



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

Yalgoo Water Reserve

Drinking water source protection plan

Yalgoo town water supply



Looking after all our water needs

Water resource protection series
Report WRP 118
June 2010

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Cover photograph: Yalgoo town-site, eastern entrance (taken by Sue Tillman)

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Preface

How do we protect public drinking water source areas?

The Australian drinking water guidelines (ADWG) (NHMRC & NRMCC 2004a) outlines how we should protect drinking water in Australia. The ADWG recommends a ‘catchment to consumer’ framework that uses a risk-based, multiple-barrier approach. A similar approach is recommended by the World Health Organization in other countries worldwide.

This ‘catchment to consumer’ framework ensures a holistic assessment of risks to drinking water to maximise the delivery of safe drinking water to consumers.

A risk-based approach means that we look at all the different risks to water quality, and how to address them. A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system. The first barrier is the catchment (or recharge area) of a drinking water source. Within this barrier, water quality contamination risks need to be addressed. This plan helps to do that. Other barriers against contamination include:

- storage of water
- treating the water (e.g. chlorination)
- maintenance of pipes
- monitoring of water quality.

As water treatment practices evolve, many people think that we no longer need to protect the catchment because we can ‘engineer out the risks’. Nothing could be further from the truth (Krogh et. al 2008). Recent research and experience shows that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. That’s why this drinking water source protection plan is important. It’s about protecting the catchment’s water quality now and in the future.

In Western Australia, the Department of Water protects public drinking water source areas (PDWSAs) by using the law; putting the ADWG into practice; writing plans, policies and guidelines; and providing input into land-use planning.

The ADWG outlines 12 elements to protect drinking water. We implement element two (assessment of the drinking water supply system) and element three (preventative measures for drinking water quality management) by writing drinking water source protection plans. Plans have been, or are being written for all PDWSAs around the state. They give an overview of a drinking water source and outline the risks to water quality and how to address them. Our regional offices work with the community, other government agencies and landowners to put the recommendations into practice.

We also define special areas within PDWSAs: priority areas and protection zones. There are three different priority areas; each assigned a certain level of risk to water quality. Protection zones surround drinking water extraction points, so that the most vulnerable areas may be protected from contamination. Under legislation, some activities are restricted in protection zones.

If you would like more information about how we protect drinking water in Western Australia, go to <<http://drinkingwater.water.wa.gov.au>>.

The following table outlines the stages involved in the preparation of this drinking water source protection plan:

Stages in development of a plan		Comment
1	Prepare drinking water source protection assessment document. (2004)	Prepared after initial catchment survey and preliminary information gathering. This document may not be required if a drinking water source protection plan already exists or alternative documents provide suitable information.
2	Conduct stakeholder consultation. (2009 - 10)	Advice sought from key stakeholders using the assessment document as a tool for information and discussion.
3	Prepare draft drinking water source protection plan. (2009 - 10)	Draft protection plan developed taking into account input from stakeholders and any additional advice.
4	Conduct stakeholder consultation (May - June 2010)	Draft protection plan provided for a three-week stakeholder consultation period.
5	Publish approved drinking water source protection plan. (June 2010)	Final protection plan published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of this public drinking water source area can now be progressed.

Summary

The small regional centre of Yalgoo is located in the Mid West region of Western Australia, approximately 217 km east of Geraldton along the Geraldton-Mt Magnet Road. The town services the surrounding mining and pastoral industry and has a population of approximately 110 people (Shire of Yalgoo 2008).

Yalgoo Borefield, located in the Yalgoo Water Reserve, provides water to the Yalgoo scheme supply. The borefield is located approximately 4.5 km north-east of the town-site and abstracts water from an unconfined, fractured rock aquifer. The unconfined nature of the aquifer means the groundwater resource is vulnerable to contamination from land uses occurring within the borefield recharge area. The Yalgoo Water Reserve was proclaimed in 1990 to help protect the public drinking water source from such contamination.

The Water Corporation published the *Yalgoo drinking water source protection assessment* in 2004, which identified land uses and activities in the Yalgoo Water Reserve and assessed corresponding risks to groundwater quality. The 2010 *Yalgoo Water Reserve drinking water source protection plan* builds on this assessment by assessing current risks to groundwater, proposing a new water reserve boundary and detailing recommendations to protect water quality.

Recommendations to protect water quality within the Yalgoo Water Reserve include:

- amending the Yalgoo Water Reserve boundary to better reflect the Yalgoo Borefield recharge area and remove town-site areas.
- priority 1 (P1) area management for land within Yalgoo Water Reserve.
- wellhead protection zones around each production bore within Yalgoo Borefield.
- best management practices for land uses and activities within the Yalgoo Water Reserve.

1 Drinking water source overview

1.1 Existing water supply system

Yalgoo Borefield (see Figure 2) is operated by the Water Corporation and consists of three production bores (2/83, 1/84 and 3/83) and one unequipped bore (6/82). Bores 2/83 and 1/84 are located in one compound approximately 4.5 km from the Yalgoo town-site, just west of the current Yalgoo Water Reserve boundary. Bore 3/83 is located approximately 1.5 km further north-east and Bore 6/82 is located another 1.5 km northeast of Bore 3/83, both within the current Yalgoo Water Reserve. Yalgoo town water supply is primarily supplied from bore 3/83 with bores 2/83 and 1/84 on standby. Bore 6/82 may also be used as a production bore in the future.

The bores draw water from a fractured rock aquifer. They are screened between 24 and 60 m bgl and have a static water level generally within 13 to 21 m bgl (Water Corporation 2008). Water abstracted from the borefield is treated before it is pumped to the 225 kL Yalgoo water tank, located on high ground outside the water reserve, approximately 1 km to the north west of the town (see Figure 3). The treated water is gravity fed from the Yalgoo water tank into the town water supply.

1.2 Water treatment

Water abstracted from the Yalgoo Borefield is treated in a water treatment plant situated near bores 2/83 and 1/84 (see Figure 3). The high energy reverse osmosis (HERO) plant was commissioned in 1997 to address groundwater quality issues, particularly high levels of naturally occurring arsenic, nitrate and silica. In the treatment process, the raw water is passed through a titanium oxide ion exchange media for arsenic removal. It then undergoes nitrate removal via reverse osmosis. Finally, it is disinfected with chlorine gas as a barrier against possible microbial contamination. Treated water is then supplied to customers through the Yalgoo scheme reticulation network (Water Corporation 2008).

It should be recognised that although treatment and disinfection are essential barriers against contamination, management of the catchment is the first step in protecting water quality and ensuring a safe drinking water supply. This approach is endorsed by the *National water quality management strategy: Australian drinking water guidelines 6, 2004 (ADWG)* (NHMRC & NRMCC 2004a) and reflects a risk-based, multiple-barrier approach for providing safe drinking water to consumers. This combination of catchment protection and water treatment will deliver a more reliable, safer and lower-cost drinking water to consumers than either approach could achieve individually.

1.3 Catchment details

1.3.1 Physiography

The topography of the Yalgoo area is low to gently undulating with elevations reaching a maximum of about 125m AHD. Low, rocky ranges edged by long, low-angle colluvial and alluvial slopes that merge into broad floodplains are typical. The lower areas are mostly covered by Mulga scrub (Laws 1982).

1.3.2 Climate

Yalgoo experiences a semi-arid climate with an average rainfall of 258mm. Most rainfall occurs in winter with occasional cyclonic storms during summer. Average potential evaporation is 3,175 mm per annum. The mean maximum temperature ranges from about 37°C (January) to 18 °C (July) while the mean minimum temperature ranges from 20 °C (January) to 6 °C (July) (BOM 2010).

1.3.3 Hydrogeology

Yalgoo is located on a greenstone belt of Archaean age within the Yilgarn Craton. The area is underlain by a sequence of mafic and felsic volcanics, and gabbroic rocks intruded by dolerites, sills and dikes. These rocks are locally deeply weathered to more than 65 m and overlain by alluvial sediments up to 4m thick. Groundwater is found within weathered and fresh fractured rock, generally 13-21m bgl. The unconfined nature of the aquifer makes it vulnerable to contamination from surrounding land uses (Water Corporation 2008).

The aquifer is thought to be recharged from direct infiltration of rainfall. There is a south-west trending drainage line extending from approximately 8 km north-east of bore 3/83, past Yalgoo town-site and into a salt lake system. Groundwater is inferred to flow to the south-west. Groundwater salinity ranges from 750 mg/L TDS to over 1000mg/L TDS, probably increasing downstream. The safe yield of the aquifer has been estimated as 92 500kLper year (Water Corporation 2008).

1.4 Future water supply requirements

The Water Corporation predicts that the current borefield and licensed abstraction are adequate to meet Yalgoo's anticipated public water supply demand for at least the next five years.

1.5 Existing drinking water source protection

The Yalgoo Water Reserve was proclaimed in 1990 under the *Country Areas Water Supply Act 1947* (WA) for the purpose of protecting Yalgoo's public drinking water supply. By-laws created under this Act enable the Department of Water to control potentially polluting activities, regulate land use, inspect premises and take the necessary steps to prevent or clean up pollution. In 2004, the Water Corporation

prepared the *Yalgoo Water Reserve drinking water source protection assessment*. This document outlined risks to water quality from land uses and activities in the Yalgoo Water Reserve. This drinking water source protection plan builds on and replaces the drinking water source protection assessment.

The Yalgoo Water Reserve has been managed as a Priority 1(P1) area. New land uses and activities have been assessed against Water quality protection note (WQPN) no.25: *Land use compatibility in public drinking water source areas*. The Department of Planning has advised that the Yalgoo Water Reserve will be recognised as a Special Control Area in the Shire of Yalgoo's next Town Planning Scheme.

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* (WA). Under this Act, the right to use and control surface water and groundwater is vested with the Crown. The Act requires licensing of groundwater abstraction (pumping water from a bore, spring or soak) within groundwater areas proclaimed under the Act and all artesian wells throughout the State.

The Yalgoo groundwater resource lies within the Gascoyne Groundwater Area which was proclaimed in 1991 under the *Rights in Water and irrigation Act 1914* (WA). The Water Corporation is licensed to draw 75 000 kL (Groundwater Well Licence 109408) from the Yalgoo Borefield for public water supply purposes. The current number of services is 66. Abstraction in 2009-10 was 45 124 kL.

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 safe, good quality drinking water to consumers.

The Water Corporation regularly monitors the quality of raw water from the Yalgoo Water Reserve for microbiological, health-related and aesthetic (non-health-related) characteristics. This data shows the quality of water in the Yalgoo Water Reserve. An assessment of the drinking water quality once treated is also made against the ADWG to ensure safe, good quality drinking water is available to consumers. 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 Yalgoo town water supply from March 2005 to March 2010 is presented in Appendix B. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at <www.watercorporation.com.au> What we do > Water quality > Water quality publications > Water quality annual report 2008-09.

Water Corporation and the Department of Health have a memorandum of understanding for the drinking water of several Mid West region schemes including Yalgoo. This gives an exemption from compliance with nitrate guideline values and was put in place due to the naturally occurring high levels of nitrate in the area's groundwater. Treated water from the Yalgoo scheme may contain nitrate concentrations between 11.29 and 22.58 mg/L nitrate as N. This is above the 2004 ADWG health guideline of 11.29 mg/L nitrate as N. The exemption explains that consumption of water with nitrate at these levels does not pose a risk to adults; however, it can adversely affect the health of infants under three months of age. Community health nurses advise carers of infants in this age group to use alternative water sources such as bottled water to prepare bottled feeds.

Contamination risks relevant to drinking water sources are described below.

2.1 Microbiological

Pathogens are types of microorganisms that are capable of causing disease. These include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are commonly found in the faeces of humans and domestic animals (such as dogs and cattle).

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. salmonella, *Escherichia coli* and cholera),

protozoa (e.g. *Cryptosporidium*, *Giardia*) and viruses. *E. coli* counts are a way to measure these pathogens and provide an indication of faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors including the existence of pathogen carriers (e.g. humans and domestic animals), the transfer to and movement of the pathogen in the water source and its ability to survive in the water. The percentage of humans in the world that carry pathogens varies. For example, it is estimated that between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia* (Geldreich 1996).

The ability of pathogens to survive in water also differs between species. Salmonella may be viable for two to three months, *Giardia* may still infect after one month in the natural environment (Geldreich 1996) and *Cryptosporidium* oocysts (cells containing reproductive spores) may survive weeks to months in fresh water (NHMRC & NRMMC 2004a).

When people consume drinking water contaminated with pathogens the effects vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes even death. During 2000, seven people died in Walkerton, Canada, because the town water source and supply was contaminated by a pathogenic strain of *E. 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.

2.2 Health related

Land-use activities within the Yalgoo Water Reserve can directly affect water quality and treatment. Chemicals adsorbed to suspended material, such as soil particles, can occur in drinking water sources. This may occur as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMMC 2004a). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

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, incorrect use or leakage from storage areas. In such cases, the relevant authorities should be notified promptly and the spill cleaned up.

Hydrocarbons (e.g. fuels, oils) are potentially toxic to humans, and harmful chemical by-products may be formed when they are combined with chlorine during the water-treatment process. Hydrocarbons can occur in water supplies as a result of spills and leakage from vehicles.

Drinking water supplies can also be contaminated by nutrients (such as nitrogen) from fertiliser applications, faulty septic systems, leach drains and from 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).

2.3 Aesthetic

Impurities in drinking water can affect its aesthetic qualities, including its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, cloudy water with a distinctive odour or strong taste is not necessarily harmful to health, while clear, pleasant-tasting water may still contain harmful microorganisms (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).

2.4 Groundwater bores

The Yalgoo Water Reserve is located within the Gascoyne groundwater area which is proclaimed under the *Rights in Water and Irrigation Act 1914 (WA)*. Under the provisions of sections 26D and 5C of the Act, a licence is required to construct a bore or abstract water within a proclaimed groundwater area (unless exempt under the *Rights in Water and Irrigation Exemption and Repeal [Section 26C] Order 2001*). The Water Corporation operates drinking water bores in the Yalgoo Water Reserve. If bores for other purposes (e.g. irrigation, private household use) are drilled near a public drinking water supply bore, they can cause contamination of the drinking water source. For example, a poorly constructed private bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer.

It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source. This will be assessed through the Department of Water's water licensing process where applicable under the *Rights in Water and Irrigation Act 1914 (WA)*. 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 Yalgoo Water Reserve is located on Crown land. Current land uses and activities are outlined below. This information has been summarised in Table 1 at the end of this section. This table also identifies the recommended management priorities for different hazards. Appendix C of this plan uses data in Table 1 and this section to recommend protection strategies for key stakeholders to consider.

3.1.1 Crown land

Pastoral lease

Most of the proposed Yalgoo Water Reserve falls over pastoral lease, mainly Carlaminda Station and a small area of Gabyon Station (see Figure 3). The main land use on these stations is stock grazing. Carlaminda homestead is situated within the reserve. Risks to the water source from these land uses include pathogens, nutrients, hydrocarbons and chemicals.

Mining

Mining tenements are found throughout the proposed Yalgoo Water Reserve. These include exploration licences and mining leases. Mineral exploration is active within the reserve however extraction is not currently occurring. Mineral extraction in the future is probable. Old mine shafts and pits from past mining activities are present and pose a risk to groundwater. The main risks to the water source from mining activities include pathogens, hydrocarbons and chemicals.

Roads and tracks

Yalgoo North Road is the primary road passing through the Yalgoo Water Reserve. It is a public, unsealed road and passes close to the borefield through the middle of the reserve. Maintained by the Shire of Yalgoo, it is used to access Carlaminda Station, as an alternative route to towns to the north (e.g. Cue) and as a haulage route for mining trucks. Several unsealed minor roads and tracks pass through the reserve: these are used to access Carlaminda Station, Yalgoo Borefield and the telecommunications tower. The main risks to the drinking water source posed by roads include hydrocarbons and chemicals.

Telecommunications and electricity infrastructure

There is a telecommunications tower on Lot 60 which is close to the Yalgoo Water Reserve's eastern boundary (see Figure 3). There are also electricity and telephone lines leading to the water treatment plant and Yalgoo homestead. Risks to the drinking water source from these land uses include hydrocarbons and chemicals; however, the risk is considered low.

Drinking water treatment plant

A water treatment plant and associated back wash ponds are located close to Bore 1/84 and Bore 2/83. The backwash ponds are situated opposite the treatment plant on the other side of Yalgoo North Road. The ponds store and evaporate wastewater from the treatment plant and may contain high PH, salt, nitrate and arsenic levels. The main risks to groundwater quality from the drinking water treatment plant include pathogens, hydrocarbons, chemicals and nutrients.

3.1.2 Aboriginal sites of significance

Aboriginal sites of significance are those areas that Aboriginal people value as important and significant to their cultural heritage. The sites are significant because they link Aboriginal culture and tradition to place, land and people over time. These areas form an integral part of Aboriginal identity and the heritage of Western Australia. The *Aboriginal Heritage Act 1972 (WA)* protects all Aboriginal sites in the state.

There are three Aboriginal sites of significance within the proposed Yalgoo Water Reserve. Those sites are Yalgoo (5908), Three Decker Hills (21137) and Yalgoo (5674).

3.1.3 Native title

Native title is a form of land title that recognises the unique ties some Aboriginal groups have to land. Native title exists where Aboriginal people have maintained a traditional connection with their land and waters, since sovereignty, and where acts of government have not removed it.

There are two native title claims within the proposed Yalgoo Water Reserve. Those claims are Mullewa Wadjari Community (WAD6119/98) and Wadjarri Yamatji (WAD6033/98).

3.2 Proposed land uses and activities

Land falling within the proposed Yalgoo Water Reserve is zoned as 'rural / mining' under the Yalgoo town planning scheme. No major land use changes are expected.

Table 1 Land use and potential water quality risks

Land use/activity	Hazard	Mgmt. priority	Compatibility of land use/ activity	Best mgmt. practice guidance
Pastoral lease				
Stock grazing – sheep & goats- extensive	Pathogens from animal waste & carcasses	Medium	Extensive stock grazing & infrastructure/ maintenance activities on pastoral leases are compatible with conditions in Priority 1 (P1) areas	Water quality protection note (WQPN) no. 35: <i>Pastoral activities within rangelands;</i> WQPN no. 96: <i>Pest animal management in public drinking water source areas;</i> WQPN no. 70: <i>Wastewater treatment-on-site domestic systems</i> State-wide policy no. 2 <i>Pesticide use in public drinking water source areas</i> PSC 88: <i>Use of herbicides in water catchment areas</i>
	Nutrients from animal waste	Medium		
	Pesticides used on animals & pasture	Medium		
Pastoral lease infrastructure/ maintenance (including stock and domestic wells as contamination pathways)	Pathogens from human activity, household rubbish & septic systems	Medium		
	Nutrients from septic systems & fertilisers	Low		
	Hydrocarbons from vehicles & machinery	Low		

Land use/activity	Hazard	Mgmt. priority	Compatibility of land use/ activity	Best mgmt. practice guidance
Mining				
Exploration & extraction (including unsealed wells as contamination pathways)	Pathogens from human activity & waste disposal. Pathogens from animal waste & carcasses in old mine pits and shafts	Medium	Mining exploration, extraction & camps are compatible with conditions in P1 areas. Tailings dams & mineral processing plants are examples of activities not compatible in P1 areas.	Water quality protection guideline series: <i>Mining and mineral processing no. 1-11</i> ; <i>Guidelines for the protection of surface and groundwater resources during exploration drilling</i>
	Hydrocarbons from machinery & vehicles	Medium		
Infrastructure and corridors				
Roads & tracks	Hydrocarbon and chemicals from vehicles & machinery	Medium	Existing public roads are acceptable in P1 areas. New 'major' roads are considered incompatible in P1 areas.	WQPN no. 44 <i>Roads near sensitive water resources</i> Statewide Policy no. 2 <i>Pesticide use in Public drinking water source areas</i> PSC88: <i>Use of herbicides in water catchment areas</i>
	Herbicides from road/ track maintenance	Medium		
Telephone & power lines, telecommunications tower	Hydrocarbons from power sources/ maintenance vehicles	Low	Telecommunications infrastructure and powerlines are compatible with conditions in a P1 area.	WQPN no. 83: <i>Infrastructure corridors near sensitive waters</i>

Land use/activity	Hazard	Mgmt. priority	Compatibility of land use/ activity	Best mgmt. practice guidance
Drinking water treatment plant & backwash ponds	Hydrocarbons, chemicals & nutrients from plant infrastructure & maintenance vehicles.	Medium	Drinking water treatment plants are compatible with conditions in P1 areas	WQPN no. 27: <i>Liners for containing pollutants using synthetic liners;</i> WQPN no.65: <i>Toxic and hazardous substances: storage & use</i>
	Pathogens from human activity, septic systems	Medium		

4 Catchment protection strategy

4.1 Protection objectives

The main objective for the Yalgoo Water Reserve is to sustain this sole drinking water resource for the town of Yalgoo. It is essential that the recharge area for the Yalgoo Borefield is protected and managed to ensure the drinking water source is not compromised by surrounding land uses.

The area currently proclaimed as Yalgoo Water Reserve is shown in Figures 1 and 2. This area does not encompass the whole recharge area for the Yalgoo Borefield meaning groundwater taken for Yalgoo's drinking water is not adequately protected. The proposed Yalgoo Water Reserve extends north-east and west of the current reserve to address this. The southern boundary has been moved northwards to exclude town-site areas and follows cadastral boundaries for ease of planning. The proposed Yalgoo Water Reserve, shown in Figures 2, 3, 4 and 5, should be proclaimed under the *Country Areas Water Supply Act 1947 (WA)* to afford the highest level of protection to Yalgoo's drinking water resource.

4.2 Priority areas

The protection of PDWSAs relies on statutory measures and policy available in legislation 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. The proposed priority areas for the Yalgoo Water Reserve have been determined in accordance with current Department of Water policy. These areas are described below and displayed in Figure 5. The department's WQPN no.25: *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 WQPN no.36: *Protecting public drinking water source areas*.

It is proposed that all land within the Yalgoo Water Reserve be assigned as P1 for the following reasons:

- water from this source constitutes a strategic sole supply to the Yalgoo town so it should be afforded the highest feasible level of protection.
- all land within the reserve is Crown land.
- existing land uses are considered compatible with conditions in P1 areas i.e. the existing land uses can be managed so that they are compatible with the management objectives of P1 areas.

4.3 Protection zones

In addition to priority areas, protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities. Specific conditions may apply within these zones such as restrictions on the storage of chemicals.

Wellhead protection zones (WHPZs) 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. WHPZs do not extend outside the boundary of the water reserve.

There are four bores within the Yalgoo Water Reserve. Each has a WHPZ with a 500m radius (see Figure 5). A drinking water treatment plant (storage of chemicals and septic tanks) a public road and grazing stock are present within the WHPZs. Best management practice is encouraged to minimise any potential impacts on the drinking water source.

4.4 Land-use planning

It is recognised under the Western Australian Planning Commission's (WAPC) *State planning strategy* (1997) 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 the WAPC's Statement of planning policy no. 2.7 *Public drinking water source policy* (2003) it is appropriate that the Yalgoo Water Reserve, its priority areas and protection zones be recognised in the *Shire of Yalgoo's Town Planning Scheme*. Any development proposals within the Yalgoo Water Reserve that is inconsistent with advice in the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this plan should be referred to the Department of Water for advice.

The department's protection strategy for PDWSAs provides for lawfully established and operated developments to continue despite those facilities posing a potential level of risk to water quality that would not be accepted for new developments. The department will provide advice to landowners/ operators on measures to improve these facilities and reduce water quality contamination risks. For further information

on the integration of land-use planning and water source protection, please refer to the Department of Water's WQPN no.36: *Protecting public drinking water source areas*.

4.5 Best management practices

There are opportunities to reduce water contamination risks by carefully considering design and management practices. To help protect water sources, the Department of Water will continue to encourage the adoption of best management practices (BMP) for various land uses.

Guidelines on best management practices for many land uses are available in the form of industry codes of practice, environmental guidelines and water quality protection notes. They outline the recommended practices to ensure the protection of water quality and can thus help managers reduce any detrimental effects of their operations. Such guidelines have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples relevant to land uses in the Yalgoo Water Reserve are listed in Table 1. Please see the 'References' section for how to access these documents.

Education and creating awareness (e.g. signage and information) are also key mechanisms for protecting water quality, especially for people visiting the area. A brochure will be produced once this plan is finalised, describing the Yalgoo 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 about the drinking water source and the need to protect it.

4.6 Surveillance and by-law enforcement

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

The Department of Water considers by-law enforcement, through surveillance of land-use activities in PDWSAs, to be an important mechanism to protect water quality. This plan recommends that surveillance and by-law enforcement for the Yalgoo Water Reserve is delegated to the Water Corporation.

Signs are erected on Yalgoo Water Reserve's current boundaries to educate and advise the public about activities that are prohibited or regulated. This plan recommends that signage is extended to cover the proposed Yalgoo Water Reserve (along its boundary and at points of interest e.g. along Yalgoo North Rd.) Signs should include an emergency contact number (in case of spills) and be maintained in good, readable condition.

4.7 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 Yalgoo local emergency management committee (LEMC), through the Mid West- Gascoyne emergency management district, should be familiar with the location and purpose of the Yalgoo Water Reserve. A locality plan should be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. The Water Corporation should have an advisory role to the HAZMAT team for incidents in the Yalgoo 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 Yalgoo Water Reserve. These personnel should have an adequate understanding of the potential impacts of spills on this water resource.

4.8 Implementation of this plan

Table 1, Section 3, identifies the potential water quality risks associated with existing land uses in the proposed Yalgoo Water Reserve. Further information and the recommended protection strategies to deal with those risks are outlined in Appendix C. Major recommendations are stated in Section 5.

After the final *Yalgoo Water Reserve drinking water source protection plan* is complete, an implementation strategy will be drawn up based on the recommendations in Section 5 and Appendix C.

5 Recommendations

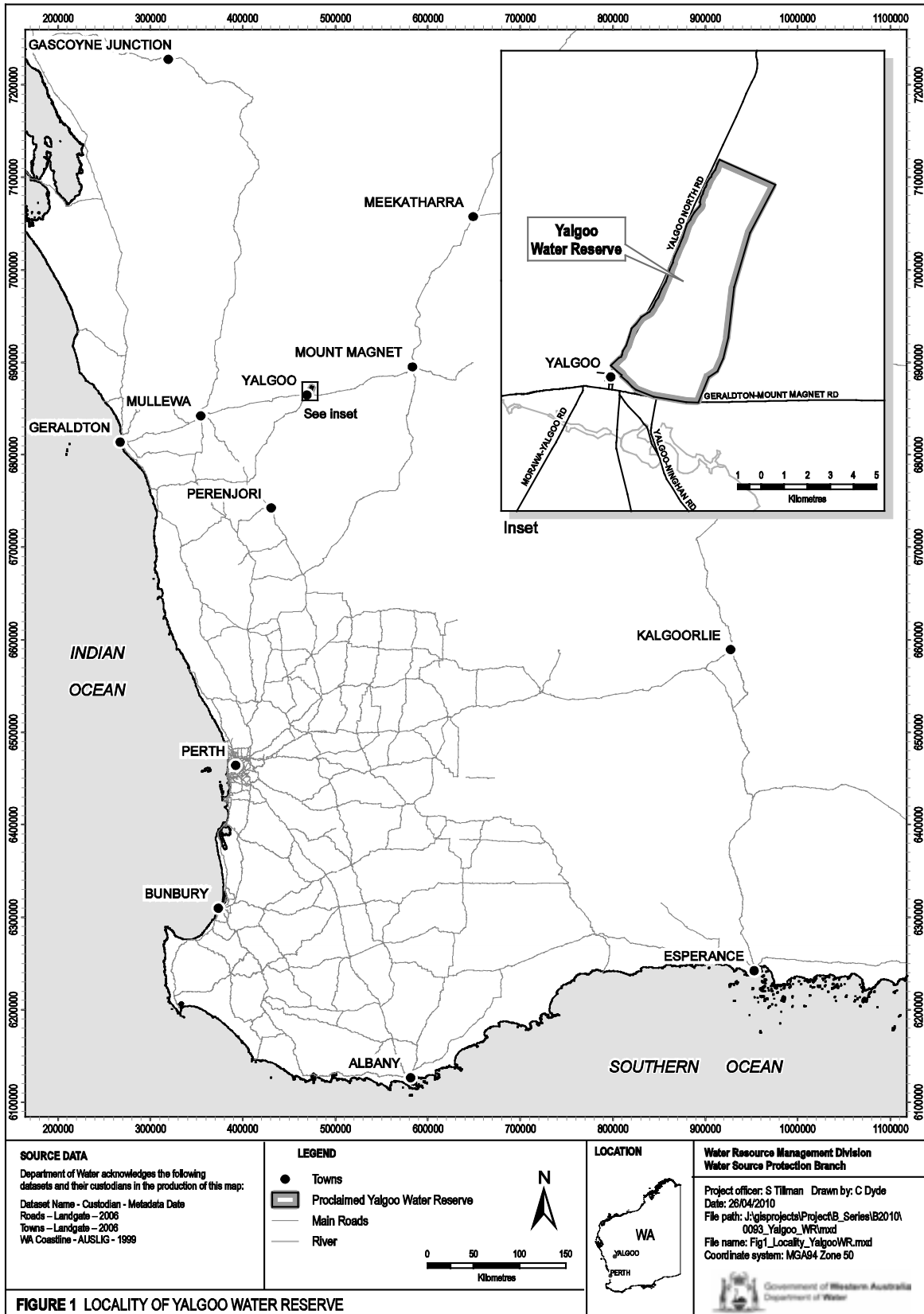
The following recommendation apply to the proposed Yalgoo Water Reserve. The bracketed stakeholders are those expected to have an interest in the relevant recommendation being implemented.

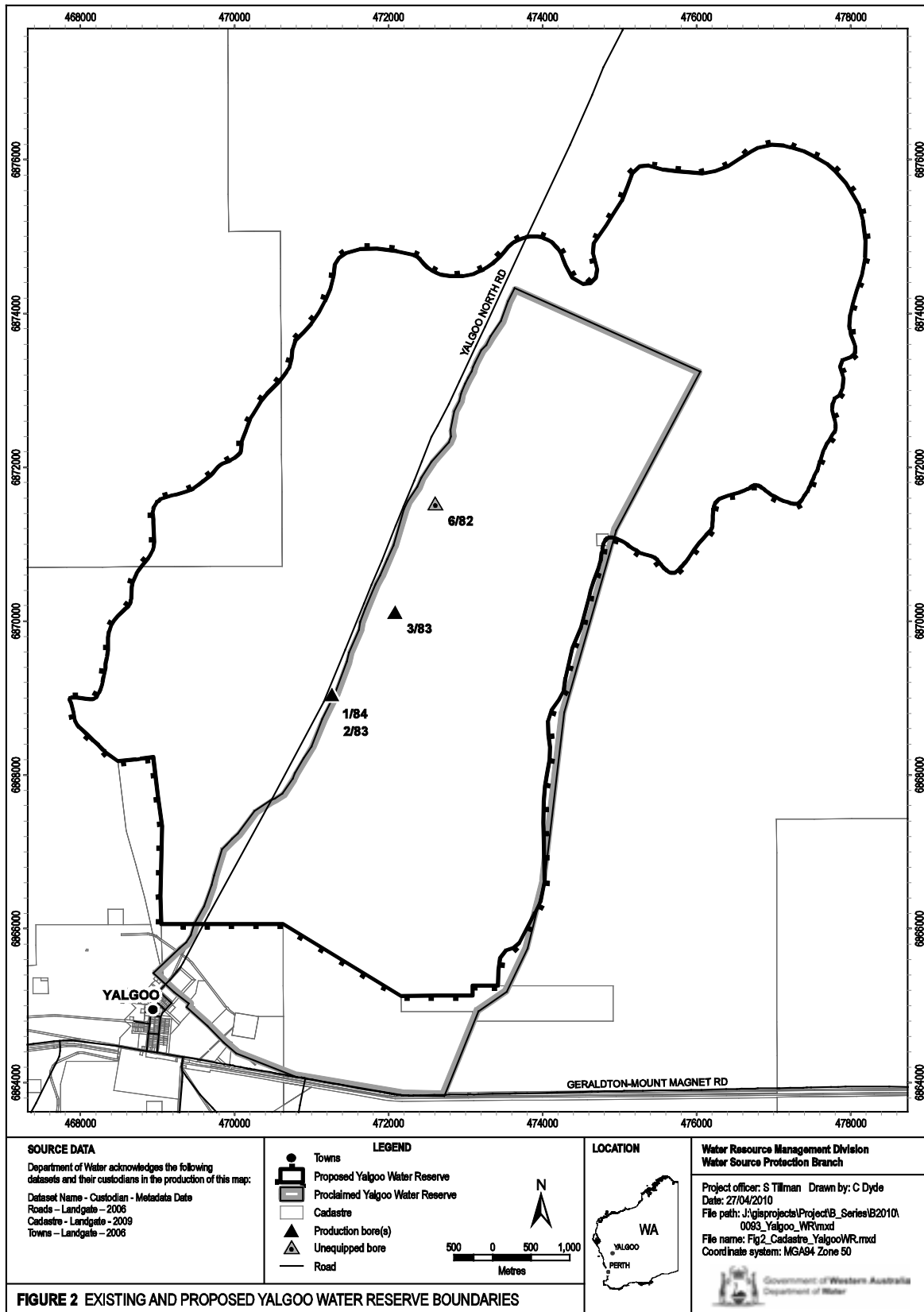
1. The proclaimed boundary of the Yalgoo Water Reserve under the *Country Areas Water Supply Act 1947* should be amended to reflect the proposed new boundary. (Department of Water)
2. The *Shire of Yalgoo town planning scheme* should recognise the Yalgoo Water Reserve as a special control area, including Priority 1 areas and wellhead protection zones, in accordance with the WAPC's *Statement of planning policy no.2.7: Public drinking water source policy*. (Shire of Yalgoo, Department of Planning)
3. Develop an implementation strategy for this plan's recommendations, including the recommended protection strategies as detailed in Appendix C, showing responsible stakeholders and planned timeframes. (Department of Water, applicable stakeholders)
4. All development proposals within the Yalgoo Water Reserve that are inconsistent with the Department of Water's Water quality protection note no.25: *Land use compatibility in public drinking water source areas* or recommendations in this plan should be referred to the Department of Water for advice. (Department of Planning, Department of Regional Development & Lands, Shire of Yalgoo)
5. Incidents covered by WESTPLAN–HAZMAT in the Shire of Yalgoo should be addressed by ensuring that:
 - the Shire of Yalgoo LEMC is aware of the location and purpose of the Yalgoo Water Reserve
 - the locality plan for the Yalgoo Water Reserve is provided to the FESA headquarters for the HAZMAT emergency advisory team
 - the Water Corporation acts in an advisory role during incidents in the Yalgoo Water Reserve
 - Personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Yalgoo Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality. (Department of Water, LEMC, Water Corporation)
6. That responsibility for monitoring and enforcement measures within the Yalgoo Water Reserve, be delegated to the Water Corporation. (Department of Water, Water Corporation)
7. Signs should be erected, maintained or replaced, as necessary, along the boundary and at points of interest within the Yalgoo Water Reserve. Signs should clearly identify the site as a PDWSA and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number. (Department of Water, Water Corporation)

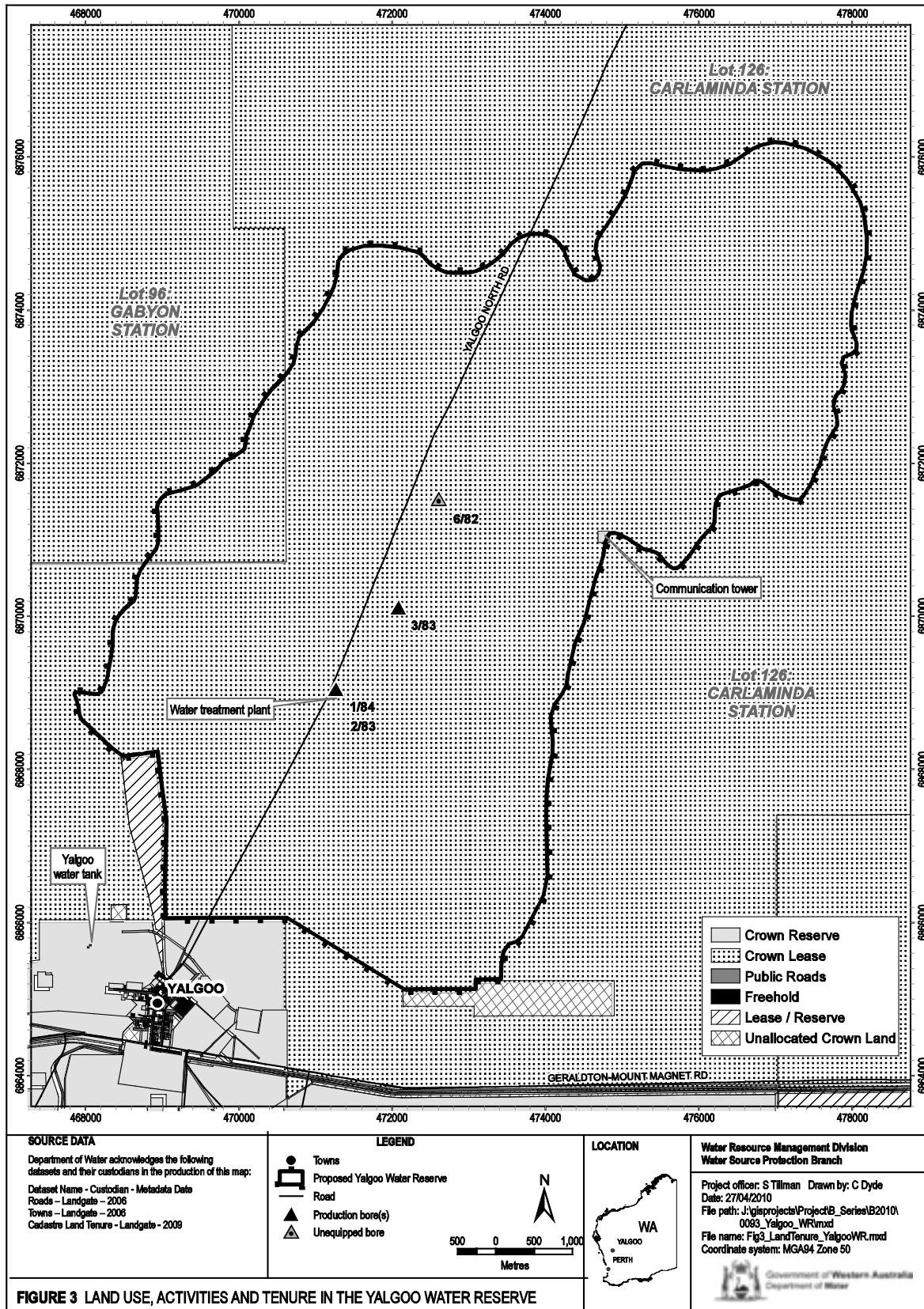
8. Operators of activities within the Yalgoo Water Reserve should use best management practices to protect water quality. (Water Corporation, Shire of Yalgoo, land and tenement holders).
9. A review of this plan should be undertaken after five years. (Department of Water)

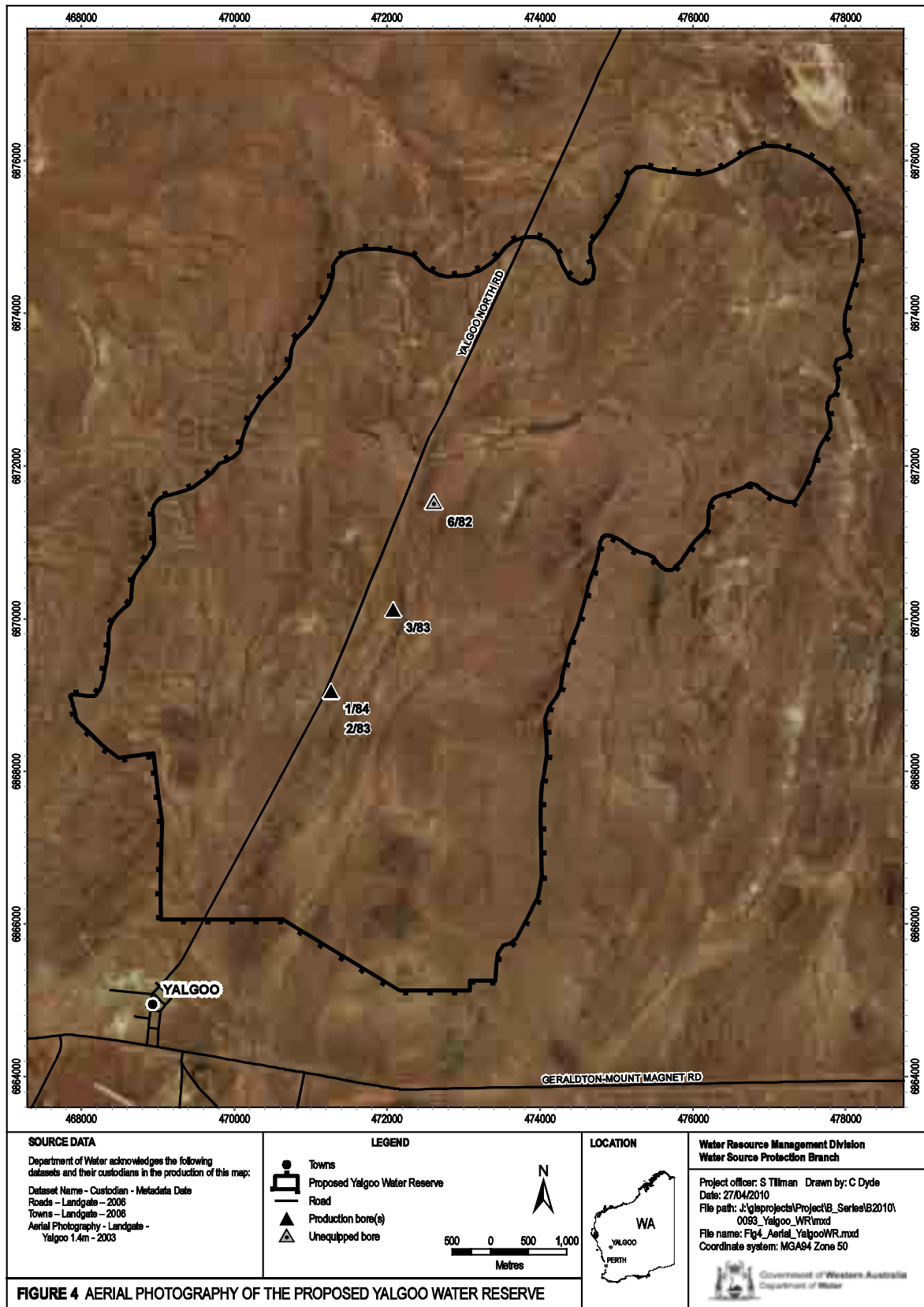
Appendices

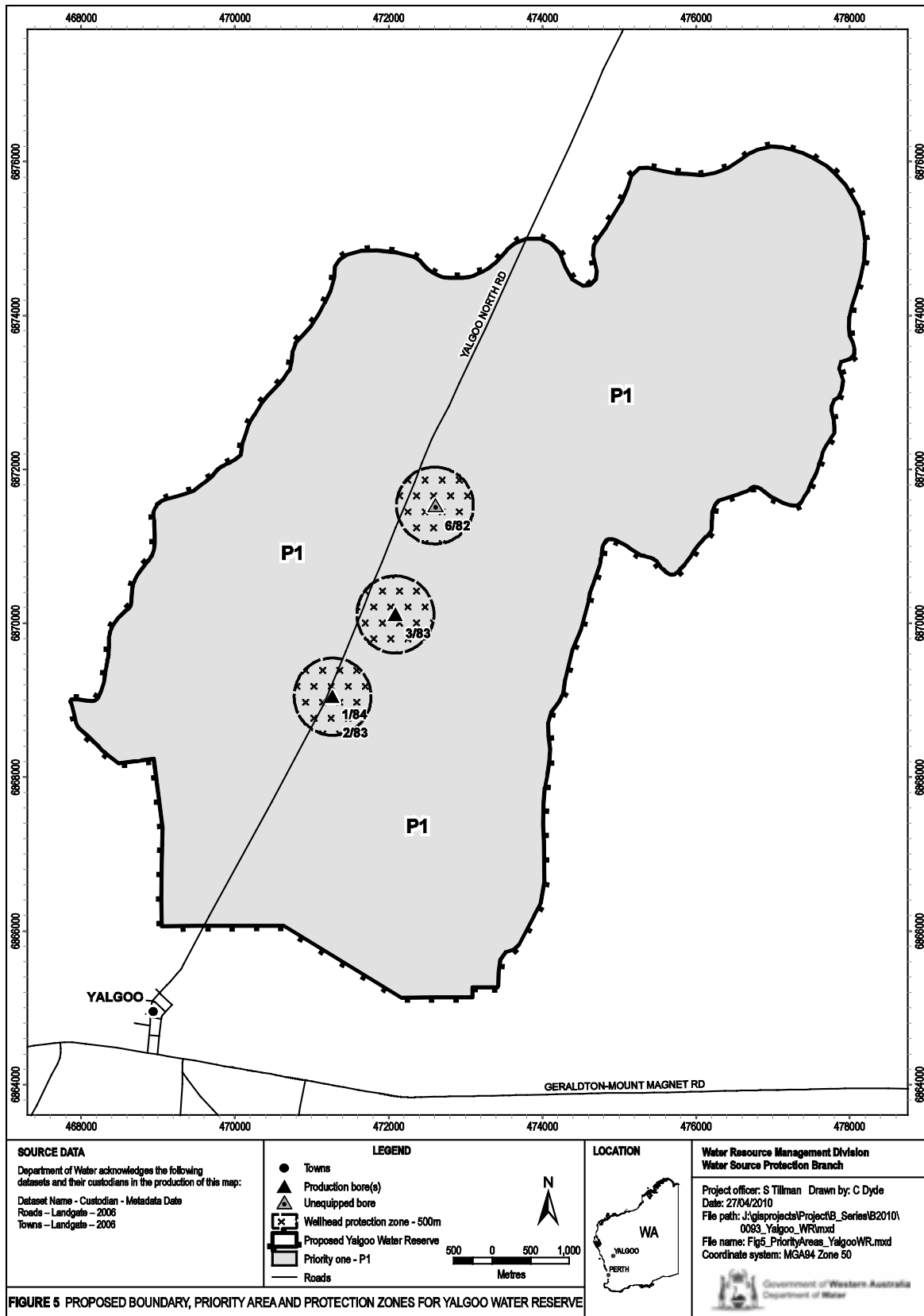
Appendix A Figures











Appendix B 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 Yalgoo Borefield in accordance with the Australian Drinking Water Guidelines (ADWG) and interpretations agreed to with the Department of Health. The raw water is regularly monitored for:

a. Aesthetic related characteristics– (Non-Health Related)

b. Health related characteristics

- Health Related Chemicals
- Microbiological Contaminants

Following is data representative of the quality of raw water in Yalgoo Borefield. 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 customers tap. Results that exceed the 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 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 the ADWG. For more information on the quality of drinking water supplied to Yalgoo refer to the most recent Water Corporation Drinking Water Quality Annual Report at <www.watercorporation.com.au> What we do > Water quality > Water quality publications > Water quality annual report 2008-09.

Aesthetic Related Characteristics

Aesthetic water quality analyses for raw water from Yalgoo Borefield are summarised in Table 1.

The values are taken from ongoing monitoring for the period March 2005 to March 2010. 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 the ADWG are shaded.

Aesthetic related detections for Yalgoo Borefield

Parameter	Units	ADWG Aesthetic Guideline Value*	Yalgoo Borefield Raw Water SP	
			Range	Median
Chloride	mg/L	250	265 - 315	300
Colour - True	TCU	15	<1 – 3	<1
Fluoride	mg/L	1.5	0.2 – 0.25	0.2
Hardness as CaCO ₃	mg/L	200	320 – 362	339
Iron unfiltered	mg/L	0.3	<0.003 – 0.01	<0.003
Sodium	mg/L	180	155 – 190	175
Total filterable solids	mg/L	500	985 - 1060	1020
Turbidity	NTU	5	<0.1 – 1.2	<0.1
Zinc	mg/L	3	0.04 – 0.06	0.05
pH	NO UNIT	8.5	7.02 – 7.72	7.17

* 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 Yalgoo Borefield 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 March 2005 and March 2010 are summarised in Table 2. Any parameters that have on occasion exceeded the ADWG are shaded.

Health related detections for Yalgoo Borefield

Parameter	Units	ADWG Health Guideline Value*	Yalgoo Borefield Raw Water SP	
			Range	Median
Arsenic	mg/L	0.007	<0.002 – 0.03	0.009
Barium	mg/L	0.7	0.02 – 0.035	0.02
Boron	mg/L	4	0.34 – 0.42	0.38
Copper	mg/L	2	0.018 – 0.02	0.019
Fluoride	mg/L	1.5	0.2 – 0.25	0.25
Molybdenum	mg/L	0.05	<0.0005 – 0.0015	0.0012
Nitrate plus nitrite as N	mg/L	11.29	14 – 20.3	18.5

Parameter	Units	ADWG Health Guideline Value*	Yalgoo Borefield Raw Water SP	
			Range	Median
Selenium	mg/L	0.01	<0.003 – 0.008	0.0045
Sulphate	mg/L	500	50 - 71	63

* 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 (NHRMC & ARMCANZ, 1996).

Microbiological Contaminants

Microbiological testing of raw water samples from Yalgoo Borefield 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.

A detection of *Escherichia coli* in raw water abstracted from any bore may indicate contamination of faecal material through ingress in the bore, or recharge through to the aquifer. A count of less than 20 MPN (most probable number) per 100 mL sample is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark of the raw water (WHO 2004). As such, counts less than 20 MPN are seen as indicating raw water that has not been recently contaminated with faecal material.

During the reviewed period of March 2005 to March 2010, positive *Escherichia coli* counts were recorded in 10.23 % of samples with one sample being higher than 20 MPN/100ml. Yalgoo Borefield abstracts water from an unconfined aquifer. The nature of the aquifer is vulnerable to microbiological contamination from stock associated with nearby farming activities. Bore refurbishment, bore headwork upgrade and bore disinfection has occurred and since this work, detections have ceased.

Appendix C 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		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Stock grazing – sheep & goats- extensive	Pathogens from animal waste & carcasses	Medium	Shallow unconfined aquifer, low stocking rates, stock can get within 3-5 m of bores, area subject to flooding	Fenced, raised earth bore compounds, sealed bores, water quality monitoring, placement of stock watering points/ yards outside of WHPZs, surveillance, vegetation buffers, infiltration & detention time	Education, BMP, advise Pastoral Land Board of location & importance of Yalgoo WR, extend signage, WHPZs, consider fencing off WHPZs or extending fencing around bores
	Nutrients from animal waste	Medium			
	Pesticides used on animals &/or pasture	Medium	Low stocking rates hence low requirement for pesticides		
Pastoral lease infrastructure/ maintenance (including stock and domestic wells as contamination pathways)	Pathogens from human activity, household rubbish & septic systems	Medium	Shallow unconfined aquifer, area prone to flooding, closest bore is ~500m south from homestead activities, bore water likely to be high in nitrate	Planning controls, levee diverts flood water around homestead, vegetation buffers, infiltration and detention time	Education, BMP, WHPZs, ensure regular maintenance of septic systems, vehicles & machinery, bund/ contain chemical & machinery storage sites, extend signage, signage to include
	Nutrients from septic systems & fertilisers	Low			

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
	Hydrocarbons from machinery & vehicles	Low			emergency contact number.
Mining- exploration and extraction (including unsealed wells as contamination pathways)	Pathogens from human activity. Pathogens from animal waste & carcasses in old mine pits and shafts	Medium	Shallow unconfined aquifer, mining activities expected to increase, area subject to flooding, most existing pits and diggings do not reach water table (however may change in winter/ flood), some old shafts infilling	Surveillance, signage, planning controls, various legislation, water quality monitoring, infiltration & detention time	Education, BMP, extend signage, signage to include emergency contact number, WHPZs, location of camps, chemical storage, wastewater systems, drilling etc out of WHPZs, fence off or infill exposed pits, ensure future wells, pits and shafts are infilled, fenced or capped when mining ceases.
	Hydrocarbons from machinery/ vehicles	Medium			
Roads and tracks	Hydrocarbons & chemicals from vehicles & machinery	Medium	Unsealed road passes close to bores through WHPZ, some mining haulage, tracks are accessible by public, roadside table drains along Yalgoo North Rd - may cause pooling of contaminated water within WHPZs	Surveillance, signage, bores on raised earth mound, water quality monitoring, signage, LEMC response, infiltration & detention time	Education, BMP, extend signage, signage to include emergency contact number, WHPZs, investigate roadside drainage system, advise LEMC of location & importance of Yalgoo WR
	Herbicides from road/ track maintenance	Low			

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Telecommunications lines and tower, power lines	Hydrocarbons from powers sources/ maintenance vehicles	Low	Essential utilities, tower on isolated hill, low maintenance	Tower is fenced & is run on solar power & valve regulated batteries, surveillance	Education, BMP, extend signage, signage to include emergency contact number
Drinking water treatment plant & backwash ponds	Hydrocarbons, chemicals & nutrients from plant infrastructure & maintenance vehicles	Medium	Above ground tanks, on site chemicals, within WHPZ, essential for water treatment	Concrete bunding, fenced site, signage, site infrastructure & water quality monitoring, lined ponds, trained personnel, Emergency response plan, spill kit	Education, BMP, WHPZs, replace/ extend signage where necessary, signage to include emergency contact number, relocate out of WHPZ if opportunity arises, ensure regular maintenance of septic systems
	Pathogens from human activity & septic systems	Medium	Within WHPZ, onsite toilet		

Appendix D Photographs



Photo 1 *Sheep grazing- pastoral lease falls over much of Yalgoo Water Reserve.*



Photo 2 *Typical stock watering point/ temporary holding pen (watering troughs are present but not shown)*



Photo 3 Groundwater is abstracted from the Yalgoo Borefield before being treated, pumped to the Yalgoo storage tank (where photo taken) and gravity fed into Yalgoo town.



Photo 4 Production bore 3/83- located on a raised earth mound within a fenced, signed compound (signage not visible in this photograph).



Photo 5 Evaporation ponds, located across the road from the Yalgoo drinking water treatment plant, store & evaporate wastewater from the plant.



Photo 6 The unsealed Yalgoo North Road (foreground) runs close to the Yalgoo drinking water treatment plant (background).



Photo 7 Bore 1/84 and 2/83 are located within the same compound as the treatment plant.



Photo 8 Inside Yalgoo drinking water treatment plant facility.

List of shortened forms

ADWG	<i>Australian drinking water guidelines</i>
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
ATU	aerobic treatment unit
bgl	below ground level
HAZMAT	hazardous materials
kL	Kilolitre
km	Kilometre
LEMC	local emergency management committee
m	Metres
mg/L	milligram per litre
mL	Millilitre
ML	Megalitre
mm	Millimetre
MPN	most probable number
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
PSC 88	public sector circular number 88
PDWSA	public drinking water source area
TCU	true colour units
TDS	total dissolved solids
WHPZ	wellhead protection zone

**WESTPLAN-
HAZMAT**

Western Australian plan for hazardous materials

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Adsorb	Adsorb means to accumulate on the surface of something. For example, microorganisms can adsorb onto soil particles.
Aesthetic guideline value	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMCC 2004a).
Australian drinking water guidelines	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2004</i> (NHMRC & NRMCC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's Bibliography).
Australian height datum	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
Allocation	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
Aerobic Treatment Unit	Aerobic Treatment Units (ATUs) are a more advanced multi stage alternative to conventional septic tanks and provide an improved quality of effluent treatment.
Aquifer	An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.
Bore	A bore is 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 is referred to as a bore field.
Catchment	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Effluent	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.
Electrical conductivity	This estimates the volume of TDS or the total volume of dissolved ions in a solution (water) corrected to 25°C. Measurement units include millisiemens per metre and microsiemens per centimetre.

Fractured rock	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.
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 2004a).
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 study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
Most probable number	Most probable number is a measure of microbiological contamination.
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i>), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i>) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.

pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
Pollution	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.
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.
Public drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> and the <i>Country Areas Water Supply Act 1947 (WA)</i> .
Recharge	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.
Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Runoff	Water that flows over the surface from a catchment area, including streams.
Scheme supply	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
True colour units	True colour units are a measure of degree of colour in water.
Total dissolved solids	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).

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 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.
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	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	A water reserve is an area proclaimed under the <i>Country Areas Water Supply Act 1947 (WA)</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater is referred to as the watertable.
Wellhead	The top of a well (or bore) used to draw groundwater is referred to as a wellhead.
Wellhead protection zone	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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