



Government of **Western Australia**  
Department of **Water**

*Looking after all our water needs*



**Yerecoin Water Reserve**  
**drinking water source protection plan**  
**Yerecoin and Piawaning town water supply**



# Yerecoin Water Reserve drinking water source protection plan

Yerecoin and Piawaning town water supply

*Looking after all our water needs*

Department of Water

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All maps in this publication were produced with the intent that they be used for the Yerecoin Water Reserve at the scale shown on the maps.

While the Department of Water has made all reasonable efforts to ensure the accuracy of data in this report, no responsibility is accepted for any inaccuracies, and persons relying on them do so at their own risk.

For more information about this report, contact the Department of Water, Water Source Protection Branch on +61 8 6364 7600 or send your enquiry to <drinkingwater@water.wa.gov.au>.

*Subject of cover photograph:* view of the Yerecoin well field

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## Preface

The Department of Water has prepared this drinking water source protection plan to assess risks to water quality within the recommended Yerecoin Water Reserve and to propose management strategies to avoid, minimise or manage those risks. The department is committed to protecting drinking water sources to meet public health requirements and ensure the availability of a reliable, safe, good quality drinking water supply to consumers.

The *National water quality management strategy: Australian drinking water guidelines* (NHMRC & NRMCC 2004a) recommends a risk-based, multiple-barrier approach to protect public drinking water sources. Catchment protection is the first barrier against contamination, with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. This plan details the location and boundary of the drinking water source which provides potable water to Yerecoin and Piawaning. It discusses existing and future uses of the water source, describes the water supply system, identifies risks and recommends management approaches to address these risks and protect the water source.

This plan has been prepared to help guide state and local government land-use planning and development decisions, as well as decisions by landowners. It should be recognised in the Shire of Victoria Plains local planning scheme, consistent with the Western Australian Planning Commission's *Statement of planning policy No. 2.7: Public drinking water source policy* (2003).

The stages involved in preparing a drinking water source protection plan are:

Stages in development of a plan		Comment
1	Prepare drinking water source protection assessment document. 1999	An assessment was not required because a 1999 <i>Yerecoin Water Reserve water source protection plan</i> had already been prepared.
2	Conduct stakeholder consultation. January 2009	Advice was sought from key stakeholders using the 1999 plan as a tool for information and discussion.
3	Prepare draft drinking water source protection plan. February–March 2009	Draft protection plan was developed taking into account input from stakeholders and any additional advice.
4	Release draft drinking water source protection plan. May 2009	Draft protection plan is released for a four-week public consultation period.
5	<b>Publish approved drinking water source protection plan.</b>  <b>June 2009</b>	<b>Final protection plan is published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of public drinking water source area can now occur.</b>



## Summary

In 1999, the Department of Water (formerly the Water and Rivers Commission) prepared the *Yerecoin Water Reserve water source protection plan*. This 2009 *Yerecoin Water Reserve drinking water source protection plan* reviews the recommendations and water quality protection strategies proposed in the 1999 plan. The key change is a redefined boundary for the water reserve to more accurately reflect new hydrogeological data.

The towns of Yerecoin and Piawaning are located in the northern agricultural region approximately 160 km north-north-east of Perth within the Shire of Victoria Plains. The sole public drinking water supply for both towns is obtained from a well field 7 km east of Yerecoin.

The well field is located on a shallow, unconfined aquifer, with water abstracted from between 2 to 6.5 m below ground level. The shallow, unconfined nature of the aquifer means that water from this source is vulnerable to contamination. Pesticide detections have occurred in the past, confirming this vulnerability.

Potential risks to drinking water quality in the recharge area include pesticides and fertilisers from cropping activities and pathogens from animal excreta in the water reserve. The ongoing assistance and goodwill of the land owner in modifying his farming practices to protect water quality is acknowledged and appreciated by the Department of Water.

The well field and water supply infrastructure in the water reserve are located on crown land managed by the Water Corporation. The remainder of the land in the recommended water reserve is in private ownership; animal grazing and broad hectare cropping are the dominant land uses. A 90 ha area of privately owned freehold land (a portion of Lot M1965) and the crown land are managed for Priority 1 (P1) source protection. The management objective for P1 land is to avoid unnecessary risks to achieve a high water quality. Farming activities in the recommended water reserve are able to continue consistent with the zoning of the land. Best management practice is recommended to achieve this outcome.

The remaining privately owned freehold land in the recommended water reserve (on Lot M1965) is managed for Priority 2 (P2) source protection. The management objective for P2 land is to ensure there is no increased risk of pollution to the water source, through minimising potentially contaminating land uses. The existing agricultural land uses in the P2 area are consistent with the zoning of the land.

A circular well head protection zone with a radius of 500 m within the P1 area is defined around each of the 32 spears in the recommended water reserve.

Water quality protection strategies within the recommended Yerecoin Water Reserve include:

- proclaiming the Yerecoin Water Reserve under the *Country Areas Water Supply Act 1947*;
- incorporating the priority areas and protection zones defined in this plan in the Shire of Victoria Plains local planning scheme as a special control area;
- implementing the protection strategies detailed in Appendix B - *Land use, potential water quality risks and recommended protection strategies*; and
- the Department of Water and Water Corporation being active in ongoing discussions with the land owner, including the provision of a regular report on water quality monitoring data and actions proposed to protect this water reserve.

# 1 Drinking water source overview

## 1.1 Existing water supply system

The town water supply for Yerecoin and Piawaning comes from a well field operated by the Water Corporation located about 7 km east of Yerecoin (Figure 1 and 2).

In 2006–07, the water supply system was significantly upgraded to improve the water treatment system and meet peak demand during summer. An additional 16 spears were drilled, a larger extraction pump installed and the water treatment facility was automated (Appendix D, Figure D1). The Yerecoin water supply system consists of 32 interconnected spears (Appendix D, Figure D2) and two collector wells. The spears abstract water between 2 to 6 m below ground level from a shallow, unconfined aquifer. This water drains to two collector wells between 3 to 6.5 m below ground level.

Total annual abstraction varied between 19 664 kilolitres (kL) and 27 447 kL for the period 1999–2006. At least 15 per cent of the water abstracted is used for cleaning and maintenance of the treatment and distribution systems.

## 1.2 Water treatment

The water treatment system was upgraded in 2006–07 and is now automated. Water drawn from the spears is pumped to an aerator and dosed with hypochlorite to oxidise the iron in solution and correct the pH. The oxidised iron is allowed to settle out of solution in a collection tank. The water is disinfected via chlorination prior to filtration through a sand pressure filter to reduce turbidity. The water is then piped into an onsite water tank before being piped to the towns. An elevated service tank connected to the town reticulation systems operates as a buffer tank to store excess water and supply the town reticulation systems when required.

It should be recognised that although treatment and disinfection are essential barriers against contamination, catchment management is the first step in protecting water quality and ensuring a reliable, safe, good quality drinking water supply. This approach is endorsed by the Australian drinking water guidelines (ADWG) and reflects a risk-based, catchment-to-consumer, multiple-barrier approach for providing safe drinking water to consumers. The combination of catchment protection and water treatment delivers a more reliably safe drinking water to consumers than any barrier could achieve individually.

## 1.3 Water reserve details

### 1.3.1 Physiography

The recommended Yerecoin Water Reserve lies within the Darling Plateau, slightly west of the divide running almost north-south between the drainage basins of the Mortlock and Moore rivers. The crests of the divide represent an old surface continuous with that of the sand plain country to the east. The residual sand from these high level plains drapes down the drainage slopes and may contain seeps during winter. The area is gently undulating (Appendix D, Figure D3).

Most of the area was cleared for farming; however, native vegetation has been retained along some drainage channels and where massive laterite or basement rock outcrop. There is a small amount of remnant native vegetation within the recommended water reserve.

### 1.3.2 Climate

The Yerecoin area has a Mediterranean-type climate with hot, dry summers and cool, wet winters. The long-term average annual rainfall is approximately 390 mm. Most of the rainfall, approximately 300 mm, occurs between May and October. The remainder occurs in the summer months and is normally associated with local thunderstorms or the southward movements of the remnants of tropical cyclones.

### 1.3.3 Hydrogeology

Yerecoin is located east of the Darling Fault. Crystalline rocks of the Yilgarn Craton underlie the area. These consist largely of granite, with gneiss, schist and quartzite that are intruded by various mafic and felsic dykes and quartz veins. The basement is overlain by a weathered profile consisting of kaolinite clay, sandy clay and sand. The profile is covered by laterite on the hills, and locally by residual sand on the slopes.

In the Yerecoin area, the residual sand is very thin and forms unconfined aquifers, possibly occupying depressions within the weathered profile. Recharge to the highly permeable aquifers is from direct rainfall infiltration which can be as much as 10 to 30 per cent of the annual rainfall.

Many of these aquifers are small and of limited extent; and are frequently exploited by farm wells, bores and excavated soaks. The Yerecoin well field abstracts water from a larger unconfined aquifer, between 2 to 6.5 m below ground level. The aquifer is vulnerable to surface contamination because the groundwater is at a shallow depth, the residual sand is highly permeable and the aquifer is unconfined.

## 1.4 Future water supply requirements

The Water Corporation considers the source adequate to meet current and short-term future water demands. There has been only slight growth in water demand over the past seven years in Yerecoin and Piawaning. There are limited opportunities for growth in water demand in the short term due to the low availability of land for purchase and no formal plans for subdivision in the area. The Water Corporation predicts that the current licensed allocation will not be exceeded for some time after 2010–11. If significant subdivision or development of land occurs in the area, an increase in the licensed allocation for the Yerecoin well field may be sought.

Four potential future groundwater sources have been identified near the existing well field. These may augment water supplies in the future.

## 1.5 Existing drinking water source protection

The Yerecoin Water Reserve has not yet been proclaimed under the *Country Areas Water Supply Act 1947*.

In 1999, the Department of Water (formerly the Water and Rivers Commission) prepared the *Yerecoin Water Reserve water source protection plan*. This document outlined risks to water quality from land uses and activities in the recommended Yerecoin Water Reserve, and made recommendations for the protection of the drinking water source. This Yerecoin Water Reserve drinking water source protection plan builds upon and replaces the 1999 plan.

Current measures undertaken by the Water Corporation for water source protection include fencing around the well field and compound, water quality monitoring, water treatment, water reserve surveillance and bore maintenance.

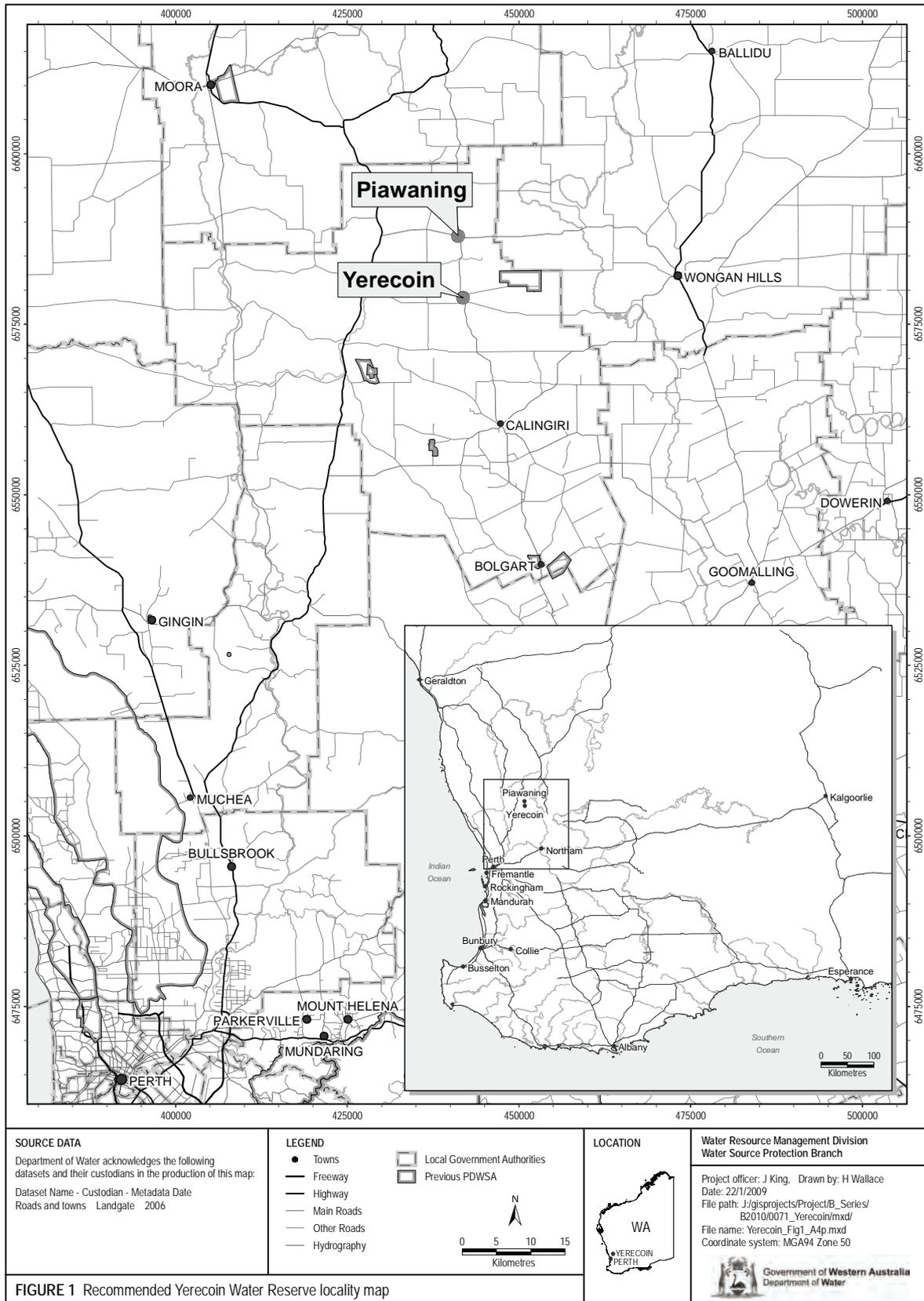
The Water Corporation and the Department of Water have worked with the landowner in the water reserve area to protect drinking water quality. Following the detection of pesticides in the water source in 2001, land near the bores and spears was fenced off and pesticide applications ceased within the fenced area. Pesticides have not subsequently been detected in groundwater monitoring results.

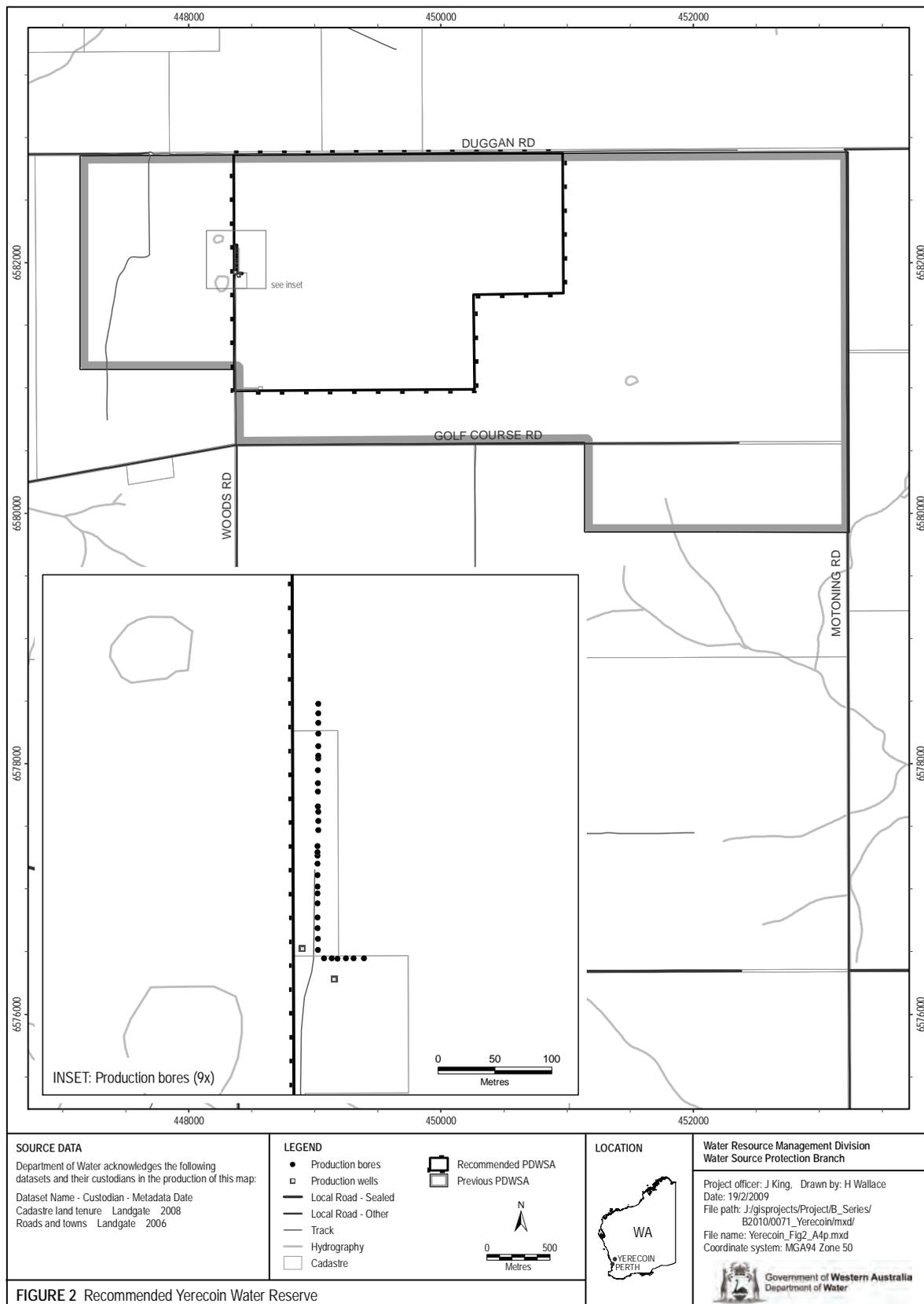
## 1.6 Department of Water management

### 1.6.1 Current allocation licence

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914*. Under this Act, the right to use and control surface and groundwater is vested with the Crown. This Act requires licensing of groundwater abstraction (pumping water from a bore, spring or soak) within proclaimed groundwater areas.

The Yerecoin Groundwater Area was proclaimed in 1997 under the *Rights in Water and Irrigation Act 1914*. The Water Corporation is licensed by the Department of Water to draw up to 30 000 kL per annum for public water supply purposes.





## 2 Water quality monitoring and contamination risks

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

The Water Corporation regularly monitors the quality of raw water from the Yerecoin Water Reserve for microbiological, health-related and aesthetic (non-health-related) characteristics. An assessment of the drinking water quality supplied to consumers is also made against ADWG. This assessment is made by an intergovernmental committee called the Advisory Committee for the Purity of Water that is chaired by the Department of Health.

A water quality summary for the Yerecoin Water Reserve from November 2003 to November 2008 is presented in Appendix A. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at <[www.watercorporation.com.au](http://www.watercorporation.com.au)> Water > Water quality > Latest report > Drinking water quality annual report>.

Common contamination risks to public drinking water source areas (PDWSA) are described below.

### 2.1 Microbiological contaminants

Pathogens are types of micro-organisms that are capable of causing diseases. These include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are mostly found in the excreta of humans and domestic animals (such as dogs and cattle).

There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (for example, salmonella, *Escherichia coli* and cholera), protozoa (for example, *Cryptosporidium*, *Giardia*) and viruses. *Escherichia coli* counts may be used as an indication of faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors such as the existence of pathogen carriers (for example, 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 effect on people consuming drinking water that is contaminated with pathogens varies considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes even death. In 2000 in Walkerton, Canada, seven people died due to contamination of the town's groundwater source and supply by a pathogenic strain of *Escherichia coli* and campylobacter (NHMRC & NRMMC 2004b).

Where possible, avoiding the introduction of pathogens into a water source is the most effective way to protect public health.

Pathogens have been detected very infrequently in the raw water of the Yerecoin well field.

## 2.2 Health-related characteristics

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills and/or incorrect use, overuse or leakage from storage areas. In such cases, prompt notification of relevant authorities and clean up of the spill are required.

Pesticides have been previously detected in the Yerecoin well field raw water and town reticulation system. In 2001, detections of atrazine and simazine in the town reticulation system resulted in changes to farming practices in the water reserve. In a separate incident in 2006, dieldrin was detected in the town reticulation system. The detection was not a notifiable event for the Department of Health as the concentration was below the ADWG health guideline value. Water Corporation conducted a thorough investigation into the source of the contamination. Analyses of soil surrounding the base of a power pole within the water reserve detected high levels of dieldrin. Western Power removed all contaminated material from the site and replaced the power pole. Dieldrin has not subsequently been detected in the raw water or town reticulation.

Drinking water supplies can also be contaminated by nutrients such as nitrogen from fertiliser application, faulty septic systems, leach drains and domestic animal faecal matter that washes through or over soil and into a water source. Nitrate and nitrite can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMCC 2004a).

Nitrate concentrations have steadily increased in the Yerecoin well field over the past 20 years, but have remained below ADWG levels.

Hydrocarbons (for example, fuels, oils) are also potentially toxic to humans and potentially harmful chemical by-products may be formed when they are combined with chlorine in the water treatment processes. Hydrocarbons can occur in water supplies as a result of spills and leakage from vehicles or fuel storage tanks. Hydrocarbons have not been detected in the Yerecoin well field raw water or town reticulation system.

## 2.3 Aesthetic characteristics

Impurities in drinking water can affect the aesthetic qualities of water such as its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to

human health; for example, water that is cloudy and has a distinctive odour or has a strong taste is not necessarily harmful to health, while clear, pleasant-tasting water may still contain harmful micro-organisms (NHMRC & NRMCC 2004b).

Iron and dissolved organic matter can affect the colour and appearance of water and salinity can affect the taste. Some properties such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes.

The ADWG sets aesthetic water quality criteria to meet the aesthetic requirements of consumers and to protect water supply infrastructure (such as pipes).

Chemical analyses of the raw water in the Yerecoin well field have shown excessive concentrations of dissolved iron, increased levels of turbidity and low pH. The drinking water treatment plant successfully treats the water to improve water quality to within ADWG levels.

## 2.4 Groundwater bores

The recommended Yerecoin Water Reserve is located within the Yerecoin Groundwater Area which is proclaimed under the *Rights in Water and Irrigation Act 1914*. Under the provisions of Sections 26D and 5C of the *Rights in Water and Irrigation Act 1914*, a licence is required to construct a bore or extract water within a proclaimed groundwater area (unless exempt under the Rights in Water and Irrigation Exemption and Repeal (Section 26C) Order 2001).

Drinking water bores are operated in the recommended Yerecoin Water Reserve by the Water Corporation. If bores for other purposes (irrigation, private household use) are drilled near to 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 the aquifer.

It is therefore important to ensure that all bores in the recommended Yerecoin Water Reserve are appropriately located and constructed to prevent contamination impacts on the public drinking water source. Where necessary, this will be assessed through the Department of Water's water licensing process 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 Minimum Bore Specifications Committee 2003).

## 3 Land-use assessment

### 3.1 Existing land uses and activities

The Yerecoin well field is located on crown land vested in the Department for Planning and Infrastructure and managed by the Water Corporation. The remainder of the water reserve is located on freehold land zoned 'Rural' under the Shire of Victoria Plains local planning scheme. Current land uses, activities and tenure are presented in Figure 3. This information has been summarised in Table 1 with recommended management priorities for the identified hazards. Appendix B collates the data in this section with Table 1 and recommends protection strategies for consideration by key stakeholders.

Appendix C reviews the status of the recommendations made in the 1999 *Yerecoin Water Reserve water source protection plan*.

#### 3.1.1 Rural land

The dominant land use in the recommended Yerecoin Water Reserve is broad hectare cropping (Appendix D, Figure D3) and grazing. The shallow, permeable aquifer in the water reserve is highly vulnerable to contamination from pesticides, nutrients and pathogens leaching through the soil.

The application of pesticides within the water reserve is currently managed to reduce the risk of groundwater contamination. Pesticides have not been applied to the land immediately up-gradient of the well field since 2001, and only non-persistent pesticides have been used in the remainder of the water reserve.

Sheep grazing occurs in the water reserve, previously within the wellhead protection zone (WHPZ). Faecal contamination of groundwater has been detected infrequently during monitoring by the Water Corporation (Appendix A).

There are approximately 90 ha of sandy land immediately up-gradient of the well field. The town water supply is particularly vulnerable to contamination from this area due to the highly permeable sands and proximity to the well field. The Department of Water has approached the landowner with a view to purchase this land for the protection of the town water supply.

#### 3.1.2 Crown land

The Water Corporation manages the well field, drinking water treatment plant, storage tanks and access tracks on crown land within the water reserve. The drinking water treatment plant is situated less than 30 m down-gradient from the southern end of the well field (Appendix D, Figure D1).

Potential risks to the water source include chlorine usage and storage in the water treatment facility, leaching of contaminants from the filter backwash sump adjacent to the treatment plant and the use of pesticides in the well field.

### 3.2 Proposed land uses and activities

There are no proposed changes to land zoning, land uses or activities in the Yerecoin Water Reserve in the Shire of Victoria Plains *Town Planning Scheme No. 4* or the draft *Town Planning Scheme No. 5*.

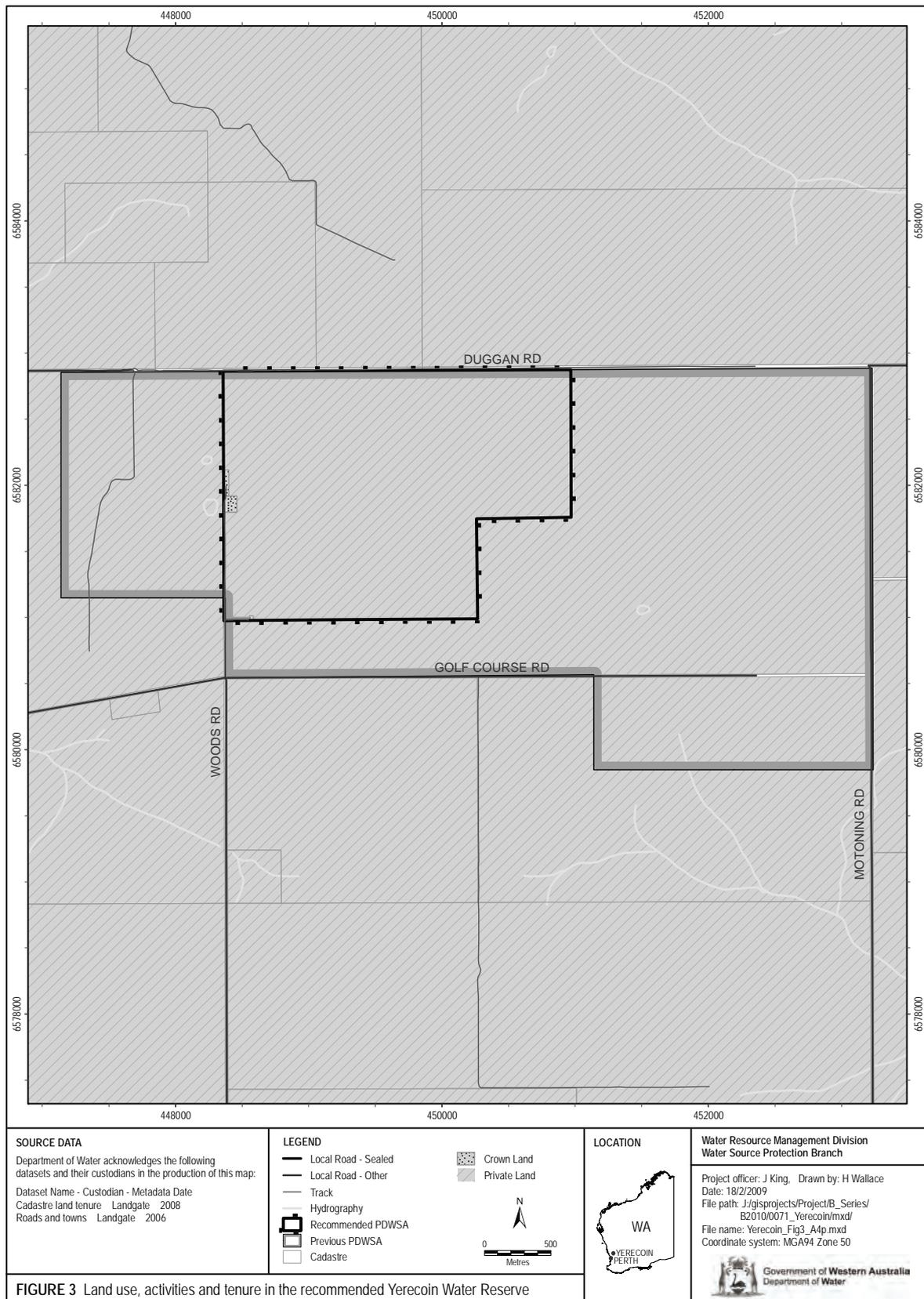


Table 1 Existing land uses and potential water quality risks

Land use/activity	Hazard	Management priority	Compatibility of land use/activity
Broad hectare cropping	Hydrocarbons and chemicals from spills or leaks	Low	Incompatible in Priority 1 (P1) areas
	Nutrients from fertilisers	Medium	Compatible with conditions in Priority 2 (P2) areas
	Pesticides	High	
Livestock grazing	Nutrients from animal excreta	Medium	Compatible with conditions in P2 areas
	Pathogens from animal excreta	Medium	
Drinking water treatment plant	Chlorine spills or leaks	Low	Compatible with conditions in P1 areas
	Contaminants from the filter backwash sump	Low	
	Pesticide application	Medium	

See Appendix B for an expansion of this table and proposed management strategies.

## 4 Water reserve protection strategy

### 4.1 Protection objectives

The objective of this water source protection plan is to protect the groundwater resource from contamination and ensure the availability of reliable, safe drinking water to consumers in Yerecoin and Piawaning. The recommended Yerecoin Water Reserve is the sole drinking water source for both towns, and there are limited alternative water sources. This plan recommends strategies to avoid, minimise and/or manage the risk of future groundwater contamination from nearby land uses and activities.

### 4.2 Proclaimed area

The Yerecoin Water Reserve has not yet been proclaimed. The water reserve boundary recommended in the 1999 *Yerecoin Water Reserve water source protection plan* is shown in Figure 2 and the amended water reserve boundary is shown in Figure 4.

The recommended boundary of the Yerecoin Water Reserve (Figure 4) is the result of an updated hydrogeological assessment of the recharge area for the aquifer. The updated water reserve is recommended to be proclaimed under the *Country Areas Water Supply Act 1947*.

### 4.3 Priority areas

The protection of PDWSAs relies on a combination of statutory and non-statutory measures for water resource management and land-use planning. The Department of Water's policy for the protection of PDWSAs includes three risk-based priority areas:

- Priority 1 (P1) areas have the fundamental water quality objective of risk avoidance.
- Priority 2 (P2) areas have the fundamental water quality objective of risk minimisation.
- Priority 3 (P3) areas have the fundamental water quality objective of risk management.

The determination of priority areas is based on the strategic importance of the land or water source, the local planning scheme zoning, the form of land tenure and existing approved land uses or activities. For further details, please refer to the Department of Water's *Water quality protection note: Land use compatibility in public drinking water source areas*.

The priority areas for the Yerecoin Water Reserve have been determined in accordance with current Department of Water policy. These areas are described

below and in Figure 4. The department's water quality protection note: *Land use compatibility in 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 water quality protection note: *Protecting public drinking water source areas*.

All crown land in the water reserve and a 90 ha area of private land within the Yerecoin Water Reserve is classified P1 for the following reasons:

- Water from this source constitutes a strategic supply to Yerecoin and Piawaning so it should be afforded a high level of protection.
- Existing land uses on the crown land are considered compatible with P1 source protection objectives.
- A 90 ha parcel of private land immediately up-gradient of the well field is of strategic importance because it is vulnerable to contamination. The Department of Water will approach the landowner about purchasing or leasing this land to maximise the protection of water quality.

The remainder of the private, rural zoned land within the Yerecoin Water Reserve is classified P2 for the following reasons:

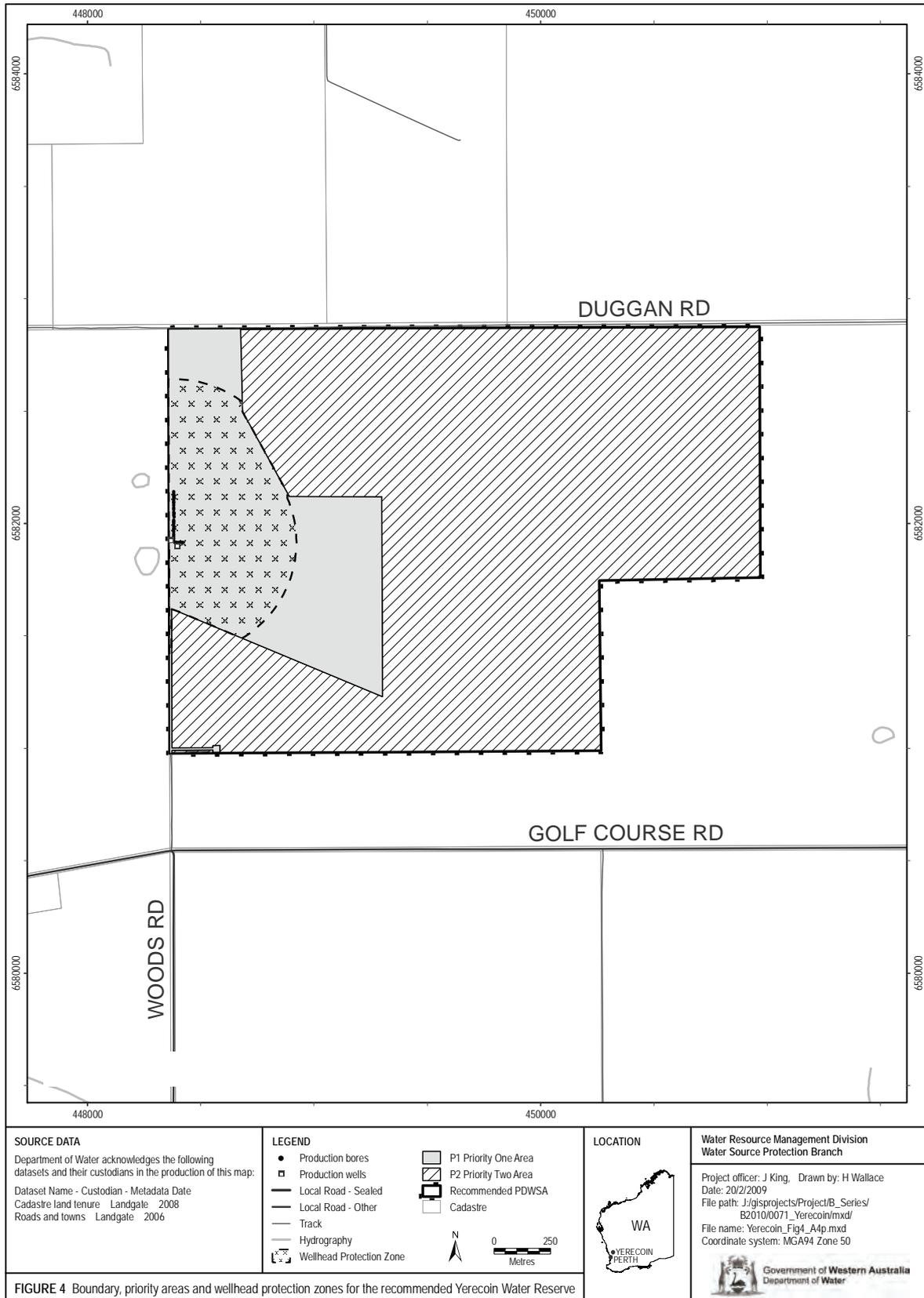
- The land is privately owned and zoned rural within the Shire of Victoria Plains local planning scheme. P2 ensures that compatible development rights are provided for.
- Existing approved land-use activities within this area are consistent with P2 source protection objectives, and should be managed through the implementation of best management practices.
- The land forms part of the recharge area for the aquifer.

## 4.4 Protection zones

Protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities (production bores). Specific conditions may apply within these zones such as restrictions on the storage and use of certain chemicals.

Wellhead protection zones (WHPZ) are generally circular (unless information is available to determine a different shape or size) with a 500 m radius around each production bore in a P1 area and a 300 m radius around each production bore in P2 and P3 areas. WHPZ do not extend outside the boundary of the water reserve.

A circular WHPZ with a radius of 500 m is defined around each of the 32 spears in the well field, as shown in Figure 4. The protection zones will not extend outside the recommended water reserve. Land-use activities within the WHPZ need to be managed to avoid contamination risks in the immediate vicinity of the well field.



## 4.5 Land-use planning

The *State planning strategy* (Western Australian Planning Commission 1997) recognises that appropriate protection mechanisms in statutory land-use planning processes are necessary to secure the long-term protection of drinking water sources. As outlined in *Statement of planning policy No. 2.7: Public drinking water source policy* (Western Australian Planning Commission 2003) it is appropriate that the Yerecoin Water Reserve, priority areas and wellhead protection zones be recognised in the Shire of Victoria Plains local planning scheme as a special control area.

Any development proposals within the Yerecoin Water Reserve that are inconsistent with advice in the Department of Water's water quality protection note: *Land use compatibility in public drinking water source areas*, or recommendations in this plan, should be referred to the Department of Water.

The department's protection strategy for PDWSAs provides for lawfully established and operated developments to continue despite their location or facilities posing a level of risk to water quality which would not be accepted for new developments. The department may negotiate with landowners/operators on measures to improve these facilities and reduce water quality contamination risks through best management practice.

In strategically significant areas, the department has developed a policy that allows it to approach landowners with a view to purchase land or negotiate water contamination risk reduction measures.

## 4.6 Best management practices

There are opportunities to significantly reduce water contamination risks by carefully considering design and management practices. The adoption of best management practices for land uses will continue to be encouraged to help protect drinking water sources. On freehold land, the Department of Water aims to work with landowners by providing management advice to achieve sound management practices for the protection of drinking water quality.

Guidelines are available for many land uses available in the form of industry codes of practice, environmental guidelines and water quality protection notes. These have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include *Agriculture – dryland crops near sensitive water resources* and *Pesticide use in public drinking water source areas* (Water and Rivers Commission 2000) which are listed in the References section. These guidelines help managers reduce the water quality impacts of their operations and are the recommended practice to ensure the protection of water quality.

Education and creating awareness (for example, signage and information) are also key mechanisms for protecting the quality of water, especially for people visiting the area who are unfamiliar with the Yerecoin Water Reserve. A brochure will be produced once this plan is endorsed, describing the Yerecoin Water Reserve, its location and the main threats to water quality. This brochure will be available to the community and will inform people in simple terms of the drinking water source and the need to protect it.

## 4.7 Surveillance and by-law enforcement

The quality of public drinking water sources within country areas of the state is protected under the *Country Areas Water Supply Act 1947*. Declaration of these areas allows existing by-laws to be applied to protect water quality.

The Department of Water considers that by-law enforcement, through surveillance of land-use activities in PDWSAs, is an important mechanism to protect water quality.

Signs are erected on the boundaries of PDWSAs to educate and advise the public of activities that are prohibited or regulated. The plan recommends that Water Corporation continue to undertake surveillance and by-law enforcement, and that delegation of the water reserve is progressed.

## 4.8 Emergency response

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Victoria Plains Local Emergency Management Committee (LEMC), through the Wheatbelt Emergency Management District, should be familiar with the location and purpose of the Yerecoin Water Reserve. A locality plan should be provided to the fire and emergency services authority of Western Australia (FESA) 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 Yerecoin Water Reserve.

Personnel who deal with WESTPLAN-HAZMAT (Western Australian plan for hazardous materials) incidents within the area should have access to a map of the Yerecoin Water Reserve. These personnel should have an adequate understanding of the potential impacts of spills on this water resource.

## 4.9 Implementation of this plan

Table 1 identifies the potential water quality risks associated with existing land uses in the Yerecoin Water Reserve. Further information and recommended protection strategies to deal with these risks are outlined in Appendix B.

Following publication of the final *Yerecoin Water Reserve drinking water source protection plan*, an implementation strategy will be drawn up based on the

recommendations in Appendix B. It will provide an indicative time frame for the recommended protection strategies and identify stakeholders who could be involved in implementation actions.

Appendix C details the current status of the 1999 *Yerecoin Water Reserve water source protection plan* recommendations and responsibilities. Recommendations that have not been completed and are still relevant have been transferred into Appendix B.

## 5 Recommendations

The following recommendations apply to the entire Yerecoin Water Reserve. Stakeholders with an expected interest in the implementation of the relevant recommendation are defined in brackets.

- 1 The boundary of the Yerecoin Water Reserve should be proclaimed under the *Country Areas Water Supply Act 1947* (Department of Water).
- 2 The Shire of Victoria Plains local planning scheme should incorporate this plan and reflect the identified Yerecoin Water Reserve boundary, Priority 1 and Priority 2 areas and the wellhead protection zones in accordance with *Statement of planning policy No. 2.7: Public drinking water source policy* (Shire of Victoria Plains).
- 3 An implementation plan should be prepared (including the recommended protection strategies detailed in Appendix B), showing key stakeholders and planned timeframes (Department of Water, applicable stakeholders).
- 4 Land-use and development proposals within the Yerecoin Water Reserve that are inconsistent with the Department of Water's water quality protection note: *Land use compatibility in public drinking water source areas* or recommendations in this drinking water source protection plan should be referred to the Department of Water for advice (Department for Planning and Infrastructure, Shire of Victoria Plains, proponents of proposals).
- 5 Incidents covered by WESTPLAN–HAZMAT in the Yerecoin Water Reserve should be addressed by ensuring that:
  - the Yerecoin LEMC is aware of the location and purpose of the Yerecoin Water Reserve
  - the locality plan for the Yerecoin Water Reserve is provided to FESA headquarters for the HAZMAT Emergency Advisory Team
  - the Water Corporation acts in an advisory role during incidents in the Yerecoin Water Reserve
  - personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Yerecoin Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality (Department of Water).
- 6 The existing monitoring program should be maintained to identify any incompatible land uses or potential threats within the Yerecoin Water Reserve. (Water Corporation).
- 7 Signs should be erected along the boundary of the Yerecoin Water Reserve to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number (Water Corporation).
- 8 Improve liaison with the landowner to implement best management practices for farming activities in the water reserve. The landowner should be informed

regarding water quality management issues as they arise (Water Corporation, Department of Water).

- 9 A review of this plan should be undertaken after five years (Department of Water).



# Appendices

## Appendix A : Water quality data

The information provided in this appendix has been prepared by the Water Corporation.

The Water Corporation has monitored the raw (source) water quality from the Yerecoin Water Reserve. This data shows the quality of water in the water reserve. An assessment of the drinking water quality is also made in accordance with the *National water quality management strategy: Australian drinking water guidelines* (NHMRC & NRMCC 2004a) and interpretations agreed to with the Department of Health. The raw water is monitored regularly for:

- aesthetic characteristics (non-health-related)
- health-related characteristics including
  - health-related chemicals
  - microbiological contaminants.

The following data are representative of the quality of raw water in the Yerecoin well field. In the absence of specific guidelines for raw water quality, the results have been compared with ADWG values set for drinking water, which defines the quality requirements at the customer's tap. Results that exceed ADWG have been shaded to give an indication of potential raw water quality issues associated with this source.

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

For more information on the quality of drinking water supplied to Yerecoin and Piawaning, refer to the most recent Water Corporation drinking water quality annual report at <[www.watercorporation.com.au](http://www.watercorporation.com.au)> > What we do > Water quality > Water quality publications > Latest report > Drinking water quality annual report.

## Aesthetic-related characteristics

The aesthetic water quality analyses for raw water from the Yerecoin well field are summarised in Table A1.

The values are taken from ongoing monitoring for the period November 2003 to November 2008. All values are in milligrams per litre (mg/L) unless stated otherwise. Any water quality parameters that have been detected are reported; those that have on occasion exceeded ADWG are shaded.

*Table A1 Aesthetic-related characteristics detected for Yerecoin well field*

Parameter	Units	ADWG aesthetic guideline value*	Yerecoin well field	
			Range	Median
Aluminium unfiltered	mg/L	-	<0.008–0.26	0.022
Chloride	mg/L	0–250	98–225	125
Colour–True	TCU	0–15	<1–9	1
Conductivity at 25 °C	mS/m	-	51–135	69
Hardness as CaCO <sub>3</sub>	mg/L	0–200	90–131	103.5
Iron unfiltered	mg/L	0–0.3	2.4–28	4.2
Manganese unfiltered	mg/L	0–0.1	<0.002–0.012	<0.002
pH	No unit	6.5–8.5	6.02–7.04	6.43
Sodium	mg/L	0–180	70–130	89
Sulfate	mg/L	0–250	29–39	32.5
Total filterable solids by summation (TFSS)	mg/L	0–500	353–532	385
Turbidity	NTU	0–5	2.4–150	30

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

## Health-related characteristics

### *Health parameters*

Raw water from the Yerecoin well field is analysed for health-related chemicals including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related water quality parameters that have been measured at detectable levels in the source between November 2003 and November 2008 are summarised in Table A2. Any parameters that have on occasion exceeded ADWG are shaded.

Table A2 *Health-related characteristics detected for Yerecoin well field*

Parameter	Units	ADWG health guideline value*	Yerecoin well field	
			Range	Median
Barium	mg/L	0.7	0.019	0.019
Boron	mg/L	4	0.06	0.06
Dieldrin	µg/L	0–0.3	<0.001–0.006	<0.004
Manganese unfiltered	mg/L	0.5	<0.002–0.012	<0.002
Nitrate as nitrogen	mg/L	0–11.29	3.2–7.3	5.7
Nitrite as nitrogen	mg/L	0.91	0.016–0.05	0.022
Nitrite plus nitrate as N	mg/L	11.29	2.6–8	6.3
Sulfate	mg/L	500	29–39	32.5

\* A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMCC 2004a).

### *Microbiological contaminants*

Microbiological testing of raw water samples from Yerecoin well field is currently conducted monthly. *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 *Escherichia coli* in raw water abstracted from any bore may indicate possible contamination of faecal material through ingress in the bore or recharge through to the aquifer (depending on aquifer type).

During the reviewed period of November 2003 to November 2008, positive *Escherichia coli* counts were recorded in 5.8 per cent of samples collected from the well field. The low occurrence of *Escherichia coli* detections is indicative of minimal contamination of the groundwater from faecal sources.

## Appendix B : Land use, potential water quality risks and recommended protection strategies

This table was prepared from data in Section 3 of this plan.

Land use/ activity	Potential water quality risks		Considerations for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Broad hectare farming <ul style="list-style-type: none"> <li>Grazing</li> </ul>	Nutrients from animal excreta	Medium	<ul style="list-style-type: none"> <li>Grazing occurs in the recharge area.</li> <li>Infrequent low levels of microbiological contaminants have been detected in the raw water.</li> <li>The aquifer is very shallow and unconfined and the soils are highly permeable.</li> </ul>	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Fenced well field and compound</li> <li>Fenced land immediately up-gradient of the well field.</li> </ul>	<ul style="list-style-type: none"> <li>Continue the water quality monitoring program.</li> <li>Continue to liaise with farmers to implement best management practices (WQPN 35: <i>Pastoral activities within rangelands</i>, WQPN 56: <i>Tanks for elevated fuel and chemical storage</i>).</li> <li>Exclude livestock from P1 area.</li> <li>Continue negotiations to purchase or lease the privately owned land classified P1.</li> </ul>
	Pathogens from animal excreta	Medium			

Land use/ activity	Potential water quality risks		Considerations for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Broad hectare farming <ul style="list-style-type: none"> <li>• Cropping</li> </ul>	Hydrocarbons and chemicals from leaks or spills	Low	<ul style="list-style-type: none"> <li>• Pesticides have previously been detected in the raw water and reticulation system.</li> <li>• The aquifer is very shallow and unconfined and the soils are highly permeable.</li> <li>• Runoff from paddocks may pool 200 m up-gradient of the well field (Department of Environment 2003).</li> <li>• Nitrate levels in the aquifer have steadily increased over the past 20 years.</li> </ul>	<ul style="list-style-type: none"> <li>• Water quality monitoring</li> <li>• No pesticide applications on land immediately up-gradient of well field</li> <li>• Fenced well field and compound</li> <li>• Liaise with farmers to implement best management practices for pesticide use.</li> </ul>	<ul style="list-style-type: none"> <li>• Continue the water quality monitoring program.</li> <li>• Continue to liaise with farmers to implement best management practices for fertiliser and pesticide use (chemical supplier recommendations; WQPN 1: <i>Agriculture - dryland crops near sensitive water resources</i>; this department's <i>Statewide policy No. 2: Pesticide use in public drinking water source areas</i>) and farm equipment servicing and fuelling (WQPN 25: <i>Mechanical servicing and workshops</i>; WQPN 56: <i>Tanks for elevated fuel and chemical storage</i>).</li> <li>• Pesticides and fertilisers should not be applied in P1 area.</li> <li>• Landholder informs relevant agency of any spills or accidents in the water reserve with the potential to contaminate (WQPN 10: <i>Contaminant spills – emergency response</i>).</li> <li>• Continue negotiations to purchase or lease the privately owned land classified P1.</li> </ul>
	Nutrients from fertilisers	Medium			
	Pesticides	High			

Land use/ activity	Potential water quality risks		Considerations for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Drinking water treatment plant	Chlorine spills or leaks	Low	<ul style="list-style-type: none"> <li>The water treatment plant and sump are located near the well field.</li> </ul>	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Fenced and locked water treatment compound</li> </ul>	<ul style="list-style-type: none"> <li>Continue the water quality monitoring program.</li> </ul>
	Contaminants from the filter backwash sump	Low	<ul style="list-style-type: none"> <li>Groundwater flow is expected to flow away from the well field.</li> </ul>	<ul style="list-style-type: none"> <li>Chlorine stored in purpose-built building within a locked compound</li> </ul>	<ul style="list-style-type: none"> <li>Continue best management practices for chemical storage and usage, and wastewater management (WQPN 65: <i>Toxic and hazardous substances – storage and use</i>).</li> </ul>
	Pesticide application	Medium	<ul style="list-style-type: none"> <li>The watertable is very shallow.</li> <li>The aquifer is unconfined and highly permeable.</li> </ul>	<ul style="list-style-type: none"> <li>Best management practices for the water treatment facility</li> <li>Best management practices for pesticide and chlorine usage</li> </ul>	<ul style="list-style-type: none"> <li>Continue best management practices for pesticide usage (chemical supplier recommendations; this department's <i>Statewide policy No. 2: Pesticide use in public drinking water source areas</i>; PSC 88: <i>Use of herbicides in water catchment areas</i>).</li> </ul>
					<ul style="list-style-type: none"> <li>Pesticides should not be stored in the water reserve.</li> <li>Ensure leachate from the sump is flowing away from the well field.</li> <li>Water Corporation informs relevant agency of any spills or accidents in the water reserve with the potential to contaminate (WQPN 10: <i>Contaminant spills – emergency response</i>).</li> </ul>

## Appendix C : Review of the recommendations in 1999 Yerecoin Water Reserve water source protection plan

Task	Status
The proposed Yerecoin Water Reserve should be gazetted under the <i>Country Areas Water Supply Act 1947</i> .	Incomplete Gazettement of the water reserve is a recommendation in this plan.
Planning strategies should incorporate the management principles outlined in WQPN: <i>Land use compatibility in public drinking water source areas</i> .	Incomplete Incorporation of the water reserve in the Shire of Victoria Plains local planning scheme is recommended in this plan.
All development proposals in the water reserve that are likely to impact on water quality should be referred to the Department of Water.	Ongoing
Signs should be erected along the boundaries of the water reserve to define and promote public awareness of the need to protect water quality.	Incomplete Signage is provided only around Water Corporation assets and the well field. Signage around the water reserve is required.
A process should be put in place to address spillage of contaminants in the water reserve.	Ongoing
A surveillance program should be established to identify incompatible land uses or potential contaminant threats within the water reserve.	Ongoing The water reserve is inspected weekly by a local Water Corporation operator; detailed surveillance and liaison occurs regularly throughout the year.
Nutrient and pesticide levels should be monitored to ensure drinking water quality criteria are not compromised.	Ongoing Water quality has been monitored monthly by the Water Corporation. There have been two separate pesticide detections in the water source.
The plan and its recommendations should be reviewed.	Complete

## Appendix D : Photographs



*Figure D1 Water treatment facility in the Yerecoin well field*



*Figure D2 Capped spears in the Yerecoin well field*



*Figure D3 Cropping activities in the recommended Yerecoin Water Reserve (note water treatment plant in the middle left of the photograph)*



## List of shortened forms

<b>ADWG</b>	Australian drinking water guidelines
<b>ANZECC</b>	Australian and New Zealand Environment Conservation Council
<b>ARMCANZ</b>	Agriculture and Resource Management Council of Australia and New Zealand
<b>CFU</b>	colony forming units
<b>EC</b>	electrical conductivity
<b>FESA</b>	Fire & Emergency Services Authority of Western Australia
<b>HAZMAT</b>	hazardous materials
<b>LEMC</b>	Local Emergency Management Committee
<b>mg/L</b>	milligrams per litre
<b>MPN</b>	most probable number
<b>mS/m</b>	millisiemens per metre
<b>NHMRC</b>	National Health and Medical Research Council
<b>NRMMC</b>	Natural Resource Management Ministerial Council
<b>NTU</b>	nephelometric turbidity units
<b>PDWSA</b>	public drinking water source area
<b>PSC 88</b>	Public sector circular No. 88
<b>TCU</b>	true colour units
<b>TDS</b>	total dissolved solids
<b>WESTPLAN- HAZMAT</b>	Western Australian plan for hazardous materials
<b>WHPZ</b>	wellhead protection zone
<b>WQPN</b>	Water quality protection note



## Glossary

<b>Abstraction</b>	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
<b>Adsorb</b>	Adsorb means to accumulate on the surface of something, for example, micro-organisms can adsorb onto soil particles.
<b>Australian drinking water guidelines (ADWG)</b>	The <i>National water quality management strategy: Australian drinking water guidelines</i> (NHMRC & NRMCC 2004a) outline acceptable criteria for the quality of drinking water in Australia (see References section).
<b>Aesthetic guideline value</b>	The aesthetic guideline value is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, for example, appearance, taste and odour (NHMRC & NRMCC 2004a).
<b>Allocation</b>	The quantity of water permitted to be abstracted by a licensee is their allocation, usually specified in kilolitres per annum (kL/a).
<b>Aquifer</b>	An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.
<b>Augment</b>	Augment means to increase the available water supply, for example, pumping back water from a secondary storage/reservoir dam.
<b>Bore</b>	A narrow, lined hole drilled into the ground to monitor or draw groundwater (also see 'production bore' and 'well field').
<b>Catchment</b>	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater is referred to as a catchment.
<b>Colony forming units (CFU)</b>	Colony forming units are a measure of pathogen contamination in water.
<b>Department of Environment and Conservation (DEC)</b>	The Department of Environment and Conservation was established on 1 July 2006, bringing together the Department of Environment and the Department of Conservation and Land Management.
<b>Effluent</b>	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.

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<b>Electrical conductivity</b>	This is a measure of a solution's capacity to conduct an electric current. It estimates the mass of total dissolved solids (TDS) in the solution. Measurement units include millisiemens per metre and microsiemens per centimetre.
<b>Fractured rock</b>	An aquifer where groundwater is present in the fractures, joints, solution cavities, bedding planes and zones of weathering igneous, metamorphic and deformed sedimentary rocks. Fractured rock aquifers are highly susceptible to contamination from land-use activities when aquifers crop-out or sub-crop close to the land surface.
<b>Health guideline value</b>	The health guideline value is the concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMCC 2004a).
<b>Hydrocarbons</b>	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.
<b>Hydrogeology</b>	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
<b>Leaching/leachate</b>	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.
<b>mg/L</b>	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
<b>Most probable number (MPN)</b>	Most probable number is a measure of microbiological contamination.
<b>Millisiemens per metre</b>	Millisiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
<b>Nephelometric turbidity units</b>	Nephelometric turbidity units are a measure of turbidity in water.
<b>Nutrients</b>	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.

<b>Pathogen</b>	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i> ), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i> ) and viruses.
<b>Pesticides</b>	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
<b>pH</b>	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.
<b>Pollution</b>	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.
<b>Production bore</b>	A bore supplying public drinking water (see also 'bore' and 'well field').
<b>Public sector circular No. 88 (PSC 88)</b>	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
<b>Public drinking water source area (PDWSA)</b>	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> and the <i>Country Areas Water Supply Act 1947</i> .
<b>Recharge</b>	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.
<b>Recharge area</b>	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.
<b>Runoff</b>	Water that flows over the surface from a catchment area, including streams.
<b>Scheme supply</b>	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
<b>Stormwater</b>	Rainwater which runs off the ground surface, roads and paved areas and is usually carried away by drains.

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<b>True colour units (TCU)</b>	True colour units are a measure of degree of colour in water.
<b>Total dissolved solids (TDS)</b>	Total dissolved solids consist 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 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMMC 2004a).
<b>Total filterable solids by summation (TFSS)</b>	Total filterable solids by summation is 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 <sub>4</sub> equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO <sub>2</sub> (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
<b>Treatment</b>	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
<b>Turbidity</b>	The cloudiness or haziness of water caused by the presence of fine suspended matter.
<b>Unconfined aquifer</b>	An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the 'watertable'.
<b>Wastewater</b>	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of contaminants.
<b>Water quality</b>	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
<b>Water reserve</b>	A water reserve is an area proclaimed under the <i>Country Areas Water Supply Act 1947</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> for the purposes of protecting a drinking water supply.
<b>Watertable</b>	The upper saturated level of the unconfined groundwater is referred to as the 'watertable'.

<b>Well field</b>	A group of bores located in the same area used to monitor or withdraw groundwater.
<b>Wellhead</b>	The top of a well (or bore) used to draw groundwater is referred to as a wellhead.
<b>Wellhead protection zone (WHPZ)</b>	A wellhead protection zone (WHPZ) is usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination threats in the nearby area.



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