Government of Western Australia
Department of Water and Environmental Regulation

Preston Beach Water Reserve

drinking water source protection review

Preston Beach town water supply

Water resource protection series
Report WRP192
November 2019

Preston Beach Water Reserve drinking water source protection review

Preston Beach town water supply

Department of Water and Environmental Regulation

Water resource protection series

Report no. 192

November 2019

Department of Water and Environmental Regulation
Prime House
8 Davidson Terrace
Joondalup Western Australia 6027
Telephone +61 8 6364 7000
Facsimile +61 8 6364 7001
National Relay Service 13 36 77
www.dwer.wa.gov.au

November 2019

ISSN 1835-3924 (online)

FIRST 115785

Acknowledgements

The following people contributed to this publication: Sue Tillman, Stephen Watson, Scott Macaulay and Andrew Watson (DWER) and Steve Collins and Clairly Lance (Water Corporation).

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

Cover photograph: Aerial photo of Preston Beach.

Contents

Tables

Summary

In 2006, the department published the *Preston Beach Water Reserve drinking water source protection plan* (DoW 2006). This review considers changes that have occurred in and around the Preston Beach Water Reserve since publishing that plan. The plan still contains relevant information, so it is important that the plan and this review are read together. Both are available on our website or by contacting us.

Preston Beach is a small coastal town about 115 km south of Perth in the Shire of Waroona (Figure A1). It is a popular tourist destination close to the ocean and Yalgorup National Park.

The Preston Beach Water Reserve is strategically important, being the sole source of drinking water for the town. Its protection as a proclaimed public drinking water source area ensures the continued supply of safe, reliable, good-quality drinking water to consumers to protect public health now and in the future. The current Preston Beach Water Reserve was gazetted in 2009 under the *Country Areas Water Supply Act 1947* (Figure A2).

The Water Corporation supplies drinking water to about 364 services in Preston Beach from two wellfields inside the Preston Beach Water Reserve. The 'Town Wellfield' is in Preston Beach and abstracts groundwater from the Leederville aquifer. This aquifer has a confining layer of rock above it which helps protect it from contamination from overlying land uses. The 'Johnston Road Wellfield' is 8 km south-east of town and abstracts groundwater from the Superficial aquifer. This aquifer is shallower and is more susceptible to contamination from surrounding land uses because it does not have a confining layer of rock above it.

Since the 2006 plan, little has changed in terms of land use and tenure in and around the Preston Beach Water Reserve. Forestry, roads (heavy-haulage truck route) sand mining, land use intensification, fire and vandalism present the largest potential contamination risks to the drinking water source. This review proposes no changes to the Johnston Road Wellfield. However, changes to the Town Wellfield are recommended based on the following:

- Bore 1/85 (and its wellhead protection zone) should be removed from the Preston Beach Water Reserve as it is no longer used to supply drinking water for the town. It is now a Water Corporation monitoring well.
- Bore 2/85 no longer requires a wellhead protection zone. This bore is confined and it was resealed in 2017 to ensure its structural integrity. Therefore, it is unlikely that contaminants from land use activities will enter the Leederville aquifer from the Superficial aquifer above or via the bore's headworks or casing (bore ingress). Protection of the bore's compound is considered adequate in this situation.
- Land in the Town Wellfield is owned by the Water Corporation and used for public water supply. It should be changed from priority 3 (P3) to priority 1 (P1) to reflects its tenure and strategic importance as a source for the town.

Figure A3 shows the proposed, reduced Preston Beach Water Reserve. After this document is published, the Department of Water and Environmental Regulation (the department) will arrange for constitution of this amended boundary under the *Country Areas Water Supply Act 1947,* and change its priority areas and protection zones in our spatial data. All land within the Preston Beach Water Reserve is proposed to be managed as a P1 area to continue avoiding contamination risks within the Preston Beach Water Reserve.

The department prepared this document in consultation with key stakeholders:

- Water Corporation
- Shire of Waroona
- Shire of Harvey
- South West Aboriginal Land and Sea Council
- Forest Products Commission
- Department of Health
- Department of Mines, Industry Regulation and Safety
- Department of Planning, Lands and Heritage
- Department of Biodiversity, Conservation and Attractions
- Department of Primary Industries and Regional Development
- Department of Fire and Emergency Services.

Stakeholders were consulted about the Preston Beach Water Reserve review and invited to comment. No concerns about the review or the proposed Preston Beach Water Reserve amendment were raised. This outcome was expected given the proposed change will result in a reduction in size of the Town Wellfield with no changes proposed to the size or management of the Johnston Road Wellfield.

This review helps implement the *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 2011), State planning policy 2.7: *Public drinking water source policy* (Western Australian Planning Commission 2003) and Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a).

Important information about the Preston Beach Water Reserve is in Table 1.

Table 1 Key information about the Preston Beach Water Reserve

Preston Beach Water Reserve	
Local government/s	Shire of Harvey and Shire of Waroona
Location supplied	Preston Beach
Number of services	364
Water service provider	Water Corporation
Aquifer type	Confined (Leederville) and unconfined (Superficial)

Preston Beach Water Reserve	
Licensed abstraction	GWL109495(4) 20,000 kL per year (Leederville) Bore 2/85 GWL97060(5) 120,000 kL per year (Superficial) Bore 1/98
Bore names and GPS coordinates	2/85 (E 374 567, N 6 361 782, zone 50) Production bore 1/98 (E 380 899, N 6 356 940, zone 50) Production bore 1/85 (E 374 499, N 6 361 958, zone 50) Monitoring bore (ex-production bore)
Date of bore completion	2/85 – 10 July 1985 1/98 – 6 November 1998
Dates of drinking water source protection reports	2006 – *Preston Beach Water Reserve water source protection plan* (DoW 2006) 2019 – Preston Beach *Water Reserve drinking water source protection review* published (this document)
Consultation	2005–06 – consultation with key stakeholders previously occurred during the development of the *Preston Beach Water Reserve drinking water source protection plan* 2018–19 – consultation with key stakeholders
Gazettal status	Constituted on 3 July 2009 under the *Country Areas Water Supply Act 1947.* This review recommends that a new, reduced, Preston Beach Water Reserve boundary be constituted.
Useful references	*Australian drinking water guidelines* (NHMRC & NRMMC 2011) State planning policy 2.7: *Public drinking water source policy* (WAPC 2003) *Preston Beach drinking water source protection plan* (DoW 2006) Water quality protection note 25 *Land use compatibility tables for public drinking water source areas* (DoW 2016b)

1 Review of Preston Beach Water Reserve drinking water source protection plan

1.1 Water supply scheme

Groundwater abstracted from the Preston Beach Water Reserve is the sole source of drinking water for Preston Beach. The Water Corporation holds two groundwater abstraction licences, issued by this department, for Preston Beach's public water supply. Groundwater licence GWL97060(5) allows the Water Corporation to abstract 120 000 kL of Superficial aquifer groundwater from bore 1/98 each year. Groundwater licence GWL109495(4) allows the abstraction of 20 000 kL of Leederville aquifer groundwater from bore 2/85 each year. Under normal operations, bore 1/98 abstracts the majority of groundwater for Preston Beach's water supply. Strict conditions are placed on the licences relating to water use, monitoring and renewal.

The Water Corporation has advised that the above licensed allocations and wellfield configurations will meet the town's public water supply requirements over the next five years. If the town experiences a sustained spike in population growth, alternative options such as desalinisation or extension of the Stirling-Harvey trunk main will be explored for Preston Beach's long-term water supply.

1.2 Boundary, priority areas and protection zones

The current Preston Beach Water Reserve was gazetted in 2009 under the *Country Areas Water Supply Act 1947* (Figure A2). It contains two wellfields: Town wellfield and Johnston Road Wellfield. The Town Wellfield is over a confined aquifer in the townsite. It is currently assigned a priority 3 (P3) area and a 300 m wellhead protection zone (WHPZ) exists around two bores (1/85 and 2/85). The Johnston Road Wellfield, about 8 km south-east of the town, consists of bore 1/98 (see Appendix C, Figure C1) surrounded by a 500 m WHPZ and a larger priority 1 (P1) area to offer extended protection for this superficial drinking water source.

This review recommends some changes to the Preston Beach Water Reserve which are described below and shown in Figure A3.

Bore 1/85 was converted from a drinking water bore to a monitoring bore in 2015 after experiencing pump failure and ongoing water quality issues. The Water Corporation has advised it will remain a monitoring bore (in a secured compound). As it no longer requires protection as a public drinking water source area (PDWSA) Bore 1/85 and its associated WHPZ will be removed from the Preston Beach Water Reserve.

Additionally, Bore 2/85 (see Appendix C, Figure C2) no longer requires a WHPZ. This bore abstracts groundwater from the confined Leederville aquifer which is overlain by about 28 m of Tamala Limestone and up to 30 m of Kardinya Shale at the bore site. It was resealed in 2017 to ensure its structural integrity. Therefore, it is

unlikely that contaminants from land use activities will enter the Leederville aquifer from the Superficial aquifer above or via the bore itself (bore ingress). Protection of the bore's compound is considered adequate in this situation.

In light of this, the Town Wellfield will be reduced in size. The boundary will incorporate bore 2/85 and its associated infrastructure, including the Preston Beach drinking water treatment plant. The Town Wellfield is on Water Corporation freehold land and should be managed as a priority 1 (P1) area to ensure maximum protection for Preston Beach's water supply.

The Johnston Road Wellfield boundary, priority area and protection zones will remain unchanged. Contamination risks from land uses and activities occurring here continue to pose a risk to groundwater quality in the Superficial aquifer. Recent particle tracking modelling results, conducted by this department, indicate that the current boundary provides adequate protection to drinking water bore 1/98 from surrounding land uses.

After this report is published, and subject to government support, the department will arrange for the constitution of the new Preston Beach Water Reserve boundary (as per Figure A3) under the *Country Areas Water Supply Act 1947* (see recommendation 1 in section 3.2.)

The boundary, priority areas and protection zones for the Preston Beach Water Reserve were determined in accordance with the department's Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a).

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

1.3 Treatment

Abstracted (raw) groundwater from all bores is pumped to the Town Wellfield to undergo treatment (see Appendix C, Figure C3). It is dosed with Calgon to decrease hardness levels before being chlorinated and passed through a media filter to remove iron and other solids (see Appendix C, Figure C4). Groundwater in the area has naturally high levels of iron and total dissolved salts (see Appendix B) so treatment focuses on correcting these. Treated water is stored in a 2250 kL ground tank before being distributed to consumers.

PDWSA management is the first step in protecting water quality and ensuring a safe drinking water supply. Although treatment and disinfection are essential barriers against contamination, catchment protection is the most important, as advocated by the *Australian drinking water guidelines* (ADWG; NHMRC & NRMMC 2011). The ADWG is based on preventing risks and installing multiple barriers for providing safe drinking water to consumers. This combination of catchment protection and water treatment delivers a more reliable, safer and lower-cost drinking water to consumers than either approach could achieve individually.

For more information on how the department protects PDWSAs, read Appendix E. For more information about our preventive risk management approach, read Appendix F.

1.4 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 is one Aboriginal site of significance in the Preston Beach Water Reserve. This is Lake Preston Sand Pit (3212) which covers part of the Johnston Road Wellfield.

Native title is the recognition in Australian law that some Aboriginal people continue to hold native title rights to land and water arising from their traditional laws and customs. The Government of Western Australia and the Noongar native title claimants have negotiated a South West Native Title Settlement. This settlement recognises the Noongar people as the traditional owners of land in the South West Settlement Area. One native title claim exists over the Preston Beach Water Reserve. This is Gnaala Karla Booja (WAD6274/1998) as shown in 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. On 8 June 2016, we 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 this. These amended by-laws currently apply within the Preston Beach Water Reserve.

The ILUAs are available from the Department of Premier and Cabinet. Refer to Water quality information sheet 39: *Aboriginal customary activities in public drinking water source areas in the South West Native Title Settlement Area* (DoW 2017) for further information.

The department 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.

This review does not propose any changes to the way significant sites and Native Title claims are currently managed in the Preston Beach Water Reserve. The Town Wellfield boundary reduction will mean that some of the PDWSA is removed from the Native Title claim area. The department will again contact the South West Aboriginal Land and Sea Council before amending the Preston Beach Water Reserve boundary under the *Country Areas Water Supply Act 1947*. The final decision on proposed

boundary changes will need to be consistent with the South West Native Title Settlement.

1.5 Enforcing by-laws, surveying the area and maintenance

This review recommends that the Water Corporation continues by-law enforcement in the Preston Beach Water Reserve under the existing delegation arrangement (see section 3.2, recommendation 6). This includes:

- erecting and maintaining signs in accordance with *S111 Source protection signage* (Water Corporation 2013)
- maintaining security and fencing surrounding the bores and associated treatment facilities.
- ongoing regular surveillance and inspections. Related water source management work.

1.6 Related water source management work

Peel Coastal groundwater allocation plan

The *Peel Coastal groundwater allocation plan* (DoW 2015) sets out how the department will manage groundwater in coastal parts of the Peel region from Mandurah and south along the coast, to just north of Myalup. The plan outlines how water resources and their dependent values will be protected from additional abstraction and how water users should adapt to the drying climate. The Preston Beach Water Reserve is the only PDWSA within the geographical scope of the allocation plan which notes that groundwater has been set aside from the relevant aquifers for public water supply purposes.

Myalup-Wellington project

The department had a large involvement with planning Water for Food projects around the state, including the Myalup-Wellington project. The Department of Primary Industries and Regional Development (DPIRD) is now coordinating this project with technical input from other agencies. The project aims to allow for more land use intensification in certain areas, including Myalup, where the Johnston Road Wellfield is, via access to piped, desalinated water from Wellington Dam.

Consultation between the department and DPIRD should continue throughout this project, to ensure that the strategic importance of Preston Beach's sole public water supply is maintained and not put at risk from potentially contaminating land uses.

1.7 Update on water quality risks

As part of this review, the department has conducted an updated assessment of water quality contamination risks to the Preston Beach drinking water source.

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

As groundwater in the Town Wellfield is drawn from a confined aquifer, there is little potential for contamination from surrounding urban land uses such as septic tanks, hydrocarbons, chemicals, fertilisers and pesticides.

The main contamination risks to the Preston Beach Water Reserve (Table 2) are from activities occurring in the Johnston Road Wellfield. This is because bore 1/98 is surrounded by sandy soils and Tamala limestone which allows contaminants to pass through relatively easily into the shallower Superficial aquifer below (from where water is abstracted).

Current permitted activities in Johnston Road Wellfield include forestry (pine plantations), roads (Johnston Road runs just north of bore 1/98 and is a heavy-haulage truck route because of sand quarry operations to the south and east of the water reserve). The main risk to groundwater from these activities includes contamination from hydrocarbons (spills and leaks) and chemicals (spills, misuse) particularly within the WHPZ and on unsealed roads/ground. Vandalism and bushfires have been a problem from time to time, causing damage to drinking water infrastructure. Potential for land use intensification in the area through the Myalup-Wellington Water for Food scheme is also a risk.

Figure A4 shows land tenure over the proposed Preston Beach Water Reserve. The entire reserve will be assigned a P1 area with the primary objective of risk avoidance.

All land use development proposals in the water reserve should be assessed against the department's Water quality protection note 25: *Land use compatibility tables for public drinking water source areas*. Any that are likely to impact on the quality of groundwater within the water reserve should be forwarded to the department's regional office for comment.

Existing, lawfully approved activities within the Preston Beach Water Reserve are allowed to continue at their current intensity. Best management practice across all land uses in the water reserve is important to protect this important drinking water source from degradation.

Other groundwater bores

Bores drilled near a public drinking water supply bore (such as for irrigation or private purposes) can cause contamination of the drinking water source and interfere with pumping regimes. For example, a poorly constructed bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer. Bores need to be appropriately located and constructed to prevent contamination of the PDWSA. This will be assessed through the department's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914.* All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Uniform Drillers

Licensing Committee 2012). It is important that GIS coordinates for all bores are recorded correctly to ensure proper assessment of the risk to drinking water bores.

No other licenced groundwater bores are within the proposed Preston Beach Water Reserve. Monitoring bore 1/85's casing should be carefully maintained to ensure no ingress of contaminants to the aquifer.

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

Land use/activity	Hazard	Comments	Best management practice guidance[1]
Roads and tracks	Hydrocarbons Chemicals	Johnston Road runs close to bore 1/98 through the WHPZ. Heavy haulage (truck route to Forrest Highway) because of quarry operations in area. Existing sealed roads are acceptable. Unsealed roads need to be managed to control access.	WQPN 44: *Roads near sensitive water resources* Road to be well maintained. Sound emergency procedures in place to deal with accidents and spills. Water Corporation signs should include an emergency phone number.
Forestry – Forest Products Commission (FPC) pine plantations	Pathogens Hydrocarbons Chemicals Nutrients	Current level of forestry is compatible with conditions within P1 areas. Herbicides are used for firebreak control. Limited nutrient application.	Public Sector Circular 88 (PSC 88) *Use of Herbicides in Water Catchment Areas* (Department of Health 2007) WQPN 121 *Plantations in public drinking water source areas* *Code of Practice for Timber Plantations in Western Australia* (Forest Industries Federation of Western Australia 2014). *Forest Management Plan 2014–2023* (Conservation Commission 2013).
Bushfire and vandalism	Damage to infrastructure	Random occurrence. Damage may result in bore infrastructure being taken offline.	Amend pumping regimes until water quality is appropriate to return to default regimes.

Land use/activity	Hazard	Comments	Best management practice guidance[1]
		Chemicals may be used to suppress bushfire. Sound emergency and contingency plans are important.	Sound emergency practices in place to deal with hazard in a safe and timely manner. Water Corporation signs should include an emergency number.
Myalup-Wellington scheme	Nutrients Chemicals	The project is still in the planning stages, and will be subject to all statutory approval processes.	DPIRD to continue to consult DWER to ensure PDWSA is considered in any future land use decision. Water quality protection note 25 *Land use compatibility tables for public drinking water source areas* (DoW 2016b).

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

1.8 Water quality information

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

Groundwater in the area has naturally high levels of iron and total dissolved salts so treatment focuses on rectifying these. It is important to appreciate that this raw-water data does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of the ADWG.

2 Consultation

2.1 Stakeholder consultation process

The department consulted key stakeholders in 2018 and 2019, to give them information about the review and the proposed amendments to the Preston Beach Water Reserve boundary, priority areas and protection zones. We provided each stakeholder with maps of the existing and proposed Preston Beach Water Reserve.

The department consulted the following:

- Shire of Waroona
- Shire of Harvey
- Water Corporation
- Department of Health
- Department of Planning, Lands and Heritage
- Department of Biodiversity, Conservation and Attractions
- Department of Primary Industries and Regional Development
- South West Aboriginal Land and Sea Council
- Forest Products Commission (FPC)
- Department of Fire and Emergency Services
- Department of Mines, Industry Regulation and Safety.

Stakeholders were invited to comment. No concerns about the review or the proposed amendment were raised. This outcome was expected given the proposed changes to the Preston Beach Water Reserve resulted in a reduction in size of the Town Wellfield and no changes to the size or management of the Johnston Road Wellfield.

3 Implementing Preston Beach Water Reserve drinking water source protection plan

3.1 Status of previous recommendations

Table 3 outlines recommendations from the 2006 plan and their current status.

Table 3 Implementation status for Preston Beach Water Reserve

No.	2006 recommendation	Comments
1	Gazettal of proposed Preston Beach Water Reserve.	Gazetted on 3 July 2009 under the *Country Areas Water Supply Act 1947.* The department will arrange for the constitution of the updated boundary (as per Figure A3) after this report is published. New (see recommendation 1).
2	Incorporation into land planning strategies; Peel, Greater Bunbury Region Scheme and town planning scheme for the Shires of Waroona and Harvey.	The current Preston Beach Water Reserve has not been incorporated into these schemes. This review recommends to include it as a special control area in future versions of these. Not yet completed (see recommendation 2).
3	Referral of development proposals that may impact water quality and that are inconsistent with Department guidance	Guidelines have been provided through the WQPN series. Development proposals that are inconsistent with our WQPN 25: *Land use compatibility tables for public drinking water source areas* should be referred to DWER. This has been continued as a recommendation of this review. Ongoing (see recommendation 3).
4	Signage to be placed around the boundary of Preston Beach Water Reserve to define it and for education and awareness	Signs advising on the location of the water reserve are erected. This has been continued as a recommendation of this review. Ongoing (see recommendation 5).

No.	2006 recommendation	Comments
5	Emergency response: • develop response plan • inform WESTPLAN- HAZMAT personnel of special requirements for the Preston Beach Water Reserve.	Emergency response plans are in place with Department of Fire and Emergency Services and the Shire of Harvey and Shire of Waroona. This has been continued as a recommendation of this review. Ongoing (see recommendation 4).
6	Surveillance program: • develop guidelines for the surveillance of water reserves • implement the surveillance program.	Water Corporation undertakes surveillance within the water reserve, and this should be continued. Ongoing (see recommendation 6).
7	Water monitoring – Water Corporation to review to include pesticides.	Water Corporation undertakes regular raw water analysis for different parameters including pesticides. The frequency is adjusted after a positive detection or as required e.g. after unseasonal early rains. Ongoing (see recommendation 6).
8.	Pine plantation management and operations (including pesticide use) should meet Department of Health and DWER standards for PDWSAs	FPC management and operations should align with the best management practices listed in Table 2. Inconsistent application of best management practices by FPC in the PDWSA has been noted from time to time. Ongoing (see recommendation 7).
9	Firebreaks – maintenance with chemical practices in PDWSAs should be reviewed	Herbicides are still being used by FPC in the PDWSA for firebreak maintenance. Minimal use of herbicides is encouraged in the PDWSA and FPC should follow best management practices as outlined in Table 2. Ongoing (see recommendation 7).
10	Table 1 implementation	Strategies listed in Table 1 have been implemented by stakeholders. DWER no longer prepares implementation strategies as a part of our review program.

No.	2006 recommendation	Comments
11	Review after five years	This report forms the first review of the 2006 plan. It will be reviewed again in seven years or in response to changes in water quality risks. New (see recommendation 8).

3.2 Consolidated recommendations

Based on the findings of this review, the following recommendations will now be applied to the Preston Beach Water Reserve. The stakeholders listed in brackets are responsible for, or have an interest in, implementing that recommendation.

1. After this report is published and subject to government support, the department will arrange for the constitution of the proposed Preston Beach Water Reserve under the *Country Areas Water Supply Act 1947* as per Figure A3. (Department of Water and Environmental Regulation and Water Corporation)
2. Incorporate the proposed Preston Beach Water Reserve boundary in the Shire of Harvey's and Shire of Waroona's local planning schemes and the Peel and Greater Bunbury Region schemes, in accordance with the WAPC's State planning policy 2.7: *Public drinking water source policy*. (Shire of Harvey; Shire of Waroona, Department of Planning, Lands and Heritage)
3. Refer development proposals within the Preston Beach Water Reserve that are inconsistent with the Department of Water and Environmental Regulation's WQPN 25: *Land use compatibility tables for public drinking water source areas* or recommendations in this review to the department's regional office for advice. (Department of Planning, Lands and Heritage, Shire of Harvey; Shire of Waroona, proponents of proposals)
4. Ensure incidents covered by Westplan–HAZMAT in the Preston Beach Water Reserve are addressed by ensuring that:
    - the Waroona and Harvey local emergency management committees are aware of the location and purpose of the Preston Beach Water Reserve
    - the locality plan for the Preston Beach 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 Preston Beach Water Reserve
    - personnel dealing with Westplan–HAZMAT incidents in the area have ready access to a locality map of the Preston Beach Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality. (Department of Water and Environmental Regulation and Water Corporation)

5. Maintain signs along the boundary of the Preston Beach Water Reserve including an emergency contact telephone number, in accordance with the Water Corporation's *S111 Source protection signage* (2013). Amend placement of signs to reflect the reduced boundary once constitution of the proposed Preston Beach Water Reserve boundary occurs. (Water Corporation)
6. Water Corporation should continue the current regime of water quality monitoring, maintenance of fencing, inspections and by-law enforcement. (Water Corporation)
7. Land use activities occurring in the PDWSA should follow best management practice as described in Table 2. (All stakeholders)
8. 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

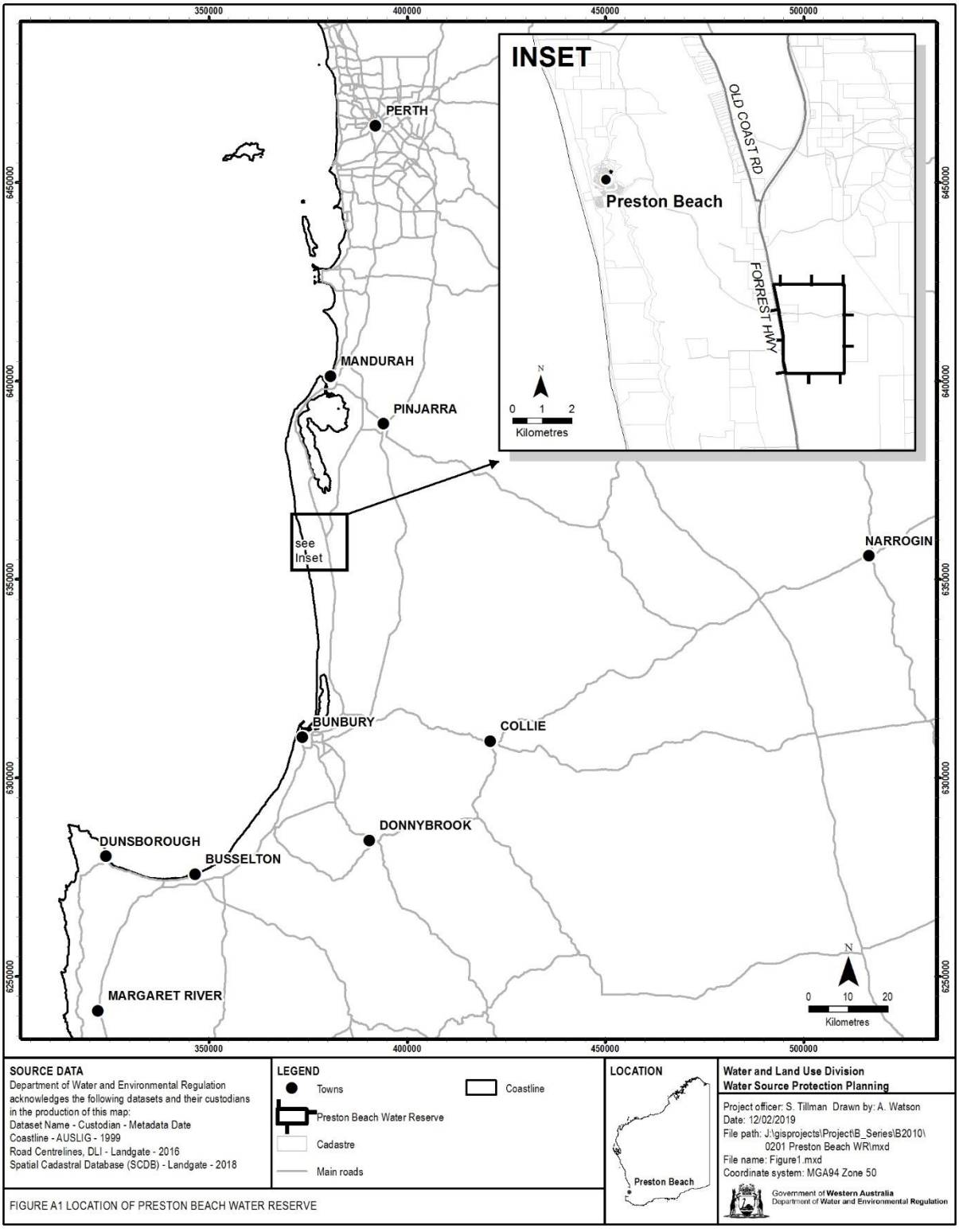

Figure A1 Preston Beach Water Reserve locality map

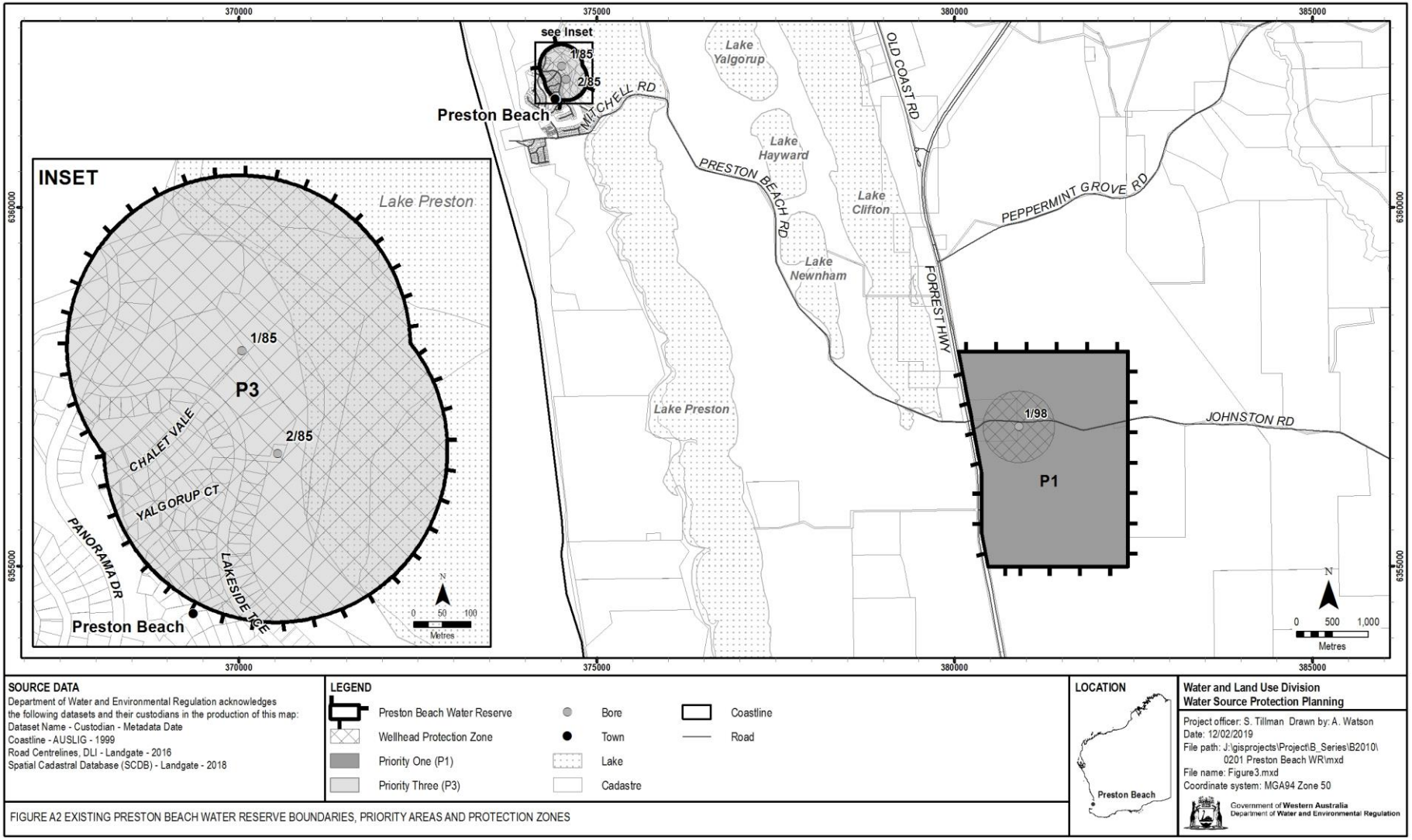

Figure A2 Existing Preston Beach Water Reserve boundaries, priority areas and protection zones

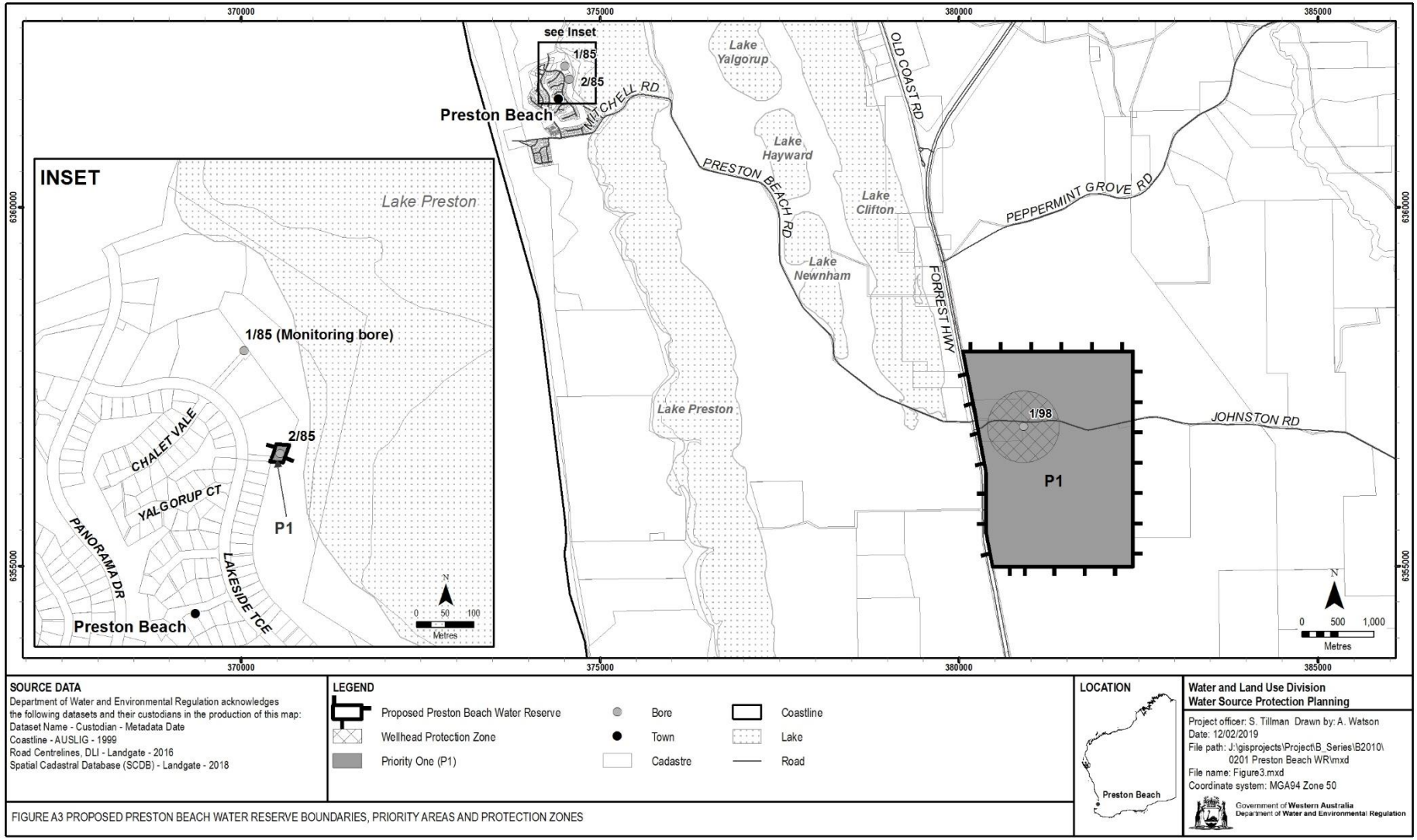

Figure A3 Proposed Preston Beach Water Reserve boundaries, priority areas and protection zones

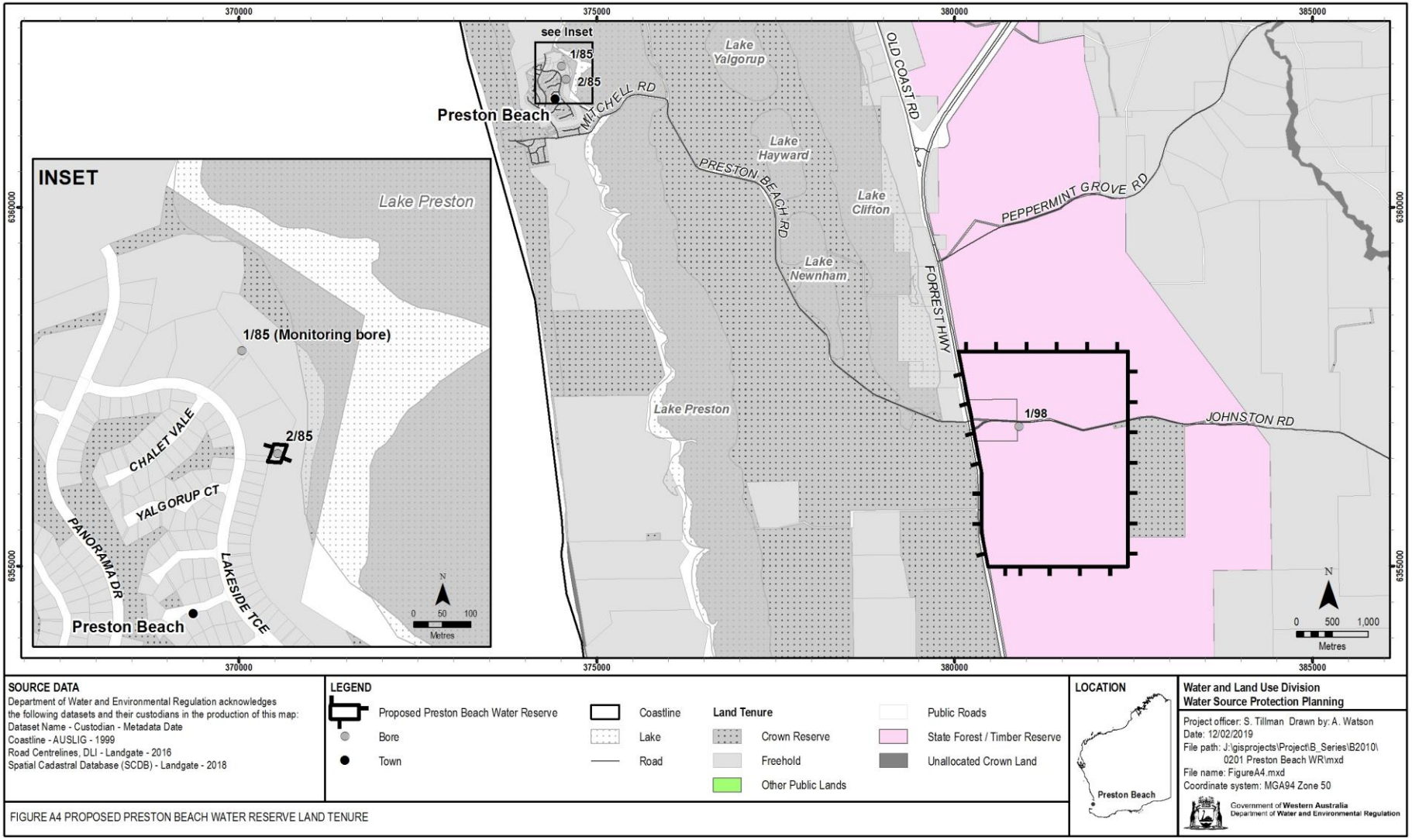

Figure A4 Proposed Preston Beach Water Reserve- land tenure

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 Preston Beach 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 Preston Beach. 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 November 2013 to October 2018.

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

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

Aesthetic characteristics

The aesthetic quality analyses for raw water from Preston Beach are summarised in the following table.

Aesthetic detections for Preston Beach [bold and italics for exceeded values]

Parameter	Units	ADWG aesthetic guideline value[1]	Preston Beach water treatment plant raw water inlet	
			Range	Mean
Chloride	mg/L	250	160–***420***	248.33
Colour (true)	TCU	15	0–6	3.2
Hardness as $CaCO_3$	mg/L	200	200–***360***	***291.11***
Iron unfiltered	mg/L	0.3	0.01–2.4	***0.31***
Manganese unfiltered	mg/L	0.1	0–0.055	0.023
Silicon as SiO_2	mg/L	80	15–18	16.89
Sodium	mg/L	180	78–***260***	141.22
Sulfate	mg/L	250	14–40	22.56
Total filterable solids by summation (TFSS)	mg/L	500	***738–1016***	***844.78***
Turbidity	NTU	5	0–***8.2***	0.95
pH measured in laboratory	no units	6.5–8.5	7.05–7.81	7.38

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

Health-related chemicals

Raw water from Preston Beach is analysed for chemicals that are potentially harmful to human health, including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that have been detected in the source are summarised in the following table.

Health-related detections for Preston Beach [bold and italics for exceeded values]

Parameter	Units	ADWG health guideline value[2]	Preston Beach water treatment plant raw water inlet	
			Range	Mean
Annual radiation dose	mSv	1	0–0.102	0.020
Fluoride laboratory measurement	mg/L	1.5	0–0.2	0.04
Manganese unfiltered	mg/L	0.5	0–0.055	0.023
Nitrate plus nitrate as N[3]	mg/L	11.29[4]	0–1.3	0.8
Radon-222	Bq/L	100	0.76–14.9	4.22
Sulfate	mg/L	500	14–40	22.56

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

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

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

Microbiological contaminants

Microbiological testing of raw-water samples from Preston Beach 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.

Appendix C – Photographs

Photographs taken by S.Tillman, Department of Water and Environmental Regulation, 2018

Figure C1 *Unconfined bore 1/98 (Johnston Road Wellfield) next to pine plantation (re-establishing after a major bushfire in 2017) and Johnston Road (follows larger tree line in background)*

Figure C2 *Confined bore 2/85 in the Town Wellfield*

Figure C3 *The entrance to bore 2/85 and Preston Beach's drinking water treatment plant is securely fenced and signed*

Figure C4 *Media filtration is the second level of treatment for raw water, after chlorination*

Appendix D – Typical contamination risks in groundwater sources

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

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

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

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

Microbiological risks

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

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

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

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (for example *Salmonella*, *E. 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 and 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 on to soil particles, making them more difficult to remove during disinfection and treatment processes.

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

Chemical risks

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

Pesticides include agricultural chemicals used to control weeds (herbicides) and pests (insecticides, rodenticides, nematicides [for worms] and miticides [for mites]). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills, incorrect use or leakage from storage areas. In these cases, the relevant authorities should be notified promptly and the spill cleaned up to prevent contamination of the drinking water source.

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

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

Other chemicals and heavy metals can be associated with land uses such as industry and landfill. These may enter groundwater and could be harmful to human health if consumed.

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

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

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

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

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

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

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

In Western Australia, the Department of Water and Environmental Regulation (the department) protects PDWSAs by implementing the ADWG, writing reports, policies and guidelines, and providing input into land use planning.

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

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

An important step in maximising the protection of water quality in PDWSAs is to define their boundaries, priority areas and protection zones to help guide land use planning and to identify where legislation applies. Our Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a) describes how we do this. It is available on the **Error! Hyperlink reference not valid.**, www.dwer.wa.gov.au.

There are three different priority areas. The objective of priority 1 (P1) areas is risk avoidance – ensuring there is no degradation of the water quality (for example over Crown land). The objective of priority 2 (P2) areas is risk minimisation – maintaining or improving water quality (for example over rural-zoned land). The objective of priority 3 (P3) areas is risk management – maintaining the water quality for as long as possible (for example, urban- or commercial-zoned land). Protection zones surround drinking water abstraction bores and surface water reservoirs so that the most vulnerable areas are protected from contamination.

Our Water quality protection note (WQPN) 25: *Land use compatibility tables for public drinking water source areas* (DoW 2016b) outlines appropriate development and activities within each of the priority areas (P1, P2 and P3).

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

If you would like more information about the ADWG and how we protect drinking water in Western Australia, visit www.dwer.wa.gov.au and read our Strategic policy: *Protecting public drinking water source areas in Western Australia* (DoW 2016a). You can also contact the department's Water Source Protection Planning section on 08 6364 7600 or email drinkingwater@dwer.wa.gov.au.

Appendix F – Understanding risks to drinking water quality

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

- SPP 2.2: Gnangara groundwater protection
- SPP 2.3: Jandakot groundwater protection
- SPP 2.7: Public drinking water source policy
- SPP 2.9: Water resources.

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

Risk-based assessments normally focus on the acceptability of risks after mitigation (residual risks). For drinking water sources, we use an assessment based on preventing risks, which considers both the maximum risk (before installing barriers) and the residual risk (after installing barriers). This means that in some cases, the maximum risks from land uses will still be considered unacceptable, even after mitigation (installing barriers) has reduced the risk. We need this more conservative approach to protect the health of consumers; those that are drinking the water.

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).

Table F1 Risk matrix: Level of risk (NHRMC & NRMMC 2011)

Likelihood	**Consequence**				
	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

Likelihood	**Consequence**				
	Insignificant	**Minor**	**Moderate**	**Major**	**Catastrophic**
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. This is 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
DoW	Department of Water (former)
DWER	Department of Water and Environmental Regulation
FPC	Forest Products Commission
HAZMAT	hazardous materials
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
P1, P2, P3	priority 1, priority 2, priority 3
PSC 88	Public sector circular number 88
PDWSA	public drinking water source area
WAPC	Western Australian Planning Commission
Westplan–HAZMAT	Western Australian plan for hazardous materials
WHPZ	wellhead protection zone
WQPN	water quality protection note

Units of measurement

Bq/L	becquerels per litre	A measure of radioactivity.
CFU	colony forming units	Used to estimate the number of viable bacteria in a sample.
EC	electrical conductivity	This estimates the volume of total dissolved solids (TDS) or the total volume of dissolved ions in a solution (water) corrected to 25ºC. Measurement units include millisiemens per metre and microsiemens per centimetre.
km	kilometres	A measure of distance, 1 km equals 1000 m.
mSv	millisieverts	Annual radiological dose, with a natural dose equivalent to 2 mSv/y.
m	metres	A measure of distance.
mg/L	milligrams per litre	A measure of concentration of a substance in a solution.
NTU	nephelometric turbidity units	A measure of turbidity in water.
pH		A logarithmic scale for expressing the acidity or alkalinity of a solution; a pH below 7 indicates an acidic solution and above 7 indicates an alkaline solution.
TCU	true colour units	A measure of degree of colour in water.
TDS	total dissolved solids	Consists of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometre filter membrane can also contribute to TDS. TDS comprises sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMMC 2011).

TFSS	total filterable solids by summation	A water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO_4 equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO_2 (silicon oxide). It is used as a more accurate measure than TDS. The higher the value, the more solids that are present and generally the saltier the taste.

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 year (kL/y).
Aquifer	A geological formation or group or formations able to receive, store and transmit significant quantities of water.
Australian drinking water guidelines	The *National water quality management strategy: Australian drinking water guidelines 6* (ADWG; NHMRC & NRMMC 2011) outlines acceptable criteria for the quality of drinking water in Australia (see *References*).
Bore	A narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
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.
Catchment area	An area constituted under the *Country Areas Water Supply Act 1947* or the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* for the purposes of protecting a drinking water supply.
Confined aquifer	An aquifer that is overlain by relatively impermeable rock or clay that limits movement of water into and out of the aquifer. Confined aquifers are usually deeper under the ground than unconfined aquifers. Groundwater in a confined aquifer is under pressure and will rise up inside a bore hole that is drilled into the aquifer.
Constitute	Define the boundaries of any catchment area or water reserve by Order in Council under the *Country Areas Water Supply Act 1947* or by proclamation under *the Metropolitan Water Supply, Sewerage and Drainage Act 1909*.

Contamination	A substance present at concentrations exceeding background levels that presents – or has the potential to present – a risk of harm to human health, the environment, water resources or any environmental value.
Drinking water source protection report	A report on water quality hazards and risk levels within a public drinking water source area; includes recommendations to avoid, minimise, or manage those risks for the protection of the water supply in the provision of safe drinking water supply.
Gazette	Publication within the Government Gazette of Western Australia of the Order in Council or proclamation defining the boundaries of any catchment area or water reserve.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2011).
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.
Maximum risk	This is the level of risk in the absence of any preventive measures (barriers) being installed in the system, or assuming that preventive measures have failed. Assessing maximum risk is useful for identifying high priority risks, determining where attention should be focused and preparing for emergencies (NHRMC & NRMMC 2011).
Microbe	A microorganism, usually one of vegetable nature, a germ. Also known as a bacterium, especially one causing illness.

Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Order in Council	Made under the Governor of Executive Council and published in the Government Gazette to constitute or abolish a catchment area or water reserve under section 9 of the *Country Areas Water Supply Act 1947.*
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Pollution	Water pollution occurs when waste products change the physical, chemical or biological properties of the water, adversely affecting water quality, the ecosystem and beneficial uses of the water.
Proclamation	Made under the Governor of Executive Council and published in the Government Gazette to constitute or abolish a water reserve, catchment area or underground water pollution control area under s.13 and 57A of the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909.*
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 2 (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.
Residual risk	This is the level of risk after considering preventive measures (barriers) that are applied in the drinking water supply system, such as fencing to keep cattle away from drinking water bores, or surveillance to identify people accessing protected areas. Residual risk provides an indication of how effective preventive strategies are, or the need for additional preventive measures (NHRMC & NRMMC 2011).
Runoff	Water that flows over the surface from a catchment area, including streams.
Semi-confined aquifer	A leaky aquifer, saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.
Sole supply	The only source of drinking water for a given town or community. These sources are important to protect as there are no other current options to supply drinking water for that location.
Stormwater	Rainwater that has run off 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.
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 constituted under the *Country Areas Water Supply Act 1947* or the *Metropolitan Water Supply, Sewerage, and Drainage Act 1909* for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater.
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.

References

Department of Health 2007, Public sector circular 88: *Use of herbicides in water catchment areas*, Government of Western Australia, Perth, available www.health.wa.gov.au.

——2013, *A guide to the use of pesticides in Western Australia – Providing information on legislation, policies and best practice,* Government of Western Australia, Perth, available www.health.wa.gov.au.

Department of Parks and Wildlife & Conservation Commission 2013, *Forest Management Plan 2014-2023*, Government of Western Australia, Perth.

Department of Water 2006, *Preston Beach drinking water source protection plan*, Government of Western Australia, Perth, available www.dwer.wa.gov.au.

——2015, *Peel Coastal groundwater allocation plan,* Water resource allocation and planning series, Report 66, Government of Western Australia, Perth, available www.dwer.wa.gov.au.

——*Water quality protection notes* (WQPNs), Government of Western Australia, Perth, available www.dwer.wa.gov.au.

- 2006, WQPN 44: *Roads near sensitive water sources*
- 2009, WQPN 36: *Protecting public drinking water source areas*
- 2012, WQPN 121 Plantations in public drinking water source areas
- 2016b, WQPN 25: *Land use compatibility tables for public drinking water source areas*
- 2017, WQIS 39: *Aboriginal customary activities in public drinking water source areas in the South West Native Title Settlement Area*

——2014, *WAter resources inventory 2014 – Water availability, quality and trends,* Government of Western Australia, Perth, available www.dwer.wa.gov.au.

——2016a, Strategic policy: *Protecting public drinking water source areas in Western Australia*, Government of Western Australia, Perth, available www.dwer.wa.gov.au.

Department of Water, Department of Regional Development, Department of Lands and Department of Agriculture and Food 2017, *Myalup Wellington project brochure*, Government of Western Australia, Perth available www.agric.wa.gov.au.

Forest Industries Federation of Western Australia's, 2014 *Code of Practice for Timber Plantations in Western Australia*, Government of Western Australia, Perth.

Geldreich, EE 1996, 'Pathogenic agents in freshwater resources', *Hydrological Processes*, vol. 10, pp. 315-333.

Government of Western Australia 1909, *Metropolitan Water Supply, Sewerage, and Drainage Act*, State Law Publisher, Perth, available www.slp.wa.gov.au.

——1914, *Rights in Water and Irrigation Act*, State Law Publisher, Perth, available www.slp.wa.gov.au.

——1947, *Country Areas Water Supply Act*, State Law Publisher, Perth, available www.slp.wa.gov.au.

——1972, *Aboriginal Heritage Act*, State Law Publisher, Perth, available www.slp.wa.gov.au.

National Health and Medical Research Council (NHMRC) & Natural Resource Management Ministerial Council (NRMMC) 2011, National water quality management strategy: *Australian drinking water guidelines*, Australian Government, Canberra, available www.nhmrc.gov.au.

National Uniform Drillers Licensing Committee 2012, *Minimum construction requirements for water bores in Australia,* 3rd edn, Australian Government National Water Commission, Braeside, Victoria, available www.dwer.wa.gov.au.

Robertson, JB & Edbery, SC 1997, Natural protection of spring and well drinking water against surface microbial contamination. I. Hydrogeological parameters, *Critical Reviews in Microbiology*, vol. 23(2), pp. 143–78.

Standing Committee on Environment and Public Affairs 2015, *Report 42: Implications for Western Australia of hydraulic fracturing for unconventional gas*, Legislative Council, Perth, Western Australia, available www.parliament.wa.gov.au.

State Emergency Management Committee 2009, State emergency management policy 2.4: *District emergency management arrangements,* as amended 12 April 2010, Government of Western Australia, Perth, available www.semc.wa.gov.au.

Water Corporation 2009, *SG097 Source protection operations manual*, unpublished corporate manual, Water Corporation, Leederville.

——2013, *S111 Source protection signage,* unpublished corporate standard, Water Corporation, Leederville.

Western Australian Planning Commission 2003, State planning policy 2.7: *Public drinking water source policy*, Government of Western Australia, Perth, available www.planning.wa.gov.au.

Further reading

Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) & Australian and New Zealand Environment and Conservation Council (ANZECC) 2000, *Rural land uses and water quality – A community resource document*, ARMCANZ & ANZECC, Canberra, available http://www.environment.gov.au/.

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

Department of Water 2011, *Living and working in public drinking water source areas,* Government of Western Australia, Perth, available www.dwer.wa.gov.au.

——*Water quality protection notes* (WQPNs), Government of Western Australia, Perth, available www.dwer.wa.gov.au.

- 2009, WQPN 36: *Protecting public drinking water source areas*
- 2016b, WQPN 25: *Land use compatibility tables for public drinking water source areas*

Hrudey, SE & Hrudey, EJ 2004, *Safe drinking water – Lessons from recent outbreaks in affluent nations,* IWA Publishing, London.

National Health and Medical Research Council (NHMRC) & Natural Resource Management Ministerial Council (NRMMC) 2004, W*ater made clear – A consumer guide to accompany the Australian drinking water guidelines,* Australian Government, Canberra, available www.nhmrc.gov.au.

Sharp Hon C (MLC and Chairman of the Standing Committee) 2000, *Report of the Standing Committee on Ecologically Sustainable Development in relation to the quality of Perth's water supply*, Legislative Council, Perth, Western Australia, available www.parliament.wa.gov.au.

Standing Committee on Public Administration 2010, *Report 11: Recreation activities within public drinking water source areas,* Legislative Council, Perth, available www.parliament.wa.gov.au.

Western Australian Planning Commission 2006, State planning policy 2.9: *Water resources*, Government of Western Australia, Perth, available www.planning.wa.gov.au.

World Health Organization 2011, *Guidelines for drinking-water quality*, 4th edn, World Health Organization, Geneva, www.who.int/.

Department of Water and Environmental Regulation
Prime House
8 Davidson Terrace Joondalup
Western Australia 6027

Locked Bag 10, Joondalup DC WA 6919

Phone: 08 6364 7000
Fax: 08 6364 7001
National Relay Service 13 36 77
dwer.wa.gov.au