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

Bremer Bay Water Reserve

drinking water source protection plan

Bremer Bay town water supply

Water resource protection series
Report WRP 179
July 2018

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Department of Water and Environmental Regulation
168 St Georges Terrace
Perth Western Australia 6000
Telephone +61 8 6364 7000
Facsimile +61 8 6364 7601
National relay service 13 36 77
www.dwer.wa.gov.au

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For more information about this report, contact
Water Source Protection Planning on +61 8 6364 7000 or drinkingwater@dwer.wa.gov.au.

Cover photograph: Aerial photo of Bremer Bay Water Reserve

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Summary

Bremer Bay is on the south coast of Western Australia, approximately 515 km south-east of Perth and 180 km east of Albany, within the Shire of Jerramungup. The town services the local agricultural industry and provides a base for seasonal fishing and tourism.

Bremer Bay's drinking water comes from a groundwater wellfield south-west of the town, operated by the Water Corporation. There are three existing bores (1/09, 9/00, and 10/00), which draw water from a locally recharged, shallow unconfined to semi-confined aquifer that is vulnerable to contamination from surface land uses. A fourth bore (9/84) has recently failed and will be decommissioned. Water Corporation has proposed three new bores (3/15, 4/15 and 5/15) to meet Bremer Bay's future water demand.

To protect the drinking water source, the Bremer Bay Water Reserve was originally proclaimed in 1983 and amended in 1999 under the *Country Areas Water Supply Act 1947*. In 2008, the previous Department of Water (DoW) publicly consulted a draft drinking water source protection plan for Bremer Bay which proposed amendments to the water reserve boundary. These amendments were proposed to protect the future extension of the wellfield to the south-west and were based on detailed hydrogeological information available at that time. The same 2008 boundary is recommended in this plan.

The Bremer Bay Water Reserve is located over a mixture of crown and privately owned land. Land uses within the proposed water reserve include:

- farming activities
- a vineyard
- a sand quarry
- mechanical servicing site
- a rural–residential subdivision
- an old landfill site and waste transfer station
- a light industrial area
- the drinking water treatment plant
- parts of the Fitzgerald River National Park.

Some land uses and activities in the water reserve have the potential to impact water quality. Potential risks include pesticides and fertilisers from general farming activities, contamination through fuel and chemical spills from the light industrial area, and potential leaching of nutrients, heavy metals and chemicals from the old landfill site. This plan recommends strategies to address these water quality risks.

The Water Corporation has purchased some rural farm land in the water reserve to improve water source protection around the southern production bores. This land will

remain as a priority 1 (P1) area. Private lots will be changed from P1 to priority 2 (P2) in accordance with current Department of Water and Environmental Regulation policy.

Key recommendations of this plan are:

- Amend the boundary of the Bremer Bay Water Reserve under the *Country Areas Water Supply Act* 1947*.*
- Modify the priority areas to reflect the changes in land ownership (see Figure A4).
- Assign 500 m wellhead protection zones around the new bores (3/15, 4/15 and 5/15) (see Figure A4).
- Change the radius of the wellhead protection zones for bores 9/84 and 9/00 from 500 m to 300 m to recognise the change in priority from P1 to P2.
- Implement the recommended protection strategies as detailed in Table 2: *Land use, potential water quality risks and recommended protection strategies*.
- Incorporate the Bremer Bay Water Reserve boundary, priority areas and protection zones in the Shire of Jerramungup's local planning scheme.
- Maintain the Water Corporation surveillance program to identify any incompatible land uses or potential threats within the water reserve.

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* (WAPC 2003) and Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a).

Important information about the Bremer Bay Water Reserve is in Table 1.

Table 1 Key information about the Bremer Bay Water Reserve

Bremer Bay Water Reserve	
Local government authority	Shire of Jerramungup
Location supplied	Bremer Bay
Water service provider	Water Corporation
Aquifer type	Unconfined to semi-confined
Licensed abstraction	90 000 kL/year (the licence is subject to change)
Number of bores	Production bores – 3 Production bore proposed to be decommissioned – 1 Future production bores – 3

Bremer Bay Water Reserve	
Bore details GPS coordinates	Existing production bores (zone 50): • 1/09 (E 717 802, N 6 191 120) – replaced 5/69 in 2009 • 9/00 (E717 665, N 6 189 841) • 9/84 (E 716 893, N 6 190 857) – has recently failed and will be decommissioned. • 10/00 (E 717 179, N 6 189 365) Future production bores (zone 50): • 3/15 (E 716 100, N 6 189 250) • 4/15 (E 717 100, N 6 189 900) • 5/15 (E 717162, N 6 188 676)
Date of bore completion	Between 1969 and 2017 (existing and future bores) The water reserve has been used since 1969 and numerous bores have been replaced over the years.
Dates of drinking water source protection reports	1995 – *Bremer Bay groundwater protection plan* (Water Authority) 2004 – *Bremer Bay Water Reserve drinking water source protection assessment* (Water Corporation) 2008 – Draft *Bremer Bay Water Reserve drinking water source protection plan* (Department of Water, released for public comment) 2008 – *Bremer Bay Water Reserve drinking water source protection plan* (Department of Water, completed but unpublished due to land purchase issues that were not resolved until 2017). 2017 – *Bremer Bay Water Reserve drinking water source protection plan* published (this document)
Consultation	2008 – Bremer Bay Protection Plan Advisory Group (representative from Water Corporation, Shire of Jerramungup, Wellstead Estuary Advisory Committee and landowners) 2017 – Consultation with Water Corporation, Shire of Jerramungup and affected private landholders
Proclamation status	Proclamation under the *Country Areas Water Supply Act 1947:* • Original proclamation on 18 November 1983 • Amended boundary proclaimed on 15 June 1999 • Proposed boundary consistent with 2008 and 2017

Bremer Bay Water Reserve	
	plans will be progressed once 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 2016* (Department of Water 2016a) *Great Southern Regional Planning Framework* (Western Australian Planning Commission 2015) *Lower Great Southern Strategy* (Department of Planning 2007) *Great Southern regional water supply strategy* (Department of Water 2014)

1 Drinking water source overview

1.1 The existing water supply system

Bremer Bay is on the south coast of Western Australia, approximately 515 km south-east of Perth and 180 km east of Albany (Figure A1). It is within the Shire of Jerramungup, services the local agricultural industry, and provides a base for seasonal fishing and tourism. Approximately 752 people live in Bremer Bay, however, this increases to approximately 6000 people during the summer holiday period (Shire of Jerramungup 2016).

Bremer Bay's drinking water comes from a groundwater wellfield south-west of the town, operated by the Water Corporation (Figure A1). The wellfield consists of three production bores (1/09, 9/00 and 10/00), operated in pre-determined groups to ensure the blended supply meets *Australian drinking water guidelines* (ADWG; NHMRC & ARMCANZ 2011). In 2016, 308 residential properties were connected to the water supply.

Bore 9/84 has recently failed and cannot be used again and the Water Corporation proposes to decommission it.

The Bremer Bay bores draw water from the locally recharged, shallow Bremer West – Superficial aquifer, which is an unconfined to semi-confined, sole source of drinking water considered vulnerable to contamination from surrounding land uses.

1.2 Water treatment

Water from the bores is pumped into the Water Corporation's drinking water treatment plant where it is chlorinated, aerated, clarified and passed through sand filters. The water is disinfected to ensure microbiological quality for consumers before it is pumped to a service tank for storage and distribution through the local scheme.

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 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 catchments, read Appendix F.

1.3 Water management

1.3.1 Licence to take water

Water resource use and conservation in Western Australia is administered by the Department of Water and Environmental Regulation (DWER) in accordance with the *Rights in Water and Irrigation Act 1914*. Under this act, the right to use and control water is vested with the Crown. This means that a licence is required for drilling bores and abstracting groundwater (pumping water from a bore, spring or soak) within proclaimed groundwater areas throughout the state. Some exemptions apply such as abstracting water for domestic purposes only.

The Bremer Bay Water Reserve is located within the Bremer Bay Groundwater Area which is proclaimed under the *Rights in Water and Irrigation Act 1914*. DWER have issued the Water Corporation with a licence to abstract 90 000 kL of groundwater per year from the Bremer West – Superficial aquifer for public water supply, expiring in 2026. In 2016, the total annual abstraction was 56 570 kL, well within the licensed allocation limit.

To meet anticipated increase in water demand, the bore field is planned to be extended to the south.

In 2015, the Water Corporation investigated new bore locations and identified three sites. Changes to the water licence and existing monitoring program will be required to accommodate the new production and monitoring bores.

1.3.2 Other water resource related work

These are other published reports that are related to the Bremer Bay area. They are not directly linked to this report, but provide context and background for water-related issues in the locality of the Bremer Bay Water Reserve.

Lower Great Southern strategy 2007

A key objective of the previous Department of Planning's *Lower Great Southern strategy* is to protect public drinking water source areas, including Bremer Bay Water Reserve, through local planning strategies (e.g. use of special control areas).

Water resource inventory 2014: Water availability, quality and trends

This document provides information on trends of water demand, use and management in Western Australia. Water levels across the Bremer Bay groundwater area are generally stable or showing small declines, with levels fluctuating seasonally. DWER is currently investigating the potential of the Superficial and Sedimentary (Middle Sand and Werrillup) aquifers of the Bremer Basin for future water supplies.

Great Southern regional water supply strategy 2014

This DWER document outlines strategies for securing water supplies, including potable water supply, for the Great Southern region. Water demand for the region is anticipated to increase from 31 GL in 2013 to 51 GL by 2043, as a result of projected population growth, new mining developments, industry expansion and irrigated agriculture. This demand needs to be managed in conjunction with a predicted reduction in rainfall and resultant decline in surface and groundwater availability.

This strategy also acknowledges that the department assists local governments and communities to identify and develop fit-for-purpose water supplies through the Rural Water Planning program.

Great Southern regional planning and infrastructure framework 2015

This Western Australian Planning Commission document (including regional and subregional strategies), defines strategic directions for future land use planning and securing potable water supplies to support growth in agriculture, forestry and tourism in the Great Southern region over the next 20 years. This framework provides guidance for the preparation and amendment of local planning schemes in this region.

The framework recommends preparation or review of drinking water source protection reports for existing and future drinking water sources, including Bremer Bay.

1.3.3 Future water needs

The Water Corporation's *Water Forever*: *Whatever the Weather, a 10-year plan for Western Australia's next decade* (2012), considers new water resource options and how to make them climate-resilient. Upgrading Bremer Bay's wellfield is noted in this plan.

1.4 Characteristics of the catchment

1.4.1 Physical environment

The physiography of the Bremer Bay area is dominated by an undulating plain up to 50 m high. The sedimentary plain overlying most of the basement rock includes a number of low-lying internal drainage systems, such as Gnombup and Cardiminup Swamps, located south and west of Bremer Bay, respectively (Figure A2). The coastal areas further south of the town, are fringed by elevated dune systems located between prominent headlands of gneiss basement rock outcrops that rise up to 150 m.

1.4.2 Climate

Bremer Bay experiences a Mediterranean-type climate, characterised by warm, dry summers and cool, wet winters.

The long-term average rainfall is 458 mm. Most rain results from winter cold front systems that cross the coast between April and October (Bureau of Meteorology 2017).

1.4.3 Hydrogeology

Bremer Bay is located within the Albany–Fraser Orogen geologic province. The silt and sand of the Quaternary superficial sediments in the area are underlain by Plantagenet Group sediments that comprise mainly sandstone and spongolite of the Pallinup Siltstone and siltstone and sandstone sequences of the Werillup Formation. The basement comprises Proterozoic gneiss (Bestow 1982; Hirschberg 1983).

Bremer Bay's town water supply bores draw groundwater from the aquifer within the Quaternary sediments and the Pallinup Siltstone. The aquifer varies from unconfined to semi-confined. The bores are between 34 m and 49 m deep.

The groundwater flow system is divided by a sub-cropping basement that runs from the west-south-west to the east-north-east, about 500 m south of Borden–Bremer Bay Road (Sinclair Knight Merz 1997). South of the divide, the groundwater flows to the north-east, away from the main recharge area within the elevated mobile sand dune system, about three kilometres south-west of the town. North of the divide, recharge from direct infiltration of rainfall and runoff from the bedrock high has caused a more northerly component to the flow system.

The bedrock has also influenced the formation of Gnombup Swamp, which is considered to be a perched water body (Sinclair Knight Merz 1997). Groundwater in the perched aquifer flows towards the south-east away from the wellfield. The silty clay forms an aquitard that restricts the hydraulic connection between the shallow perched aquifer and the deeper tertiary aquifer (Simms 2000).

The aquifer is vulnerable to contamination from inappropriate land uses because recharge occurs from direct infiltration of rainfall across the whole groundwater system and the aquifer is relatively shallow.

1.5 How is this drinking water source currently protected?

1.5.1 Proclamation of the Bremer Bay Water Reserve

The original boundary of the Bremer Bay Water Reserve was constituted under the *Country Areas Water Supply Act 1947* on 18 November 1983. In 1999, an amended boundary was proclaimed to more accurately reflect hydrogeological boundaries and provide better protection of the key recharge areas, as recommended in the 1995 groundwater protection plan (Water Authority). In 2008, further boundary changes were proposed to protect the future extension of the wellfield. This plan recommends the same boundary (figures A1 to A4).

1.5.2 Shire of Jerramungup's local planning scheme

The Shire of Jerramungup's local planning scheme recognises the Bremer Bay Water Reserve as a special control area. This plan recommends to update the local planning scheme to reflect the proposed boundary of the Bremer Bay Water Reserve (see section 5.2). This will ensure that development in the water reserve can be guided by DWER's Water quality protection note (WQPN) no.25: *Land use compatibility tables for public drinking water source areas*. This note is recognised by the Western Australian Planning Commission (WAPC) in its State planning policy no. 2.7: *Public drinking water source policy*, which addresses development in public drinking water source areas (PDWSAs).

1.5.3 History of drinking water source protection reports

1995

In 1995, the Water Authority wrote a groundwater protection plan for Bremer Bay that set out recommendations and responsibilities to implement groundwater protection.

The main recharge area for the wellfield was assigned a P1 area to provide the highest level of protection. A small section immediately south of Borden–Bremer Bay Road and most of the water reserve north of the road was assigned as a P2 area. The light industrial area and the north-eastern sector of the water reserve, east of Wellstead Road and adjacent to the town's wastewater treatment plant, was assigned as a priority 3 (P3) area.

2004

The Water Corporation prepared the *Bremer Bay Water Reserve drinking water source protection assessment* in 2004. This document presented an assessment of the risks to water quality within the water reserve, and also reported on the progress of implementation of recommendations in the 1995 protection plan.

2008

In 2008, the previous Department of Water (DoW) prepared a draft drinking water source protection plan with input from the Bremer Bay Protection Plan Advisory Group, consisting of representatives from the Water Corporation, Shire of Jerramungup, Wellstead Estuary Advisory Committee and the department. Landowners and other relevant state government departments were also consulted.

The plan proposed an amended boundary for the water reserve to reflect the future extension of the wellfield to the south. This was required to meet future demands of the growing town. The final plan was not released on our website, because of concerns held by land owners that they may not be able to farm their rural-zoned land in the Bremer Bay Water Reserve.

2017

Since then, these landowner concerns have been resolved by purchasing portions of rural farm land in the southern wellfield and making changes to ensure privately owned, rural-zoned land is assigned as a P2 area. Farming is a compatible land use in P2 areas.

Production bore 1/09 and disused bore 9/84 in the northern (Gnombup) wellfield are located on privately-owned, rural land adjacent to Borden-Bremer Bay Road. This land will continue to be protected as a P1 area, because it is well-vegetated and contains a large wetland called Gnombup Swamp (also known as Gnornbup Swamp). Because of its land use, this area of land poses a lower water quality risk than the land recently purchased by Water Corporation.

The use of this land is subject to its zoning, drinking water source protection status, environmental value and local planning framework. If these factors change, it could warrant a review of the P1 status of this land.

This drinking water source protection plan reflects the above land purchase outcomes and changes to the priority areas of the farm land. It also provides additional information on the activities and risks to water quality within the Bremer Bay Water Reserve that have occurred since 2008.

1.5.4 Other groundwater bores in the area

The Water Corporation operates drinking water bores in the Bremer Bay Water Reserve. If bores for other purposes (e.g. irrigation, private household use) are drilled near a public drinking water supply bore, they can cause contamination of the drinking water source. For example, a poorly constructed private 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 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 in accordance with *Minimum construction requirements for water bores in Australia* (National Uniform Drillers Licensing Committee 2012).

There are three licensed bores on Lot 1 Wellstead Road which are used for the Wellstead homestead and the caravan park. A licence for irrigating a vineyard has been issued for Lot 50 Wellstead Road.

There is a bore and tank on Wellstead Road that can be used for emergency firefighting. The use of the bore for firefighting is exempt from licensing under the *Rights in Water and Irrigation Act 1914*.

2 Risks to Bremer Bay's drinking water source

2.1 Water quality

A wide range of chemical, physical and microbiological properties can impact on water quality and therefore affect the provision of safe, good quality, aesthetically acceptable drinking water to consumers.

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

During the past five years, water quality has not exceeded any ADWG health guideline levels (NHMRC & NRMMC 2011). Aesthetic guideline levels for hardness as $CaCO_3$, sodium, and total filterable solids by summation have been exceeded, however, these are all naturally occurring in the groundwater and not linked to surrounding land uses.

Nitrate concentrations continue to be monitored as the bores are vulnerable to contamination from surrounding low intensity agricultural land uses.

No increased levels of dissolved metals have been detected in the bores for the period June 2012 to May 2017.

2.2 Land uses and activities

The Bremer Bay Water Reserve is located over a mixture of Crown and privately owned land. Current land uses and activities and their risks to the drinking water source are described below. These risks were also documented in previous drinking water source protection reports. Table 2, at the end of this section, summarises this information in an easy-to-read format. Appendix C displays a more detailed risk assessment and includes recommended protection strategies to address water quality risks.

Land uses and activities in the Bremer Bay Water Reserve:

- general farming activities
- vineyard
- sand quarry and mechanical servicing site
- old landfill site and rubbish transfer station
- light industrial area
- rural residential subdivision
- roads and infrastructure
- former farm waste disposal site
- drinking water treatment plant
- Fitzgerald River National Park.

Land uses are illustrated in Figure A3 and in photographs in Appendix D.

2.2.1 General agriculture (farming)

Farming activities on private land are typically cropping and sheep and cattle grazing. Activities provide varying risks to water quality through application of fertilisers and pesticides, pathogens from animal faeces, and leaching from septic tanks into shallow groundwater. The current level of activity is low and poses a medium water quality risk.

Rural land uses such as, low-intensity agricultural land uses (e.g. stock grazing) and vineyards are compatible with conditions in P2 areas.

Use of best management practices for on-site wastewater management, stock grazing, the application of fertiliser and pesticides, and chemical storage in the operation of the farm and present planning controls are adequate to manage potential risks (Table 2).

2.2.2 Vineyard

A vineyard and cellar door sale is located on the southern side of the Borden–Bremer Bay Road and is likely to be outside the main recharge area for the wellfield. Use of best management practices in the operation of the vineyard and wine processing plant and present planning controls should be adequate in managing potential risks (see Table 2).

2.2.3 Sand quarry and machinery storage

The sand quarry and machinery storage site is located in the northern wellfield and has the potential to be a risk to water quality, if not managed appropriately.

Machinery and vehicles can pose a risk to Bremer Bay's drinking water quality via hydrocarbon contamination from fuel or oil spills and leaks, or vehicle accidents. Any fuel storage should be in accordance with best management practices, and emergency response (contingency) plans should be in place in case of accidents.

Bunding for fuel storage tanks should have the capacity to contain any leaks and spills in order to minimise the risk to the quality of the drinking water source.

Landowners should continue to use best management practices for sand quarry and machinery storage to help protect Bremer Bay's drinking water quality (Table 2).

Extractive industry operations (basic raw materials) are considered a compatible land use with conditions in P1 and P2 areas of PDWSAs. However, these operations are not supported in wellhead protection zones to limit adverse impacts on the quality of the drinking water source.

2.2.4 Old landfill site and waste transfer station

Parts of the town's old rubbish disposal site is located in the northern wellfield. This site poses a potential risk to groundwater. The Shire of Jerramungup closed this part of the rubbish disposal site and the fish offal pit in July 2006, and the site is now used as a transfer station. A post-closure management plan was prepared and has been implemented by the Shire of Jerramungup. The transfer station site is fenced and has restricted opening hours. The Jerramungup council minutes (April 2017) advise that the volume of waste being accepted at the transfer station will be limited to one trailer (i.e. one cubic metre) per rural property per week, effective from 1 July 2017. There is no plan to relocate the waste transfer station to a site outside the water reserve at this stage.

The monitoring bores close to the rubbish disposal site are still used. The draft 2008 plan reported that low levels of arsenic, cadmium and lead have been detected at times in some of these bores. No elevated levels of those substances have been reported in the monitoring data since then. We are still unsure if this is a natural occurrence, leachate from the rubbish tip, or from other sources yet to be identified. A number of bores in the vicinity of the site have been decommissioned as a precautionary measure. The water quality around this site should be monitored and further assessed if contaminants are detected. This site should be also reported to DWER for assessment under the *Contaminated Site Act 2003*.

Under the *Environmental Protection Act 1986,* the previous Department of Environment Regulation issued a conditional works approval (W5663/2014/1) for the Shire of Ravensthorpe's new regional waste disposal site and regional waste management facility. This site will service a number of towns, including Bremer Bay.

The old fish processing pond next to Wellstead Road is no longer used and has been rehabilitated. Accumulated waste was removed off-site and the pond is used as a farm dam. Its current land use poses little threat to water quality. Waste from the current fish processing businesses within the light industrial area is almost entirely water, and is disposed of through the sewerage system.

2.2.5 Light industrial area

In the northern wellfield, businesses in the light industrial area include:

- the Shire of Jerramungup depot
- a petrol station
- a mechanical workshop
- a dive shop
- a rural shop
- fish processing plants.

The land uses within the light industrial area pose high contamination risks from leakage of stored fuels and chemicals. Although, the area is hydrogeologically down-

gradient of the production bores, the risk is increased by the potential for spills from storage facilities. Spills may discharge into drainage lines that flow towards the low-lying areas within the wellfield, where contaminants could be drawn into the capture zone of bores. There has been evidence of past spills from oil drums and industrial containers stored in the open outside buildings. Hydrocarbons present in the nearby perched groundwater may also indicate that leakage has occurred (Simms 2000). The storage and disposal of drums and inadequate protection provided for existing above- and below-ground fuel storage facilities should be addressed in the Shire of Jerramungup's waste management strategy.

The majority of the lots in the light industrial area are connected to deep sewerage, eliminating the risk to groundwater quality from septic waste disposal. Further expansion within the existing light industrial area would need to demonstrate no increased risk to the drinking water source and ensure that appropriate buffers are maintained to production bores.

Business managers should continue to use best management practices for light industrial areas to help protect Bremer Bay's drinking water quality (Table 2).

The proposed eastward extension of the light industrial area to Frampton Way is outside the wellfield recharge zone, down-gradient of production bores and is outside the amended water reserve boundary.

2.2.6 Rural residential subdivision

There is a subdivision of special rural lots north of the Borden–Bremer Bay Road within the water reserve. The likelihood of the subdivision posing a contamination threat is low because Gnombup Swamp is a perched system and the subdivision is down-gradient of the production bores. Even so, it is important to maintain adequate wellhead protection zones around production bores located adjacent to Borden–Bremer Bay Road to avoid leachate, including pathogens from on-site wastewater disposal and treatment systems being drawn back into the bore capture zones.

Stormwater management for the subdivision also needs to consider stormwater detention devices and an increase in direct infiltration, where acceptable.

Stormwater for the special rural subdivision, north of Borden-Bremer Bay Road within the water reserve, should be managed in accordance with the Shire of Jerramungup's approved stormwater management plan. Any surface water run-off needs to be diverted away from the wellfield.

The public open space within the water reserve should be managed in accordance with best management practices (Table 2). The drainage line, flowing south-east towards the bores, was vegetated to help protect the water quality.

Any future subdivision proposals within the proposed Bremer Bay Water Reserve should be assessed in accordance DWER's WQPN no. 25: *Land use compatibility tables for public drinking water source areas*.

2.2.7 Roads

The Borden–Bremer Bay Road is the main route into Bremer Bay and runs along the northern boundary of the wellfield. Minor roads (e.g. parts of Wellstead Road, Yate Place and White Trail Road) run along the eastern boundary.

Roads can potentially have an adverse impact on water quality if fuel or chemical spills occur as a result of a road accident. There are also associated risks with the management of roads (e.g. pesticide spraying of road verges or uncontrolled stormwater run-off while upgrading road surfaces).

2.2.8 Stormwater management

There is concern that surface water run-off from the town centre along the northern boundary of the water reserve could pose a risk to Water Corporation's bores, which are located closest to Borden-Bremer Bay Road. The town centre is located outside the water reserve, however, stormwater may enter the water reserve.

Any surface water run-off from development should be diverted away from the production bores to reduce the potential water quality risk to the drinking water source.

Best management practices are provided in WQPN no. 52: *Stormwater management at industrial sites* and *Stormwater management manual* (Department of Water 2007).

2.2.9 Water Corporation land

Drinking water treatment plant

The Water Corporation operates the drinking water treatment plant on the southern side of Borden–Bremer Bay Road. Raw water enters the plant for treatment and is then pumped to a service tank for storage and distribution. In 2008, potential risks to groundwater included chlorine used for treatment and leachate from the treatment process which is stored on-site in a pond. The Water Corporation is now disposing off the leachate from the pond via reticulated sewerage.

Existing and future bores

The risks to the wellfields have been significantly reduced because the Water Corporation purchased farm land surrounding existing production bores (9/00 and 10/00) and future bores (3/15, 4/15, and 5/15); and will continue to manage the land in accordance with the objectives for P1 areas.

The draft 2008 plan noted that potential economic and planning benefits could arise from relocating the northern wellfield further to the south. Once planning for the southern portion of the bore field has been completed, the Water Corporation should consider if the northern (Gnombup) wellfield (located on private rural land and assigned for the objective of P1 area) is still required for supplying drinking water to Bremer Bay.

It should be noted that the Water Corporation still owns land associated with former bores 3/83, 6/84 and 8/84 in the northern wellfield.

Cardiminup swamp is a South Coast significant wetland and needs to be protected (Figure A2). As part of the recent land purchase of rural land within the water reserve, and subsequent subdivision, a vegetated area adjacent to the swamp was fenced. Environmental water levels for the wetland also need to be considered while planning the wellfield expansion. No ecological water requirements exist for the swamp at present.

Former farm waste disposal site

This historical waste disposal site was used by the previous owner for the disposal of offal, animal carcasses (mainly sheep and cattle), and farm waste. Several motor vehicle bodies were also evident at this site.

A groundwater investigation at this site did not identify any adverse impacts on the water quality in its vicinity (Aurora Environmental 2014). However, residues of pesticides (aldrin and dieldrin) were detected in two monitoring wells. Also, one detect of arsenic slightly above the ADWG was returned from a monitoring bore located up-gradient of the site. Water quality monitoring should continue in the vicinity of this site. As a precautionary measure, consideration should be given to removing the old waste material from this site and disposing of it at an approved landfill.

Bore compounds

The existing public drinking water bores are located within secure compounds that are owned by the Water Corporation. There have been no reported incidences of vandalism.

2.2.10 Fitzgerald River National Park

Unique flora and fauna of the region is conserved in the Fitzgerald River National Park (A class reserve), which surrounds the inlets of the Gairdner, Fitzgerald and Hamersley rivers between Bremer Bay and Hopetoun. The national park is managed by the Department of Biodiversity, Conservation and Attractions and provides tourism, nature conservation and recreation opportunities.

A portion of the Fitzgerald River National Park (known as Reserve 31737) is located to the south of Bremer Bay town site (north of Dillon Bay) and is relatively inaccessible; with limited public access to the beach and only to 4WDs. This park overlies a mobile dune system which has been identified as the major recharge area for groundwater within the Bremer Bay Water Reserve.

The former Department of Parks and Wildlife now known as the Department of Biodiversity, Conservation and Attractions (DBCA) updated the *Fitzgerald River National Park management plan (as amended* in 2011) and prepared the *Fitzgerald River National Park Information and recreation guide* (2014). Both documents do not identify any formal recreational facilities or activities in this part of the park.

2.2.11 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 four Aboriginal sites of significance within the Bremer Bay Water Reserve. These are:

- Cardiminup 1 (S01493)
- Cardiminup 2 (S01627)
- Cardiminup 3 (S01628)
- Cardiminup 4 (S02463).

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 are two registered native title claims within the Bremer Bay Water Reserve. These are Southern Noongar people (WAD6134/1998) and Wagly Kaip people (WAD6286/1998).

The State Government of Western Australia and the Noongar people have developed the South West Native Title Settlement. This settlement recognises the Noongar people as the traditional owners of land in the South West Native Title 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).

The settlement includes six identical Indigenous Land Use Agreements (ILUAs). The agreements enable some types of land-based customary activities to be undertaken by Noongar people in PDWSAs within the South West Settlement Area. The previous Department of Water amended two sets of by-laws (Metropolitan Water Supply, Sewerage and Drainage By-laws 1981 and the Country Areas Water Supply By-laws 1957) to enable Noongar people to undertake some land-based activities in PDWSA. The by-laws came into effect on 8 June 2016.

Some of the land-based activities include:

- visiting registered Aboriginal sites in reservoir protection zones
- designated camping sites for Noongar people (outside reservoir protection zones and wellhead protection zones)
- gathering invertebrates and eggs, lighting fires and gathering flora for customary purposes.

The ILUA is available via the Department of Premier and Cabinet, see www.dpc.wa.gov.au. Additional information is provided in our Water quality information sheet 39: *Aboriginal customary activities in public drinking water source areas in the South West Native Title Settlement Area* (DoW 2017).

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.

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

Table 2 Summary of potential water quality risks, land use compatibility and best management practices

Land use/activity	Hazard	Management priority	Compatibility of land use and activities	Best management practice guidance[1]
Former landfill site and waste transfer station	Nutrients Pathogens Heavy metals Chemicals Petroleum products	High	Landfill and waste transfer station are incompatible land uses in P1 areas. This land fill was closed in July 2006 and is now managed as a waste transfer station by the Shire of Jerramungup. There is no plan to relocate the waste transfer station. A new regional landfill site in Ravensthorpe will be completed this year and will service Bremer Bay. This will reduce the volume of waste accepted at the transfer station.	The historical landfill site should be reported to the Department of Water and Environmental Regulation for assessment under the *Contaminated Site Act 2003*. The Shire of Jerramungup should continue implementing the post-closure management plan, considering drinking water source protection. Options for re-locating the transfer station should be considered by the Shire of Jerramungup.
Light industrial area	Nutrients Heavy metals Hydrocarbons and chemicals	High	Light industry and storage of fuels and chemicals are compatible with conditions in a priority 3 area. The light industrial area is near bores in the northern wellfield. Businesses such as the Shire of	WQPN no.93: *Light Industry near sensitive waters* WQPN no. 49: *Service station* WQPN no. 52: *Stormwater management in industrial sites* WQPN no. 28: *Mechanical servicing and*

Land use/activity	Hazard	Management priority	Compatibility of land use and activities	Best management practice guidance[1]
			Jerramungup depot shed, a petrol station, storage sheds, dive shop, and fish processors are located in the light industrial area.	*workshops* *Stormwater management manual for Western Australia*
Low intensive agricultural land uses (e.g. stock grazing)	Pathogens Nutrients Pesticides	Medium	Rural land uses such as cropping and grazing are compatible with conditions in P2 areas.	WQPN 70: Wastewater treatment and disposal – domestic systems WQPN no. 35: *Pastoral activities within rangelands* *WQPN no. 1: Agriculture – dryland crops near sensitive water resources* *PSC 88: Use of herbicides in water catchment areas* (Department of Health, 2007)
Former farm waste disposal site at Borden–Bremer Bay Road	Pesticides and other farm chemicals Nutrients Pathogens	Medium	Waste disposal sites are considered incompatible land uses in P1 areas. This former farm waste disposal site is located on the P1 land which has recently been purchased by the water service provider.	Water quality monitoring should continue to be undertaken in accordance with the ADWG. Testing should consider the parameters for the contamination risks posed by the site. Removing and disposing of the old waste material at an approved landfill site should be considered as a precautionary measure.
Sand quarry and machinery storage site	Hydrocarbons	Medium	Sand quarries are considered compatible land uses with conditions in (P1, P2 and P3 areas). Sand quarries in wellhead	Brochure: *Liquid chemicals on agricultural land* WQPN no. 15: *Extractive industries near sensitive water resources*

Land use/activity	Hazard	Management priority	Compatibility of land use and activities	Best management practice guidance[1]
			protection zones are considered incompatible.	WQPN no. 65: *Toxic and hazardous substances – storage and use* *WQPN no. 28: Mechanical servicing and workshops* *WQPN no. 56: Tanks for elevated chemical storage* WQPN no. 61: *Tanks for ground level chemical storage* WQPN no. 8: Mechanical servicing and workshops WQPN no. 29: *Mobile mechanical servicing and cleaning*
Vineyard and cellar door sale	Hydrocarbons and chemicals Pesticides Nutrients from fertilisers	Medium	Wineries are a compatible land use with conditions in a P2 area	*Environmental management guidelines for vineyards* (WRC *et al.* 2002) PSC88: *Use of herbicides in water catchment areas* (Department of Health, 2007) WQPN no. 73: Wineries and distilleries
Rural residential subdivision – north of Borden-Bremer Bay	Pathogens Nutrients Pesticides	High	Special rural subdivision to a lot size of 2 ha or greater is compatible with conditions in a P2 area.	WQPN 70: *Wastewater treatment and disposal – domestic systems* *Stormwater management manual* Revegetate along the drainage line in the public

Land use/activity	Hazard	Management priority	Compatibility of land use and activities	Best management practice guidance[1]
Road	Hydrocarbons and other chemicals		Public open space for a second subdivision has been included as it contains a drainage line that flows towards the production bores	open space area WQPN no. 6: *Vegetation buffers to sensitive water resources*
Roads and tracks	Hydrocarbons and chemicals Pesticides Nutrients	Medium	Roads are compatible land uses with conditions in P1 and P2 areas, and acceptable in P3 areas.	WQPN no. 44: *Roads near sensitive water resources* PSC88: Use of herbicides in water catchment areas (Department of Health, 2007). WQPN no. 10: Contaminant *spills - emergency response*
Infrastructure and associated maintenance: • power lines • pipelines • tracks • bores, fixtures and pipelines	Hydrocarbons and chemicals	Low	Infrastructure (e.g. electrical substations, gas and water pipelines, power lines) is compatible with conditions in P1 and P2 areas, and acceptable in P3 areas.	WQPN no. 83 Infrastructure corridors near sensitive water resources. WQPN no. 10 Contaminated spills – emergency response National Uniform Drillers Licensing Committee's *Minimum construction requirement for water bores in Australia* (2012).
Drinking water treatment plant	Chemicals	Low	The water treatment plant is compatible with conditions in a P1 area.	WQPN no. 65: *Toxic and hazardous substances – storage and use*

Land use/activity	Hazard	Management priority	Compatibility of land use and activities	Best management practice guidance[1]
Fitzgerald River National Park	Hydrocarbons Nutrients Rubbish	Low	National parks are acceptable in a P1 area. Reserve 31737 is located in the southern part of the water reserve and managed by Department of Biodiversity, Conservation and Attractions. Its management plan does not identify any recreational facilities or activities in this part of the park.	Operational policy 13: *Recreation within public drinking water source areas on Crown land*
Vegetation loss through fire and clearing	Turbidity	Low	Bushfire and prescribed burns present a potential water quality risk through loss of vegetation.	Vegetation clearing is subject to the *Environmental Protection Act 1986* clearing regulations. The Department of Fire and Emergency Services can restrict burning times and total fire bans under the *Bushfire Act 1954* prescribes fire bans

[1] Water quality protection notes (WQPNs) are available www.dwer.wa.gov.au or see *Further reading*.

3 Protecting your drinking water source

The objective of water source protection is to preserve water quality at its current level and where practical, achieve an improvement, so as to provide a safe drinking water supply to the Bremer Bay town water supply scheme.

This plan recognises the right of existing approved land uses to continue to operate within the water reserve. However, the water reserve should be managed to reduce risk to water quality from the various land uses. The minimisation of risks to water quality for public supply is imperative for the protection of public health.

3.1 Proclaiming public drinking water source areas

The amended boundary of the Bremer Bay Water Reserve will be proclaimed under the *Country Areas Water Supply Act 1947* when this plan is finalised. The new boundary will more accurately reflect hydrogeological boundaries and protect an important recharge area to the south of the water reserve (Figure A4).

The Shire of Jerramungup should incorporate the new boundary into its local planning scheme, consistent with State planning policy no. 2.7: *Public drinking water source policy* (WAPC 2003). PDWSAs are commonly shown in planning schemes as special control areas. This provides guidance for state and local government planning decision makers and developers.

Proclamation of a PDWSA will not change the zoning of land. All existing, approved land uses and activities in a proclaimed area can continue. However, we recommend that best management practices are employed in PDWSAs to protect the quality of the drinking water source. New developments or expansion of existing land uses or activities need to consider the recommendations in this plan. As a general guide, DWER does not recommend land use intensification in a PDWSA because of the increased risks to water quality and public health.

For more guidance on appropriate land uses and activities please refer to our WQPN no. 25: *Land use compatibility tables for public drinking water source areas* (DoW 2016b).

3.2 Priority areas

The proposed priority areas for the Bremer Bay Water Reserve have been determined in accordance with DWER's current policy. These areas are described below and displayed in Figure A4. Our WQPN no.25: *Land use compatibility tables for public drinking water source areas* outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas. For an explanation of the background and support for protection of PDWSAs, please refer to WQPN no. 36: *Protecting public drinking water source areas*.

Priority areas determined in the 1995 groundwater protection plan and publicly consulted 2008 drinking water source protection plan were as follows:

- The main recharge areas for the northern and southern wellfields were P1.

- A small section of private land immediately south of the Borden–Bremer Bay Road and most of the area north of the road was P2.
- The light industrial area and the north-eastern sector of the water reserve, east of Wellstead Road and adjacent to the town's wastewater treatment plant were P3.

The 1995 and 2008 plans assigned rural private land and Crown land as P1 for the following reasons:

- Water from this source was a strategic supply to the Bremer Bay town water supply scheme so it was afforded the highest feasible level of protection.
- Existing land uses on the Crown land were considered compatible with P1 source protection objectives.
- The private rural land was considered of strategic importance because it occurred over a shallow aquifer vulnerable to contamination from inappropriate land uses, and development was undesirable given close proximity of production bores.

However, from 2008 to 2017, land purchase and leasing options were considered by DWER for some private P1 land. This has now been resolved by the Water Corporation purchasing parts of private rural land surrounding the existing and future production bores in the southern wellfield. This land will remain a P1 area to give the highest level of protection to the wellfield (Figure A4).

As part of this plan, the rural farm land, which has recently been subdivided and remains in private ownership, will be changed from P1 to P2. This is consistent with DWER's policy for rural-zoned land.

3.3 Protection zones

Each public drinking water bore requires a wellhead protection zone to protect it from immediate contamination risks. Activities within wellhead protection zones need to be managed to maximise protection against contamination. In P1 areas, wellhead protection zones are a 500 m radius around the bore, and in P2 and P3 areas, the radius is 300 m. This plan proposed the following changes to Bremer Bay's wellhead protection zones:

- The wellhead protection zones of bores 9/00 and 9/84 will be amended from a 500 m to a 300 m radius to be consistent with the change in priority from P1 to P2.
- Remove the wellhead protection zone from bore 9/84 after it has been decommissioned.
- The three new bores proposed by the Water Corporation (3/15, 4/15 and 5/15) are located within a P1 area. A 500 m wellhead protection zone will be assigned for each of these bores (Figure A4).

3.4 Planning for future land uses

As outlined in State planning policy no. 2.7: *Public drinking water source policy* (WAPC 2003) it is appropriate that the updated boundary of the Bremer Bay Water Reserve, its priority areas and protection zones be recognised in the Shire of Jerramungup local planning scheme. Any development proposals in the Bremer Bay Water Reserve that are inconsistent with advice in our WQPN no.25: *Land use compatibility tables for public drinking water source areas* or recommendations in this plan, need to be referred to our nearest regional office for advice.

The DBCA has responsibility for management planning over a significant portion of the water reserve under the *Conservation and Land Management Act 1984*. On these lands, Western Australian Planning Commission processes do not apply. Any proposals within Bremer Bay Water Reserve being considered under the *Conservation and Land Management Act 1984* that may affect water quality should be referred to the Department of Water and Environmental Regulation for comment.

3.5 Using best management practices

There are opportunities to reduce water contamination risks by carefully considering design and management practices. To help protect water sources, DWER will continue to encourage the adoption of best management practices (see Table 2).

3.6 Enforcing by-laws and surveying the area

The quality of water in PDWSAs within country areas of the state is protected under the *Country Areas Water Supply Act 1947*. Proclamation of PDWSAs allows by-laws to be applied to protect water quality.

DWER considers by-law enforcement, through surveillance of land-use activities in PDWSAs, to be an important mechanism to protect water quality.

This plan recommends that the Water Corporation continue by-law enforcement under the existing delegation arrangement (see section 6.2, recommendation no. 7).

This also includes:

- Erecting and maintaining signs in accordance with S111 Source protection signage (Water Corporation 2013).
- Maintaining security and fencing surrounding the existing bore compounds and water treatment plant.
- Erecting security fencing around the future bores, once constructed and commissioned.
- Ongoing regular surveillance and inspections, and reporting of significant incidents through the source protection subcommittee of the Advisory Committee for the Purity of Water, chaired by DWER.

3.7 Responding to emergencies

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Jerramungup local emergency management committee, through the Great Southern emergency management district, should be familiar with the location and purpose of the Bremer Bay Water Reserve. A locality plan will be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. The Water Corporation should have an advisory role to the HAZMAT team for incidents in the Bremer Bay Water Reserve.

Personnel who deal with Westplan–HAZMAT incidents within the area should have access to a map of the Bremer Bay Water Reserve. These personnel should have an adequate understanding of the potential impacts of spills on this drinking water source.

4 Consultation

4.1 Stakeholder consultation process

This plan updates and amends the 1995 *Bremer Bay groundwater protection plan*, the 2004 *Bremer Bay Water Reserve drinking water assessment*, and the draft 2008 *Bremer Water Reserve drinking water source protection plan*. Stakeholder input received between 2008 and 2017 was considered as part of updating the 2018 plan.

The 2008 draft plan was developed with input from the Bremer Bay Protection Plan Advisory Group consisting of representatives from the Water Corporation, Shire of Jerramungup, Wellstead Estuary Advisory Committee and the previous Department of Water, and in consultation with landowners and other relevant state government departments and stakeholders.

It was released on our website for public comment from 2 May 2008 to 13 June 2008. Six submissions were received, with key concerns relating to:

- potential impacts on private land located in P1 areas
- potential land use restrictions on rural farm land
- land use risk to the quality of the drinking water source
- land management responsibilities
- long-term water planning matters.

Options to deal with these concerns had to be considered and resolved to reflect the rights of land owners to farm their land. This was resolved by the Water Corporation purchasing portions of the farm land surrounding the production bores (see Figure A4). This land purchase was finalised in 2017.

The submissions on the 2008 draft plan were considered as part of this 2018 plan.

We received funding assistance through the South Coast Natural Resource Management Inc. – supported by the Australian Government and the Government of Western Australia to help prepare the draft 2008 protection plan.

5 Implementing Bremer Bay's drinking water source protection plan

5.1 Status of previous recommendations

Most of the recommendations from the 1995 groundwater protection plan and publicly consulted 2008 drinking water source protection plan have been implemented, including:

- Identification of a regional waste disposal site for Bremer Bay: the previous Department of Environment Regulation issued a conditional works approval for a regional waste disposal site in Ravensthorpe. This facility will be used by the Shire of Jerramungup for future waste disposal. The Bremer Bay waste transfer station will continue to be used for collecting waste oils, batteries, types and other tyres of wastes.
- Water Corporation purchased some portions of rural farm land surrounding the bores in the southern wellfield.
- New signs were erected to alert people to the location and purpose of the Bremer Bay Water Reserve.
- Revegetation along a drainage line has been undertaken.

Other recommendations have been carried forward into this 2018 plan (see section 5.2).

5.2 Consolidated recommendations

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

1. Proclaim the amended boundary of the Bremer Bay Water Reserve under the *Country Areas Water Supply Act 1947*. (Department of Water and Environmental Regulation).
2. Incorporate the findings of this plan and the location of the Bremer Bay Water Reserve (including its priority areas and protection zones) in the Shire of Jerramungup's local planning scheme in accordance with the State planning policy no. 2.7: *Public drinking water source policy*. (Shire of Jerramungup).
3. Refer development proposals within the Bremer Bay Water Reserve that are inconsistent with DWER's WQPN no.25: *Land use compatibility tables for public drinking water source areas* or recommendations in this plan to the DWER regional office for advice. (Department of Planning Lands and Heritage, Shire of Jerramungup, proponents of proposals).
4. The wellhead protection zone associated with bore 9/84 should be removed from the Bremer Bay Water Reserve once the bore has been decommissioned. (Water Corporation and DWER).

5. Ensure incidents covered by Westplan–HAZMAT in the Bremer Bay Water Reserve are addressed by ensuring that:
    - The Shire of Jerramungup local emergency management committee (which is part of the Great Southern Management District) is aware of the location and purpose of the Bremer Bay Water Reserve.
    - The locality plan for the Bremer 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 Bremer Bay Water Reserve.
    - Personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Bremer Bay 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 Bremer Bay 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, surveillance and by-law enforcement. (Water Corporation).
8. Any proposals within Bremer Bay Water Reserve being considered under the *Conservation and Land Management Act 1984* that may affect water quality should be referred to DWER for comment. (Department of Biodiversity, Conservation and Attractions)
9. This report will be reviewed in seven years or in response to changes in water quality contamination risks. (Department of Water and Environmental Regulation).

Appendices

Appendix A – Figures

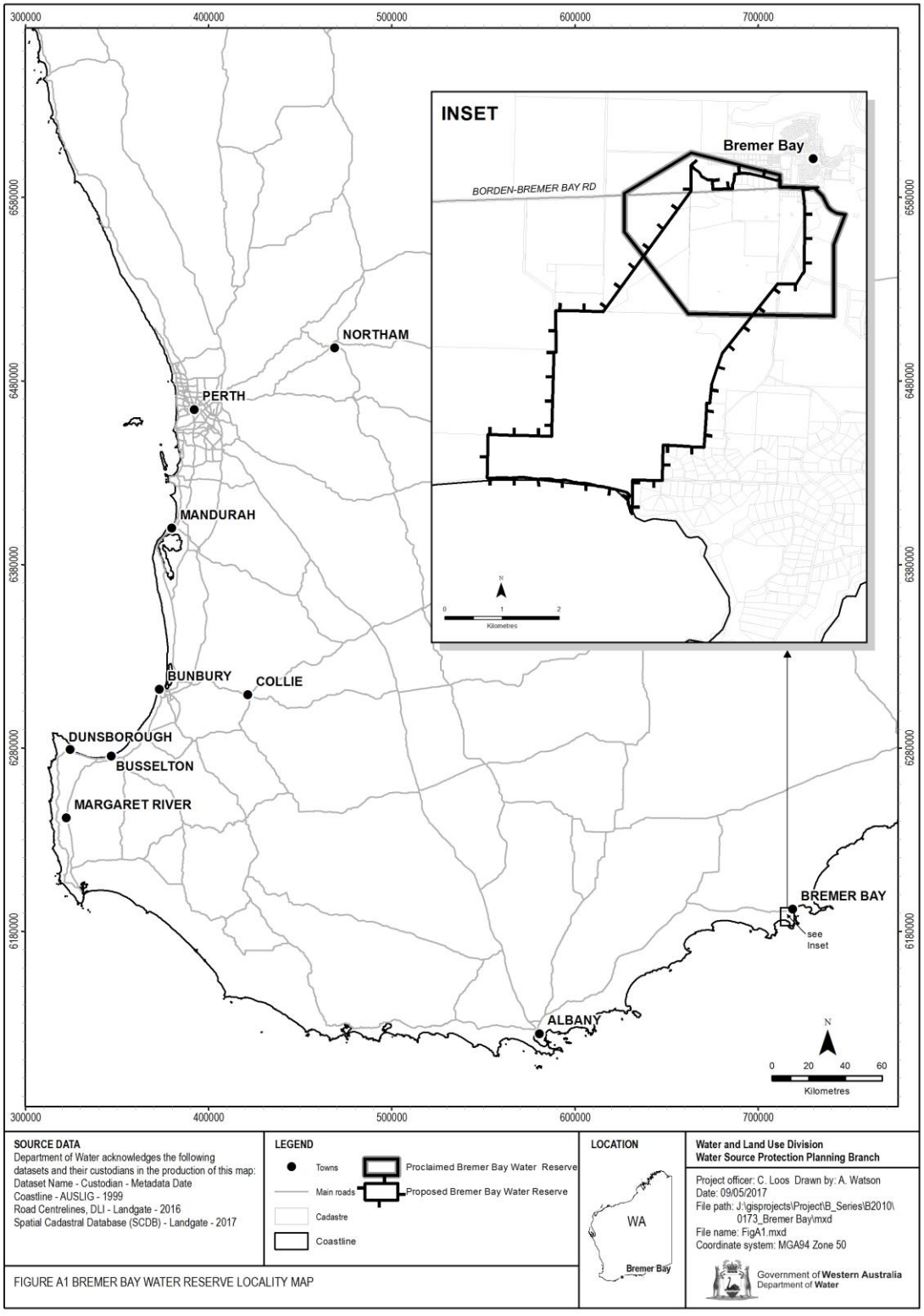

Figure A1 Bremer Bay Water Reserve locality map

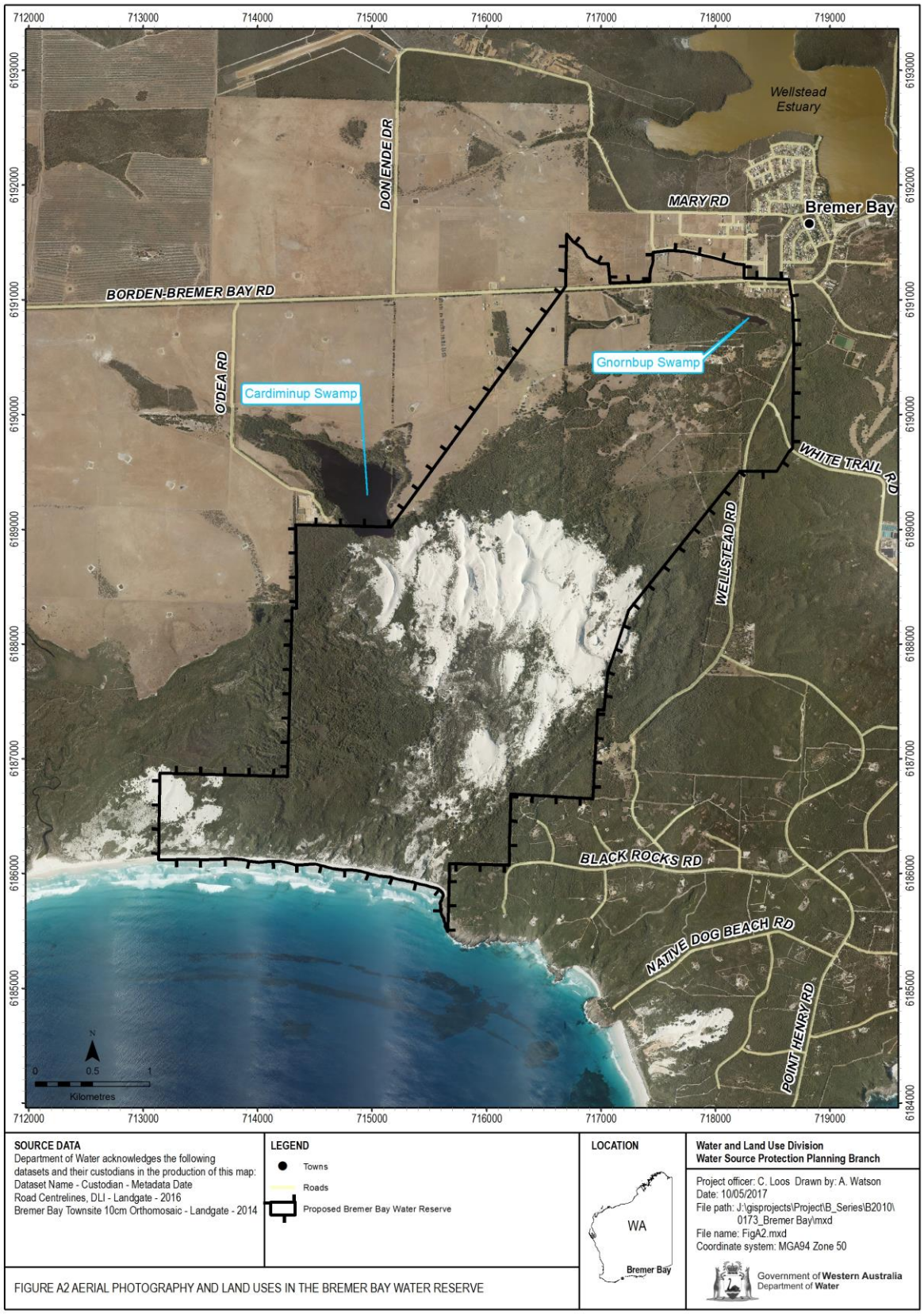

Figure A2 Bremer Bay Water Reserve aerial photo showing land uses

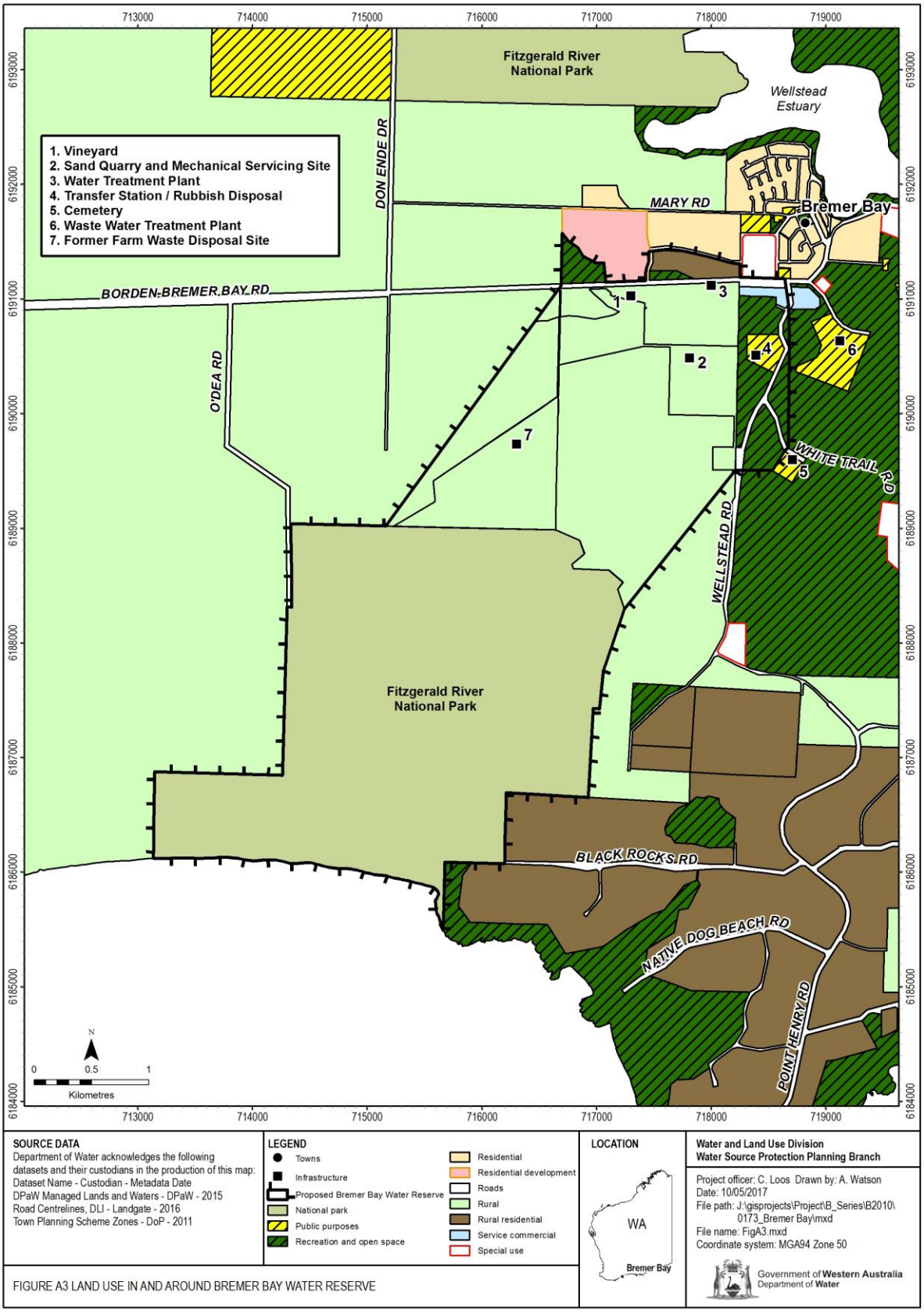

Figure A3 Bremer Bay Water Reserve land tenure

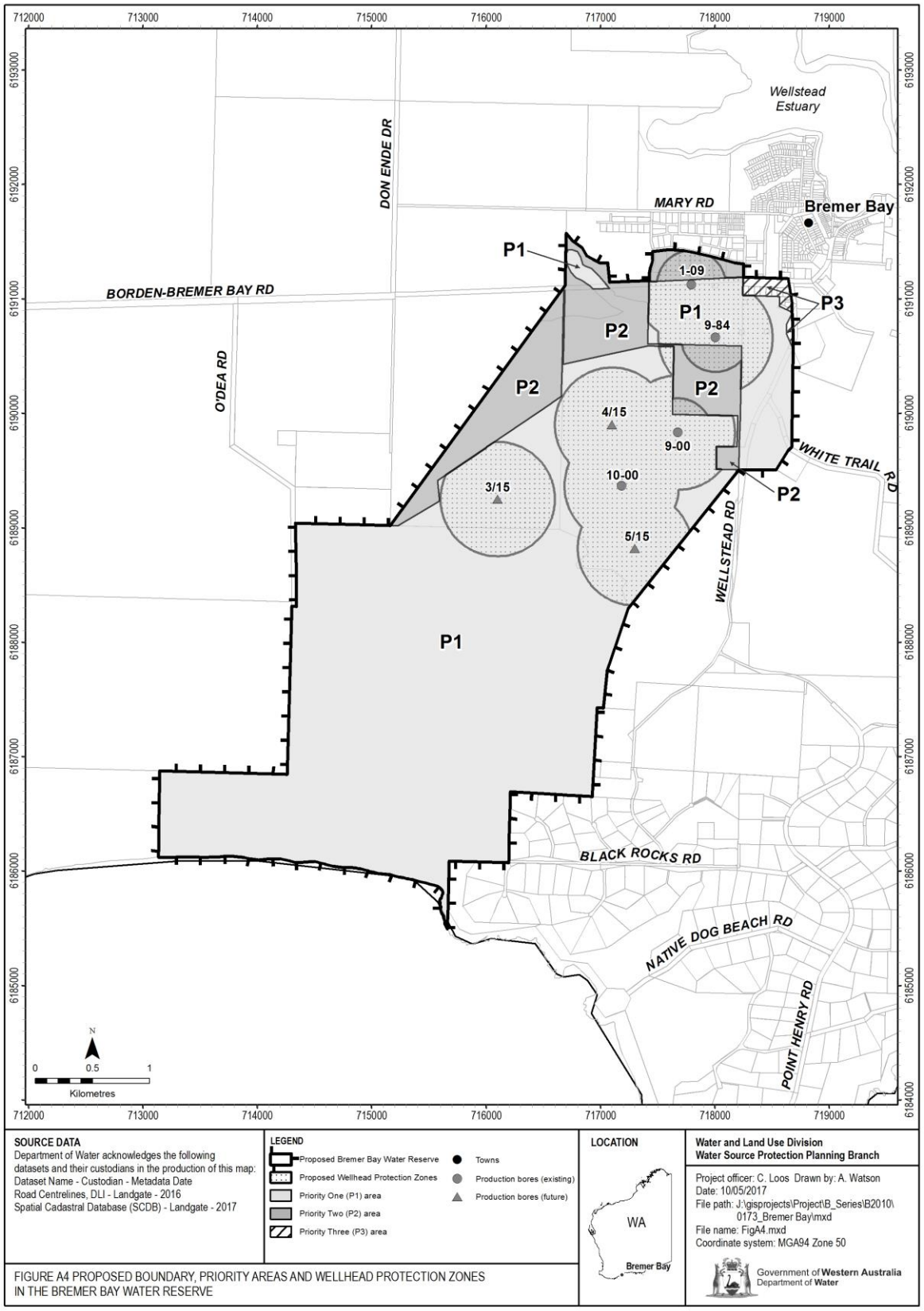

Figure A4 Bremer Bay Water Reserve boundary, priority areas and protection zones

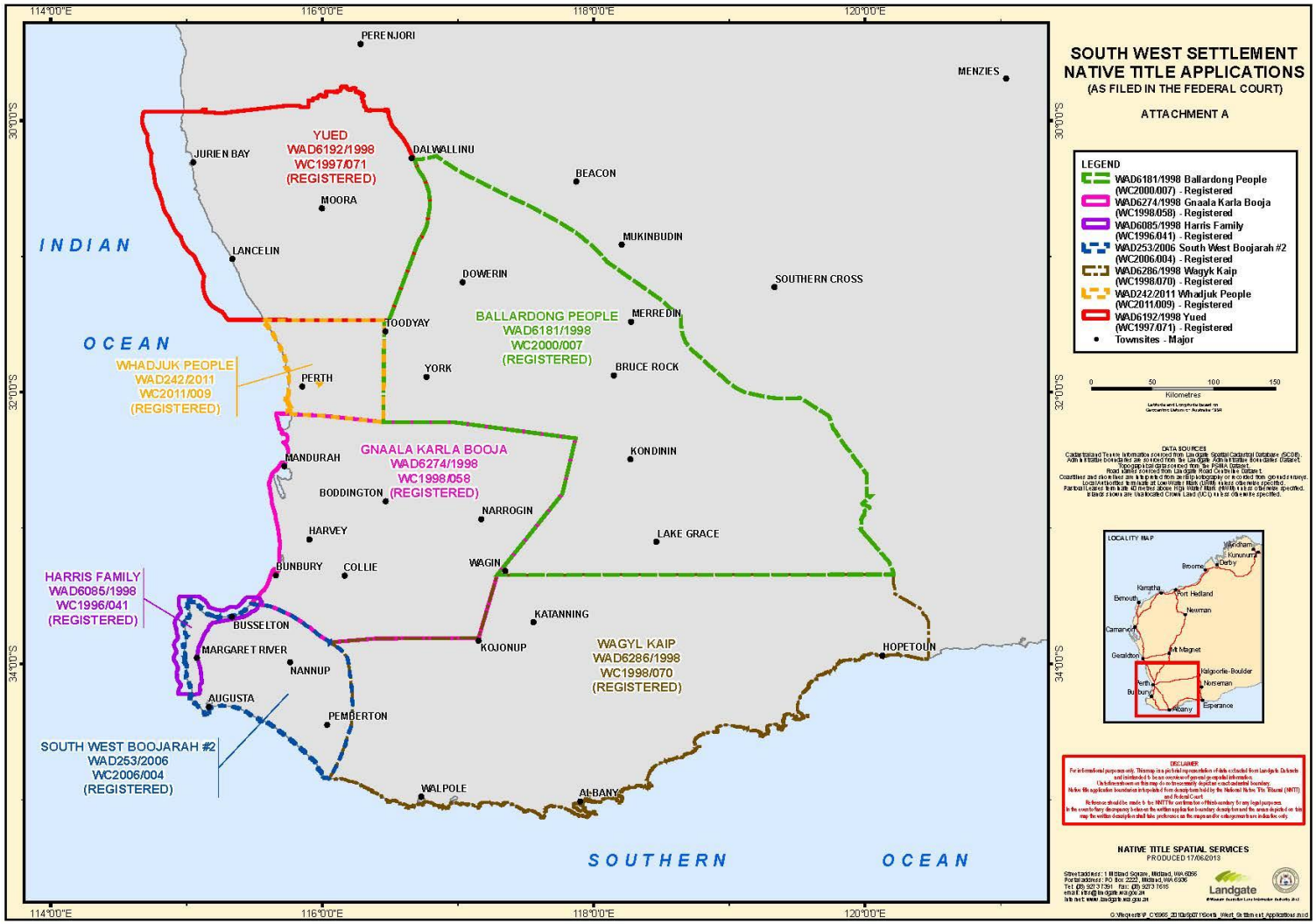

Figure A5 South West Native Title Agreement area (source: Department of Premier and Cabinet)

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 Bremer Bay 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 Bremer Bay 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 June 2012 to May 2017.

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

For more information on the quality of drinking water supplied to Bremer Bay 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 Bremer Bay Water Reserve are summarised in the following table.

Aesthetic detections for Bremer Bay Water Reserve

Parameter	**Units**	**ADWG aesthetic guideline value***	**Bremer Bay Water Reserve**	
			Range	**Median**
Chloride	mg/L	250	205[#]	205
Colour (true)	TCU	15	1–2	1.5

Parameter	Units	ADWG aesthetic guideline value*	Bremer Bay Water Reserve	
			Range	Median
Copper	mg/L	1	0.004–0.005	***0.005***
Hardness as $CaCO_3$	mg/L	200	190–***280***	*235*
Iron unfiltered	mg/L	0.3	0.015–0.06	0.038
Manganese unfiltered	mg/L	0.1	<0.002–0.002	<0.002
Silicon as SiO2	mg/L	80	50–55	52.5
Sodium	mg/L	180	140–***190***	165
Sulfate	mg/L	250	28–30	29
Total filterable solids by summation	mg/L	600	***902–927***	***914.5***
Turbidity	NTU	5	0.2[#]	0.2
pH measured in laboratory	no units	6.5–8.5	7.43–7.49	7.46

* An aesthetic guideline value is the concentration or measure of a water quality characteristic that is associated with good quality water

[#] The range is a result of a single detection.

Health-related chemicals

Raw water from Bremer Bay Water Reserve was 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 Bremer Bay Water Reserve

Parameter	Units	ADWG health guideline value*	Bremer Bay Water Reserve	
			Range	Median
Arsenic	mg/L	0.01	0.003–0.006	0.005
Barium	mg/L	2	0.007[#]	0.007
Boron	mg/L	4	0.12–0.14	0.133
Copper	mg/L	2	0.004–0.005	0.005
Fluoride	mg/L	1.5	0.5–0.6	0.559
Manganese unfiltered	mg/L	0.5	<0.002–0.146	0.012
Molybdenum	mg/L	0.05	<0.0005 – 0.0008	<0.0005
Nitrate as nitrogen	mg/L	11.29	3.8–7.2	5.229
Nitrite as nitrogen	mg/L	0.91	<0.002–0.012	<0.002
Nitrite plus nitrogen as N	mg/L	11.29[†]	3.8–7.2	5.268
Selenium	mg/L	0.01	<0.003–0.003	<0.003
Sulfate	mg/L	500	28-30	29
Uranium	mg/L	0.017	0.001–0.002	0.001

* 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).

[†] 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.

[#] The range is a result of a single detection.

Microbiological contaminants

Microbiological testing of raw water samples from Bremer Bay 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, no positive *E. coli* counts were recorded in the 50 samples collected and analysed.

Appendix C — Land use, potential water quality risks and recommended protection strategies

Land use/ activity	Potential water quality risks		Considerations for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Former landfill site and waste transfer station	The potential risks associated with the old waste disposal site and transfer station are: • nutrients • pathogens • heavy metals • chemicals • petroleum products.	High	This is a historical land use (this part of the landfill site closed in July 2006). The site is managed by the Shire of Jerramungup. The transfer station holds waste before transfer to Boxwood Hill landfill. There is no plan to relocate the transfer station outside the water reserve.	Water quality monitoring. Several bores have been decommissioned as a precautionary measure. A new regional landfill site in Ravensthorpe is proposed to service Bremer Bay from this year onwards. This will reduce the volume of waste accepted at the transfer station in the water reserve.	Landfill sites and waste transfer stations are incompatible land uses in P1 areas. The historical landfill site should be reported to the Department of Water and Environmental Regulation for assessment under the *Contaminated Site Act 2003*. Jerramungup should continue implementing the post closure management plan under consideration of drinking water source protection. Improve the battery and drum storage area at the waste transfer station to ensure adequate bunding and weatherproofing. Options for re-locating the transfer station should be considered by the Shire of Jerramungup.
Light industrial area	The potential risks associated with light industrial areas are: • hydrocarbons and chemicals from fuel and chemical spills from vehicles and machinery • nutrients from onsite wastewater disposal • heavy metals from chemical spills.	High	The light industrial area is near bores in the northern wellfield. It includes businesses such as Shire of Jerramungup depot shed, petrol station, storage sheds, dive shop, and a fish processing site. Hydrocarbons have been found in nearby perched groundwater which may indicate that leakage has occurred. Shire of Jerramungup planning approvals exist for fuel storage and waste disposal.	Water quality monitoring. Several bores have been decommissioned as a precautionary measure. The majority of the lots are connected to the reticulated sewerage system.	Light industry and storage of fuels and chemicals is compatible with conditions in priority 3 areas. Conduct a field assessment of all businesses in Gnombup Terrace, including fuel and chemical storage to ensure adequate bunding and to determine any other risks (e.g. chemical spillages). Investigate opportunities for remaining lots to be connected to the reticulated sewerage system (if required). Include storage and disposal of drums and adequate protection provided for existing above- and below-ground fuel storage facilities in Shire of Jerramungup's waste management strategy. WQPN no.93: *Light Industry near sensitive waters and sites.* WQPN no. 8: *Mechanical servicing and workshops*. WQPN no. 52: *Stormwater management in industrial sites.* WQPN no. 49: *Service stations.* Stormwater management manual for Western Australia.

Land use/ activity	Potential water quality risks		Considerations for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Low intensive agricultural land uses (e.g. stock grazing)	The potential risks associated with extensive agricultural land uses are: • pathogens from stock and on-site effluent disposal and treatment system • nutrients from fertiliser applications • chemicals from pesticide application • hydrocarbons from use of vehicle and machineries.	Medium	Farming activities are generally stock grazing and cropping. Fertilisers and pesticides are likely to be applied. On-site wastewater treatment and disposal systems. These systems need to be maintained and kept in a good state of repair.	Water quality monitoring.	Rural land uses such as cropping and grazing are compatible with conditions in priority 2 areas. WQPN 70: *Wastewater treatment and disposal – domestic systems.* WQPN no. 35: *Pastoral activities within rangelands.* WQPN no. 1: *Agriculture – dryland crops near sensitive water resources.* PSC 88: *Use of herbicides in water catchment areas* (Department of Health 2007).
Vineyard and cellar door sale	The potential risks associated with vineyard and cellar door sale are: • hydrocarbons and chemicals from fuel and chemical spills • pesticides from pest and weed control • nutrients from fertiliser use.	Medium	A small vineyard and cellar sale exists on priority 2 land in the water reserve. There is a vegetation buffer along the drainage line that runs below the vineyard, as well as vegetation strips around the area of vines. Fertilisers and pesticides are likely to be applied.	Water quality monitoring.	A vineyard is a land use considered compatible with conditions in a priority 2 area. Encourage landowner to establish vegetation buffers around any future plots of vines. Encourage landholder to undertake best management practices according to the Environmental management guidelines for vineyards (WRC et al. 2002). Landholder to inform relevant agency of any spills or accidents in the catchment with the potential to contaminate the quality of the drinking water source. WQPN no. 73: Wineries and distilleries. PSC 88: *Use of herbicides in water catchment areas* (Department of Health 2007).

Land use/ activity	Potential water quality risks		Considerations for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Former farm waste disposal site at Borden-Bremer Bay Road	The potential risks associated with the former farm disposal site are: • hydrocarbons from abandoned vehicles • pesticides and other farm chemicals • nutrients from farm waste, carcasses and hides • pathogens from farm waste, carcasses and hides.	Moderate	Historical farm waste disposal site used for disposal of offal, animal carcasses. Hides and skeletons of cattle and sheep, and other farm wastes were observed at the site. Several motor vehicle were also evident at the site. Potential leaching of contaminants from waste disposal site. A groundwater investigation at the former farm waste disposal site did not identify any adverse impacts on the water quality in its vicinity (Aurora environmental, 2014). Aldrin and dieldrin below guideline levels were detected. An arsenic level above the Australian drinking water guideline was detected in one monitoring bore	This former farm waste disposal site is located on P1 land. This portion of land has recently been purchased by the water service provider, and will be managed for the objective of P1 drinking water source protection.	Landfill sites are considered incompatible land uses in P1 areas. Water quality monitoring should continue to be undertaken in accordance with the Australian drinking water guidelines. Testing should consider the parameters for the contamination risks posed by the site. Removing and disposing off the old waste material at an approved landfill site should be considered as a precautionary measure.

Land use/ activity	Potential water quality risks		Considerations for management	Current preventive measures	Recommended protection strategies
	Hazard	**Management priority**			
Sand quarry and machinery storage site	The potential risks associated with sand quarry are: • hydrocarbons.	Medium	The sand quarry and machinery storage site is located on rural land proposed to be assigned for the objectives of a priority 2 water source protection. Best management practices are required for chemical storage and excavation to the highest known water table. A 3 m buffer to the water table is recommended. Servicing of mechanical equipment and vehicles should be undertaken outside the water reserve. Bunding of chemical storage tank (ground and elevated storage). Rehabilitate cleared areas in accordance with the Department of Water and Environmental Regulation's guidelines and Shire of Jerramungup's licence conditions.	Water quality monitoring.	Sand quarry is a land use considered compatible with conditions in PDWSAs (P1, P2 and P3). A sand quarry in wellhead protection zones is considered incompatible. Servicing of mechanical equipment and vehicles should be undertaken outside the water reserve. Bunding of chemical storage tank (ground and elevated storage) should be in accordance with best management practices. Rehabilitation cleared areas should be rehabilitated in accordance with the Department of Water and Environmental Regulation's guidelines and Shire of Jerramungup's licence conditions. Brochure: *Liquid chemicals on agricultural land* WQPN no. 65: *Toxic and hazardous substances – storage and use* WQPN no. 15: *Extractive industries near sensitive water resources* WQPN no. 28: *Mechanical servicing and workshops* WQPN no. 56: *Tanks for elevated chemical storage* WQPN no. 61 *Tanks for ground level chemical storage* WQPN no. 28: *Mechanical servicing and workshops* WQPN no. 29: *Mobile mechanical servicing and cleaning*
Rural residential subdivision north of Borden–Bremer Bay Road	The potential risks associated with rural residential subdivision are: • hydrocarbons and chemicals from fuel and chemical spills • pesticides from pest control • nutrients from fertiliser used for gardens.	High	The subdivision is located just north of the Borden–Bremer Bay Road. Groundwater in this area flows in a northerly direction away from the production bores. Public open space for a second subdivision has been included in the water reserve as it contains a drainage line that flows towards the production bores. On-site wastewater treatment and disposal systems are likely to be used.	The subdivision will be connected to the reticulated sewerage system.	Special rural subdivision to lot size of 2 ha or greater is compatible with conditions in a priority 2 area. WQPN 70: *Wastewater treatment and disposal – domestic systems.* Department of Water and Environmental Regulation's *Stormwater management manual* Maintain vegetation along the drainage line in the public open space area. Implement stormwater management that takes into consideration water source protection objectives and proximity to production bores.

Land use/ activity	Potential water quality risks		Considerations for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Roads and tracks traversing the bore field	The potential risks associated with roads are: • hydrocarbons and chemicals from fuel and chemical spills from vehicles and machinery • pesticides from weed-spraying along edges of roads • nutrients from surface run-off.	Medium	The Borden-Bremer Bay Road runs along the northern boundary of the wellfield and Wellstead Road runs along the eastern boundary of the wellfield. Borden-Bremer Bay Road transects wellhead protection zone of bore 1/09. Major roads can potentially have an adverse impact on water quality if fuel or chemical spills occur as a result of a road accident. Pesticide may be used to control weeds along road verges. Unsealed roads need to be managed to control access.	Water quality monitoring.	A road is a land use compatible with conditions in a priority 1 and 2 area, and acceptable land use in a priority 3 area. Close or restrict unused tracks, if possible. Ensure adequate gates and signage to prevent access to private property within wellhead protection zones. Ensure sumps and run-off control measures are adequate and away from production bores. Ensure contingency plans are in place for any spills resulting from accidents. WQPN no. 44: *Roads near sensitive water resources* WQPN no. 10: *Contaminant spills - emergency response* PSC88: *Use of herbicides in water catchment areas* (Department of Health 2007).
Infrastructure maintenance • power lines • pipelines • associated maintenance tracks • production bores and associated fixtures/ structures	The potential risks associated with infrastructure are: • hydrocarbons and chemicals from fuel and chemical spills from vehicles and machinery.	Low	Location and purpose of production bores should be taken into consideration in any fire emergency plans. Possible chemical contamination from the use of fire suppressants (foams) and fire retardants in the control of bushfires.	Water quality monitoring. Shire of Jerramungup LEMC emergency response.	Infrastructure (e.g. electrical substations, gas and water pipelines, powerlines) is compatible with conditions in P1 and P2 areas, and acceptable in P3 areas. The water service provider should ensure all bores are sealed and constructed in accordance with the *Minimum construction requirements for water bores in Australia* (National Uniform Drillers Licensing Committee, 2012). Review raw (source) water quality monitoring program to ensure any potential risk can be detected. WQPN no. 83 Infrastructure corridors near sensitive water resources. WQPN no. 10 Contaminated spills – emergency responses PSC 88: *Use of herbicides in water catchment areas* (Department of Health 2007).

Land use/ activity	Potential water quality risks		Considerations for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Drinking water treatment plant	The potential risks associated with a drinking water treatment plant are: • chemicals stored on site for the operation of the water treatment plant.	Low	The Water Corporation's drinking water treatment plant is located on the southern side of the Borden–Bremer Bay Road and close to several production bores	Water quality monitoring. Leachate from pond is now disposed of via reticulated sewerage.	A water treatment plant is a land use compatible with conditions in a priority 1 area. WQPN no. 65: *Toxic and hazardous substances – storage and use.* *WQPN no. 83 Infrastructure corridors near sensitive water resources.* Department of Water and Environmental Regulation's *Stormwater management manual.*
Fitzgerald River National Park	The potential risks associated with a national park are: • hydrocarbons and chemicals from fuel and chemical spills from vehicles that may enter the national park • pesticides from weed-spraying firebreaks • rubbish left behind by people.	Low	Reserve 31737 is located in the southern part of the water reserve. The reserve is managed by DPaW and generally does not pose a risk to water quality.	The reserve is managed by DPaW. There is limited public access which is restricted to the beach and is 4WD only. There are no designated recreation activities within the reserve.	National parks are acceptable in a priority 1 areas. Ensure that the management plan for the Fitzgerald River National Park recognises the objective of drinking water source protection. Use pesticides in accordance with PSC88: Use of Herbicides in water catchment areas (Department of Health 2007) (if required).
Vegetation loss through fire and clearing	The potential risks associated with vegetation loss are: • turbidity.	Low	Bushfire and prescribe burns present a potential risk through loss of vegetation. Loss from clearing vegetation. The Department of Fire and Emergency Service can restrict burning times and total fire bans under the *Bushfire Act 1954* prescribes fire bans.	The water reserve is well vegetated.	Vegetation clearing is subject to the *Environmental Protection Act 1986* clearing regulations. Ensure all vegetation clearing proposals are referred to Department of Water and Environmental Regulation for advice. Firebreaks are maintained by landowners.

[1] Water quality protection notes (WQPNs) are available www.dwer.wa.gov.au or see *Further reading*.

Appendix D – Photographs

Images by Department of Water and Environmental Regulation

Figure D1 Bremer Bay Water Reserve

Figure D2 Bore compound at Bremer Bay

Figure D3 Bremer Bay waste transfer station

Figure D4 Service station in Bremer Bay Water Reserve

Figure D5 Vineyard and Cellar door sale in Bremer Bay Water Reserve,

Figure D6 Stormwater drainage in Bremer Bay

Figure D7 Unsealed track in Bremer Bay Water Reserve

Figure D8 Bremer Bay Water Reserve

Appendix E – 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 contamination can occur indirectly when faecal material infiltrates 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 F — 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 a preventive risk–based and multiple-barrier approach. 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.

A preventive risk–based approach 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
- 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, 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 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.

DWER's Water quality protection note (WQPN) no. 25: *Land use compatibility in PDWSAs* outlines appropriate development and activities within each of the priority areas (P1, P2 and P3). A draft update of this document was released for public comment in October 2014, and an updated version is expected to be published during 2016.

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 DWER) and are strategic documents that integrate land use planning with

water management. There are currently land use and water management strategies for Gnangara, Jandakot and Middle Helena.

If you would like more information about the ADWG and how we protect drinking water in Western Australia, visit www.dwer.wa.gov.au or contact DWER's Water source protection planning branch on +61 8 6364 7000 or email drinkingwater@dwer.wa.gov.au.

Drinking water source protection reports produced by the Department of Water and Environmental Regulation

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 G – 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, a preventive risk–based assessment 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
DBCA	Department of Biodiversity, Conservation and Attractions
DWER	Department of Water and Environmental Regulation
HAZMAT	hazardous materials
LEMC	local emergency management committee
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
P1, P2, P3	priority 1, priority 2, priority 3
PSC 88	Public sector circular number 88
PDWSA	public drinking water source area
TCU	true colour units
WAPC	Western Australian Planning Commission
Westplan–HAZMAT	Western Australian plan for hazardous materials
WHPZ	wellhead protection zone
WQPN	water quality protection note

Units of measurement

ha	hectare
m	metres
mg/L	milligram per litre
mm	millimetre
km	kilometre

Volumes of water

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

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, for example appearance, taste and odour (NHMRC & NRMMC 2011).
Allocation	The volume of water that a licensee is permitted to abstract, usually specified in kilolitres per annum (kL/a).
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*).
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.
Effluent	Treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2011).

Hydraulic gradient	The change in hydraulic head per unit of distance, which determines the rate of groundwater flow.
Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The branch of geology that deals with the occurrence, distribution and effects of groundwater. It is the study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Hydrology	The science dealing with water on the land, including such things as its properties, laws and geographical distribution.
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.
mg/L	A measurement of something (such as salinity) in a solution, i.e. 0.001 grams per litre.
Nutrient load	The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area.
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.
Permeability	Also referred to as hydraulic conductivity, this is the ability of a rock or soil unit to transmit fluids. Its magnitude depends on the size of the pore spaces (see porosity) and the degree to which they are interconnected.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
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.

Point source	Pollution originating from a specific localised source, such as sewage or effluent discharge; industrial waste discharge.
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.
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.
Runoff	Water that flows over the surface from a catchment area, including streams.
Sedimentary rocks	Rocks that have been formed by the deposition of materials. Examples are limestone, sandstone and siltstone.
Sedimentary aquifer	Aquifers occurring in sedimentary rocks.
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.
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.
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.
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.
Watertable	The upper saturated level of the unconfined groundwater.
Wellfield	A group of bores located in the same area used to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater.
Wellhead protection zone	Usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination risks.
Westplan–HAZMAT	State emergency management plan for hazardous materials emergencies.

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Department of Water and Environmental Regulation
168 St Georges Terrace Perth WA
Locked Bag 33 Cloisters Square Perth WA 6850
Phone: 08 6364 7600
Fax: 08 6364 7601
National Relay Service 13 36 77
dwer.wa.gov.au

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