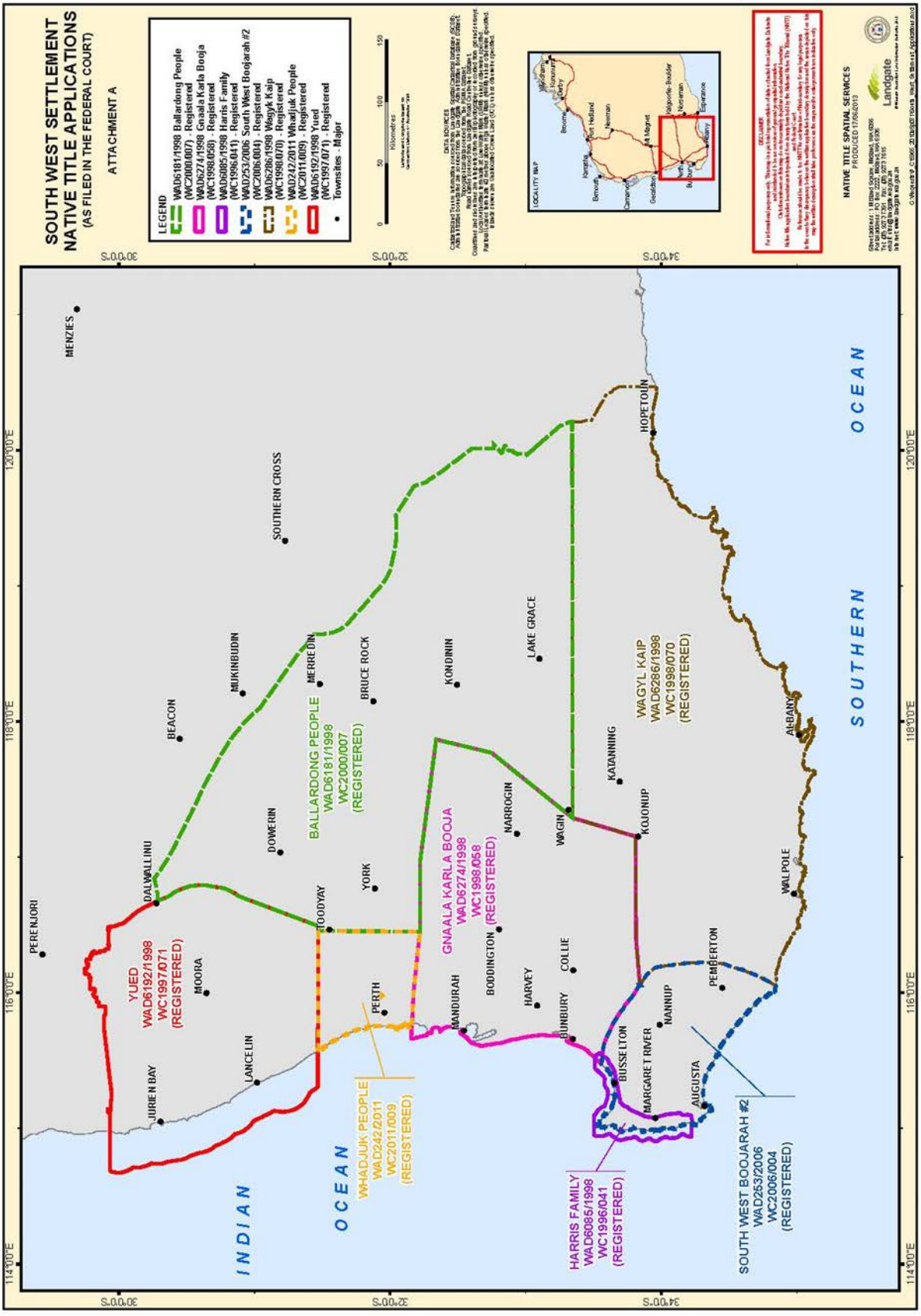

Figure A5 South West Native Title Agreement area (source: Department of Premier and Cabinet)

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 Dandaragan bore field 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 Dandaragan bore field. 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 January 2011 to December 2015.

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 Dandaragan refer to the most recent Water Corporation drinking water quality annual report at watercorporation.com.au.

Aesthetic characteristics

The aesthetic quality analyses for raw water from Dandaragan bore field are summarised in the following table.

Aesthetic detections for Dandaragan bore field

Parameter	**Units**	**ADWG aesthetic guideline value[3]**	**Dandaragan bore field (raw water)**	
			Range	**Median**
Ammonia as nitrogen[4]	mg/L	0.41	0.075	0.075
Chloride	mg/L	250	220–245	230
Colour (true)	TCU	15	<1–3	<1
Hardness as $CaCO_3$	mg/L	200	80–95	90
Iron unfiltered	mg/L	0.3	***6.8–12***	***10***
Manganese unfiltered	mg/L	0.1	***0.3–0.36***	***0.32***
Silicon as SiO_2	mg/L	80	38–45	44
Sodium	mg/L	180	120–140	130
Sulfate	mg/L	250	25–31	27
Total filterable solids by summation	mg/L	600	510–557	540
Turbidity	NTU	5	***5.1–85***	***21***
pH measured in laboratory	no units	6.5–8.5	***6.02–6.47***	***6.24***

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

[4]Only one sample taken during the reporting period.

Health-related chemicals

Raw water from Dandaragan bore field is analysed for chemicals that are 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 Dandaragan bore field

Parameter	**Units**	**ADWG health guideline value[5]**	**Dandaragan bore field (raw water)**	
			Range	**Median**
Barium[6]	mg/L	2	0.09	0.09
Boron[5]	mg/L	4	0.06	0.06
Fluoride laboratory measurement	mg/L	1.5	0.2–0.25	0.25
Iodide[5]	mg/L	0.5	0.03	0.03
Manganese unfiltered	mg/L	0.5	0.3–0.36	0.32
Nickel	mg/L	0.02	0.006–0.007	0.0065
Nitrite plus nitrate as N	mg/L	11.29[7]	<0.05–0.02	<0.05

[5]*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 2004).*

[6]*Only one sample taken during the reporting period.*

[7]*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 Dandaragan bore field 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, there were no positive *E. coli* counts recorded in any samples.

Appendix C — Photographs

The following photographs are reproduced with permission from Michael Sawyer, Water Corporation.

Figure C1 Dandaragan Water Reserve – bore compound is locked and secure

Figure C2 Dandaragan Water Reserve – water supply production bore 1/81

Figure C3 Dandaragan Water Reserve – water supply production bore 1/81

Figure C4 Dandaragan Water Reserve – treatment plant at right of background and monitoring bore 2/77 on the left

Figure C5 *Dandaragan Water Reserve – monitoring bore 2/77 on the right and failed production bore 1/82 retained as a monitoring bore in the background*

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 soil. A wide range of microbiological, chemical and physical contamination risks can impact on water quality and therefore affect the provision of a 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 water supply infrastructure (such as iron corroding pipes).

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 *E. 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) and pests (insecticides, rodenticides, nematicides (for worms) and miticides (for mites)). 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 preventative 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 preventative 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 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 the public drinking water source area (PDWSA) (the area from which water is captured to supply drinking water). 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. Another community benefit from PDWSA protection is that it complements the state's conservation initiatives.

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 plan is important. We should not forget that ultimately it's about protecting your health by protecting water quality now and for the future.

In Western Australia, the Department of Water and Environmental Regulation 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 important tools to protect water quality in proclaimed PDWSAs. These Acts 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 has developed a number of state planning policies to help guide development in public drinking water source areas.

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. 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.

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

With 129 proclaimed 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 report – each providing for different needs. The following table shows the differences between the types of reports.

There is 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 Western Australian Planning Commission (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 or refer to our WQPN no. 36: *Protecting public drinking water source areas*. You can also contact the department's Water source protection planning branch on +61 8 6364 7600 or email drinkingwater@dwer.wa.gov.au.

Drinking water source protection reports

Drinking water source protection report	Scope and outcome	Consultation	Time to prepare	Implementation table	Proclamation
Drinking water source protection assessment (DWSPA)	Desktop assessment of readily available information.	Preliminary	Up to 3 months	No	Proclamation to protect water quality and guide land use planning can occur as a result of any type of drinking water source protection report.
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 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 integrated 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 preventive risk-based assessment process 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)*

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, because 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	*Australian drinking water guidelines*
ANZECC	Australian and New Zealand Environment Conservation Council
HAZMAT	hazardous materials
ILUA	Indigenous Land Use Agreement
LEMC	local emergency management committee
MGA	map grid of Australia
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
P1, P2 and P3	priority 1, priority 2 and priority 3
PSC 88	Public sector circular number 88
PDWSA	public drinking water source area
TCU	true colour units
Westplan–HAZMAT	Western Australian plan for hazardous materials
WHPZ	wellhead protection zone
WQPN	water quality protection note

Units of measurement

m	metres
mg/L	milligrams per litre
km	kilometres
km^2	square kilometres

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.
Advisory Committee for the Purity of Water	The non-statutory interdepartmental committee that operates under the chairmanship of the Department of Health. Amongst other functions, it provides advice to the ministers for health and water on protecting, monitoring and managing drinking water quality and fosters inter-agency co-operation on related matters.
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 annum (kL/a).
Allocation limit	Annual volume of water set aside for use from a water resource.
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*, 2011 (NHMRC & NRMMC 2011) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see *References*).
Augment	To increase the available water supply. For example, pumping back water from a secondary storage/reservoir dam.
Bore	A narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
Bore field	A group of bores to monitor or withdraw groundwater (also see *wellfield*).
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Contamination	A substance present at concentrations exceeding background levels that presents – or has the potential to present – a risk of harm to human health, the environment, water resources or any environmental value.
Dissipate	To become scattered or dispersed.

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. Land use and water management strategies and drinking water source protection area; assessments, plans and reviews are different types of drinking water source protection reports.
Groundwater area	An area proclaimed under the *Rights in Water and Irrigation Act 1914* for the purposes of licensing and managing water use.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2011).
Hectare	A measurement of area, equivalent to 10 000 square metres.
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrology	The science dealing with water on the land, including such things as its properties, laws and geographical distribution.
Indigenous Land Use Agreement	A voluntary agreement between a native title group and others about the use of land and waters. The State Government of Western Australia and the Noongar native title claimants negotiated an ILUA agreement.
Interbedded	Layers between, or alternating with, other layers of differing geological character.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
Map grid of Australia	The official co-ordinate projection for use with the Geocentric Datum of Australia 1994 (GDA94).
Microbe	A microorganism, usually one of vegetable nature, a germ. Also known as a bacterium, especially one causing illness.
Nephelometric turbidity units	A measure of turbidity in water.

Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
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.
Pollution	Water pollution occurs when waste products change the physical, chemical or biological properties of the water, adversely affecting water quality, the ecosystem and beneficial uses of the water.
Porosity	The ratio of water (or air) filled pore spaces to the total volume of the rock or soil, expressed as a percentage or fraction.
Public drinking water source area	The area from which water is captured to supply drinking water. It includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* or the *Country Areas Water Supply Act 1947*.
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*.
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	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.

Reservoir	A dam, tank, pond or lake that captures water from a surface catchment to create a water supply source.
Runoff	Water that flows over the surface from a catchment area, including streams.
Scheme supply	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
Semi-confined aquifer	A leaky aquifer, saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.
Stormwater	Rainwater that has runoff the ground surface, roads, paved areas etc., and is usually carried away by drains.
Superficial aquifer	Shallow (near to the surface) aquifers which are easily recharged and can be readily accessed by bores.
Total filterable solids by summation	A water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO_4 equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO_2 (silicon oxide). It is used as a more accurate measure than total dissolved solids. The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
True colour units	A measure of degree of colour in water.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water quality	Collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	An area proclaimed 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.

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.
Westplan–HAZMAT	State emergency management plan for hazardous materials emergencies.

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