



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

*Looking after all our water needs*



**Donnybrook Water Reserve  
drinking water source protection plan  
Donnybrook Town Water Supply**



# Donnybrook Water Reserve drinking water source protection plan

Donnybrook town water supply

*Looking after all our water needs*

Department of Water

Water resource protection series

Final report

June 2009

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While the Department of Water has made all reasonable efforts to ensure the accuracy of these data, it accepts no responsibility 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>.

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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 Donnybrook Water Reserve and to recommend 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 supply of reliable, safe, good quality drinking water 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. Catchment protection requires an understanding of the catchment and the hazards and hazardous events that can compromise drinking water quality and the development of preventative strategies and operational controls to ensure the safest possible water supply to consumers.

This plan details the location and boundary of the drinking water source which provides potable water to the Donnybrook water supply. 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 guide state and local government land-use planning decisions. It should therefore be recognised in the *Shire of Donnybrook–Balingup local planning scheme*, consistent with the Western Australian Planning Commission's Statement of planning policy No. 2.7: *Public drinking water source policy* (2003). Other stakeholders should use this document as a guide for protecting water quality in the Donnybrook Water Reserve.

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.  2006	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.  2008	Advice sought from key stakeholders using the assessment document as a tool for information and discussion.
3	Prepare draft drinking water source protection plan.  (February 2009)	Draft protection plan developed taking into account input from stakeholders and any additional advice.
4	Release draft drinking water source protection plan.  (April 2009)	Draft protection plan released for a six-week public consultation period.
5	Publish approved drinking water source protection plan.  (June 2009)	Final protection plan published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of public drinking water source area can now occur.

## Summary

The town of Donnybrook is located in the south-west of Western Australia, about 40 km south-east of Bunbury on the Preston River (Figure 1). It is the administrative centre for the surrounding fruit and vegetable growing industry and rural and timber industries. The permanent population of Donnybrook is about 3000.

Drinking water for the town of Donnybrook is obtained from a wellfield located within the townsite comprised of six production bores screened in the Leederville Formation.

This formation is considered a shallow and unconfined aquifer, due to a thin cover of superficial sediments which allows direct recharge from rainfall. Accordingly, the Donnybrook wellfield is vulnerable to contamination from land uses.

The objective of this drinking water source protection plan is to protect the quality of water in the Donnybrook wellfield and to ensure the ongoing availability of safe, good quality drinking water to consumers. This will be achieved by:

- proclaiming the assessed recharge area as a water reserve under the *Country Areas Water Supply Act 1947*
- identifying wellhead protection zones (WHPZ) and priority areas to ensure risks from contamination are avoided, minimised or managed
- recommending the water reserve be adopted into the Shire of Donnybrook–Balingup’s Townsite Expansion Strategy and Town Planning Scheme
- implementing best management practice and water quality protection notes with the help of key stakeholders and the community
- increasing public awareness about drinking water protection issues specific to Donnybrook through this document, signage and brochures.

Recommended protection strategies, such as priority areas and wellhead protection zones, will be applied to the water reserve. Water quality will be preserved at its current level or improved where practical to provide a safe drinking water supply to the town of Donnybrook.

The plan recognises the right for existing approved land uses to continue to operate in the water reserve. For example, the wellfield is located close to Noneycup Creek along with a number of potentially contaminating land uses. It is important that these land uses are subject to best management practice to protect water quality.



# 1 Drinking water source overview

## 1.1 Existing water supply system

The town of Donnybrook obtains drinking water from a wellfield which comprises six production bores (11, 1/75, 2/75, 3/75, 2/82 and 1/84). In addition to the production bores, there are three monitoring bores (10, 12 and 5B/75). All bores are located on the western part of the Donnybrook townsite (Figure 2). Production bores are screened in Donnybrook sandstone at various depths within the Leederville Formation (Table 1).

Water is pumped from the production bores to a water treatment plant located in Trigwell Street. Following treatment, the water is stored in a 4500 kilolitre (kL) tank before being distributed to consumers.

Table 1 Donnybrook production bore details

Bore	Location	Depth (m bTOC*)	Screen Interval (m bTOC*)
11	Reserve St	65	57.0–64.2
1/75	Baxter St	25	17.9–25.1
2/75	Marmion St	22	15.4–22.6
3/75	Golf Links	74	43.3–73.1
2/82	Baxter St	21	15.4–21.0
1/84	Scout Hall	91	35.05–59.05

(\*metres below top of casing)

## 1.2 Water treatment

Raw water from the Donnybrook wellfield is aerated and dosed with caustic soda for pH correction, chlorinated and then stored in the tank for distribution. Chlorination is a disinfection barrier against possible microbiological contamination.

It should be recognised that although treatment and disinfection are essential barriers against contamination, management of the wellfield is the first step in protecting water quality. This approach is endorsed by the *National water quality management strategy: Australian drinking water guidelines* (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, lower cost drinking water supply to consumers than either barrier could achieve individually.

## 1.3 Catchment details

### 1.3.1 Physiography

The town of Donnybrook is located on the Darling Fault, straddling the Preston River. The Darling Fault delineates the eastern periphery of the southern Perth basin and separates the Archaean granitic rocks of the Yilgarn Block to the east from sediments in the Bunbury Trough, a structural sub-division of the Perth Basin (Wilde & Walker 1982). The Darling Scarp which marks the western edge of the Darling Plateau lies between 1 and 3 km to the east of the town with the gently undulating Blackwood Plateau to the west. The Blackwood Plateau ranges from 80 to 180 m above sea level, with the surface comprising thin superficial formations above the Cretaceous Leederville Formation.

### 1.3.2 Climate

Donnybrook experiences a Mediterranean-type of climate, with warm dry summers and cool wet winters. The average annual rainfall for Donnybrook is 985.1 mm. The mean maximum / minimum temperatures for Donnybrook range from 13.9 °C to 30.4 °C in January, and from 5.7 °C to 16.5 °C in July. For more information on the climate in Donnybrook, go to the Bureau of Meteorology website at <[www.bom.gov.au](http://www.bom.gov.au)>.

### 1.3.3 Hydrogeology

The Leederville Formation consists of discontinuous beds of sandstone, siltstone and shale, which forms a multi-layered aquifer system (Wharton 1981). Two main aquifer systems have been identified near Donnybrook, described as the Leederville Formation and the Lower Leederville Formation. These formations are separated by a 50 to 75 m thick shale layer. The upper formation extends from the surface to depths of around 110 m, the top of the lower aquifer being found at depths of around 180 m (Water Authority 1995). Groundwater is abstracted for the town water supply from the Leederville Formation at depths ranging from 15 to 64 m (Table 1).

Recharge to the Leederville Formation is primarily by direct infiltration from rainfall on the Blackwood Plateau where the formation outcrops. However, direct recharge also occurs in the Donnybrook townsite and surrounds. Groundwater flow in the Leederville Formation is towards the north-west and is strongly controlled by the Darling Fault, which acts as a hydraulic barrier along the eastern margin of the Bunbury Trough (Water Corporation 2006).

Groundwater quality in the Leederville Formation is generally fresh to marginal and commonly has a high iron content.

Within Donnybrook the Leederville Formation is considered unconfined, due to a thin cover of superficial sediments which allows direct recharge from rainfall. For this reason the Leederville aquifer is vulnerable to contamination from land uses in this area.

### 1.3.4 Hydrology

Noneycup Creek is also considered to recharge the Leederville Formation. As a result, the Leschenault Estuary–Preston River subcatchment area for Noneycup Creek has been used for the boundaries of the Donnybrook Water Reserve.

A flood study using the physical geography of Noneycup Creek conducted in 1988 indicates there is potential for production bore 2/75 to be affected by a 1 in 100 year flood event. This type of event may also flood parts of the light industrial area located on Marmion St and increase the risk of contamination to the drinking water source as it may transport chemicals, hydrocarbons, nutrients and pathogens from flooded areas into production bores.

## 1.4 Future water supply requirements

Future development of the Donnybrook town water supply is likely to be achieved through additional new production bores to the current wellfield. The drinking water source proposed for any additional bores was still being examined when this plan was published.

## 1.5 Existing drinking water source protection

The Donnybrook drinking water source has not yet been proclaimed through an Order in Council under the *Country Areas Water Supply Act 1947*.

This plan proposes to proclaim the Donnybrook Water Reserve and assign Priority 1 (P1), Priority 2 (P2) and Priority 3 (P3) areas. Appendix A describes the department's approach to drinking water source protection and explains the use of priority areas and protection zones used to help guide land use planning.

In 2006 the Water Corporation prepared the Donnybrook Water Reserve drinking water source protection assessment (Water Corporation 2006). That document outlined risks to water quality from land use activity in close proximity to the production bores used for supply of drinking water. This drinking water source protection plan builds upon and replaces the drinking water source protection assessment. It proposes that a water reserve based on the Leschenault Estuary–Preston River (Noneycup Creek) subcatchment area be utilised as the Donnybrook drinking water source, which includes a drainage channel known as Noneycup Creek.

The Shire of Donnybrook–Balingup has undertaken rehabilitation work along the banks of the Noneycup Creek and has published the Draft Noneycup Creek Management Plan 2008–2013 (Shire of Donnybrook – Balingup, 2007a) .

The proposed rehabilitation of Noneycup Creek includes removal of weeds and replanting native vegetation.

Establishing a native vegetation buffer along this creek will help to improve the water quality of surface water runoff entering the drainage channel.

This plan recommends the Shire of Donnybrook–Balingup recognises the Donnybrook Water Reserve within the Townsite Expansion Strategy and Town Planning Scheme No. 4 as a special control area, consistent with the Statement of planning policy No. 2.7: *Public drinking water source policy* (Western Australian Planning Commission 2003). The types of development supported in the water reserve are described in the Department of Water's water quality protection note: *Land use compatibility in public drinking water sources areas* (Department of Water various dates).

## 1.6 Department of Water management

### 1.6.1 South West regional water plan

Other relevant Department of Water publications within Donnybrook include:

The *draft South West regional water plan*, published in June 2008, provides the strategic direction for water management in the South West region of Western Australia. It can be obtained from the Department of Water website; see <[www.water.wa.gov.au](http://www.water.wa.gov.au)> Regional and rural WA > Regional water plans > South West regional water plan.

### 1.6.2 South West groundwater areas allocation plan

The *South West groundwater areas allocation plan*, sets out where water is available, the policies for how all groundwater abstraction and use will be managed in the area, and how the ecological, social and economic needs for water have been considered. The plan also provides for water trading in fully allocated resources.

### 1.6.3 Preston River flood study

The *Preston River flood study* within the Donnybrook townsite (Noneycup Creek) assessed the designated floodway and levels for a 1 in 100 year flood event. The study and map was conducted using the physiographic (physical geography) state of the river as it existed in 1988. The flood study can be obtained by contacting the Department of Water on telephone: +61 8 6364 7600.

### 1.6.4 Current allocation licence

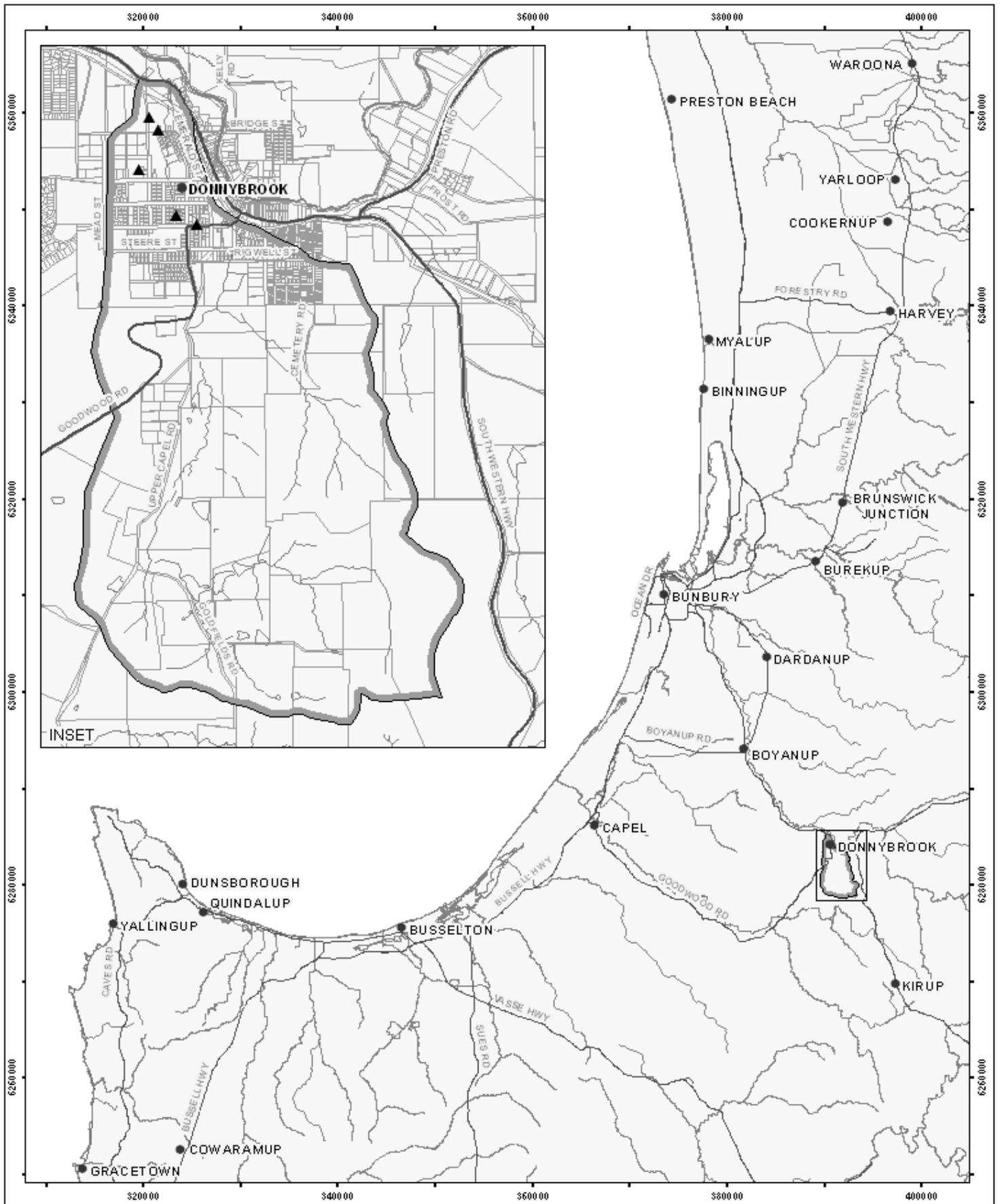
Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914* (the RIWI Act). Under this Act, the right to use and control surface and groundwater is vested with the Crown. This Act requires licensing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

The RIWI Act requires a licence to draw water from surface water and groundwater areas proclaimed under the Act (except for domestic and stock use) and all artesian wells throughout the state.

The Donnybrook groundwater resource lies within the Busselton–Capel Groundwater Area, which was proclaimed in 1989 under the RIWI Act.

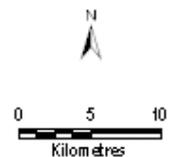
The Water Corporation is licensed to draw 450 000 kL (Groundwater Well Licence No. GWL70002(3)) per annum from the Leederville Formation in the Donnybrook area for public water supply purposes.

The current number of services is 738, made up of 607 domestic, 73 commercial and 58 other water use services. Abstraction in 2007–2008 was 411 522 kL.



**SOURCE DATA**  
 Department of Water acknowledges the following datasets and their custodians in the production of this map:  
 Dataset Name - Custodian - Metadata Date  
 Production bores - Water Corporation - 2008  
 Cadastre land tenure - Landgate - 2008  
 Roads and towns - Landgate - 2006

- LEGEND**
- Towns
  - ▲ Water Corporation Production Bores
  - Roads
  - Hydrography
  - Donnybrook Water Reserve
  - Cadastre

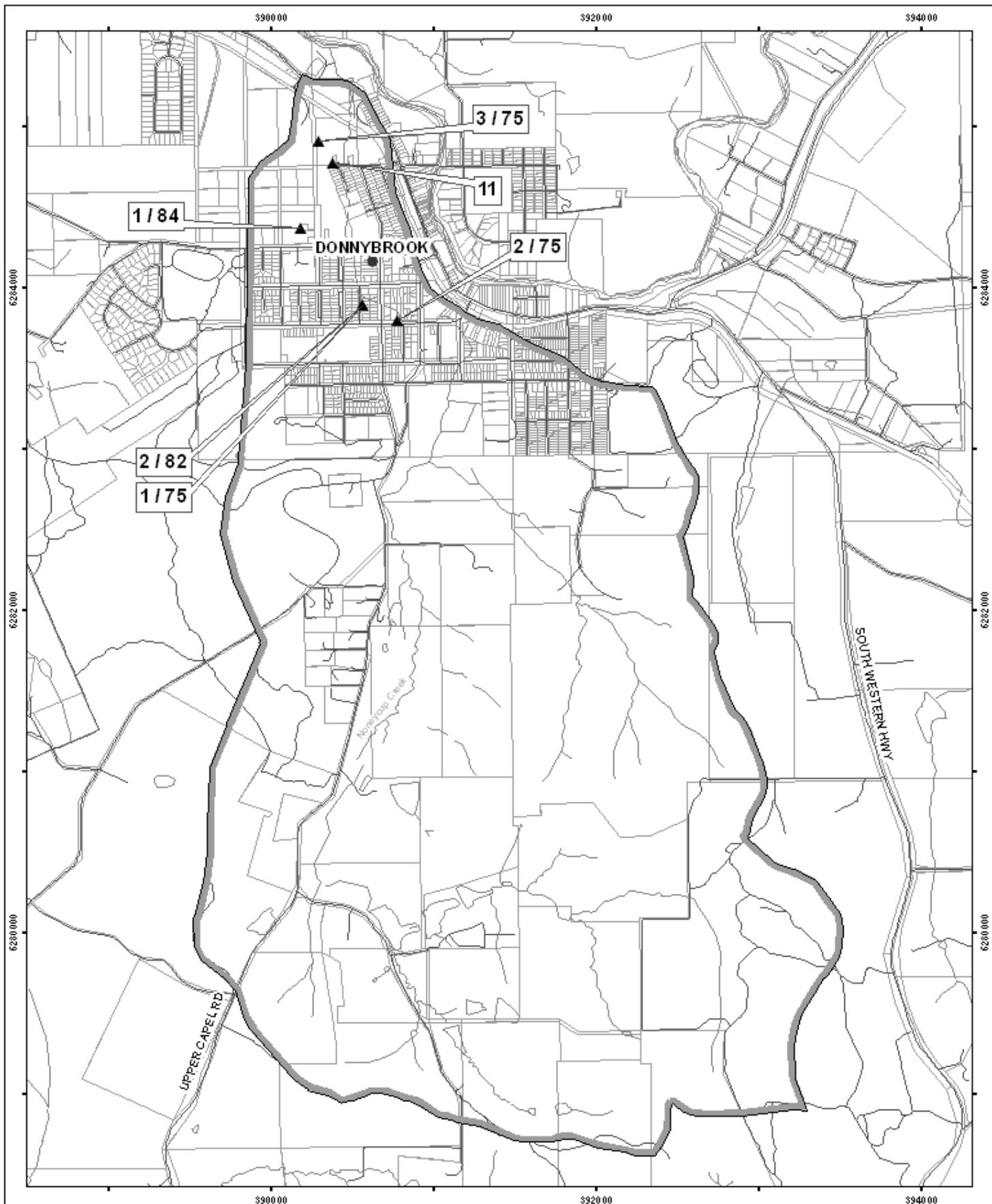


Water Resource Management Division  
 Water Source Protection Branch

Project officer: C. Roberts  
 Drawn by: H. Wallace  
 Date: 22/12/2008  
 File path: J:\gisprojects\Project6\_Series/  
 B2010.0057\_Donnybrookkm.sxd  
 File name: Donnybrook\_Fig1\_A4p.mxd  
 Coordinate system: MGA94 Zone 50



**FIGURE 1** DONNYBROOK WATER RESERVE LOCALITY MAP



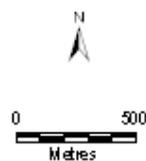
**SOURCE DATA**

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- Dataset Name - Custodian - Metadata Date
- Production bores - Water Corporation - 2008
- Cadastral land tenure - Landgate - 2008
- Roads and towns - Landgate - 2006
- Public drinking water source areas - DoW - 2008

**LEGEND**

- Towns
- ▲ Water Corporation Production Bores
- Roads
- Hydrography
- █ Donnybrook Water Reserve
- Cadastre



**LOCATION**



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Project officer: C Roberts  
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 Date: 23/12/2008  
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 B2010.M057\_Donnybrook.mxd/  
 File name: Donnybrook\_Fig2\_P4p.mxd  
 Coordinate system: MGA94 Zone 50



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**FIGURE 2 DONNYBROOK WATER RESERVE**

## 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 Donnybrook wellfield for microbiological, health-related and aesthetic (non-health-related) characteristics. This data shows the quality of water in the catchment. An assessment of the drinking water quality is then compared with the ADWG.

A water quality summary for the Donnybrook town water supply from November 2003 to October 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)> > Publications > Water Quality > Latest Annual Report.

Contamination risks relevant to the Donnybrook Water Reserve drinking water sources are described below.

### 2.1 Microbiological contaminants

Microbiological testing of raw water samples is conducted for pathogens which are types of micro-organisms that are capable of causing disease. These include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are mostly found in the faeces 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 (*salmonella*, *Escherichia coli* and cholera), protozoa (*Cryptosporidium*, *Giardia*) and viruses.

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 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).

When people (while fishing, marroning, swimming or the like) or domestic animals come into contact with a body of water, pathogens may enter that water source. This primarily occurs through the direct transfer of faecal material (even a very small

amount can cause contamination) or indirectly through runoff transporting faecal material into the water.

The ability of pathogens to survive in surface 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 & NRMCC 2004a).

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 Canada (Walkerton 2000) (Hrudey, SE & Hrudey, EJ 2004) seven people died due to contamination of the town water source and supply by a pathogenic strain of *Escherichia coli* and campylobacter (NHMRC & NRMCC 2004b). Preventing the introduction of pathogens into the water source is the most effective barrier in avoiding this public health risk from pathogens.

## 2.2 Health-related characteristics

Land- and water-based uses and activities within a catchment can directly impact on water quality and treatment. For example, off-road driving contributes to erosion and the uprooting of vegetation which can increase turbidity in water. Subsequently, the effectiveness of treatment, such as disinfection processes, can be reduced with increased turbidity.

Erosion results in the mobilisation of soil particles that are released into the air and tributaries, increasing the turbidity of the main water body. Pathogens can adsorb onto these soil particles and may be shielded from the effects of disinfection. Increased turbidity also impacts upon other environmental constituents, for example, smothering riparian vegetation and reducing the transfer of light within the water column, which affects plant growth.

Chemicals attached to suspended material, such as soil particles, can occur in drinking water sources as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMCC 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 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.

Drinking water supplies can be contaminated by nutrients such as nitrogen as a result of leaching from fertiliser application, faulty septic systems, leach drains and

from domestic animal faecal matter that washes through or over soil and into the water source.

Nitrate and nitrite can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMMC 2004a).

Hydrocarbons (for example, fuels, oils) are 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.

## 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 & NRMMC 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 Donnybrook Water Reserve is located within the Busselton–Capel groundwater area which is proclaimed under the RIWI Act. Under the provisions of Sections 26D and 5C of the RIWI Act, a licence is required to construct a bore or extract water within a proclaimed groundwater area, unless exempt under the RIWI Exemption and Repeal (Section 26C) Order 2001.

Drinking water bores are operated in the Donnybrook Water Reserve by the Water Corporation. If bores for other purposes (for example, 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 an otherwise uncontaminated aquifer.

It is therefore important to ensure that any bores are appropriately located and constructed in order to prevent contamination impacts on the public drinking water source.

This issue will be considered through the Department of Water's water licensing process where applicable under the RIWI Act. 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

Contamination risks that exist within the Donnybrook Water Reserve include light industrial land use, existing and approved future residential development, a hospital, horticultural activities, horse riding, a golf course and other recreational facilities (Figure 3). Appendix B summarises the land use hazards and management priorities identified for these risks.

#### 3.1.1 State forest

There are two state forest areas that are partially contained in the water reserve boundary which are the Wellington location 5024 - timber reserve No.17325 and the State forest No. 27. These areas cover approximately 16 per cent of the Donnybrook Water Reserve area and are located south-west and south-east of the Donnybrook townsite, respectively.

These state forest areas are vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation (DEC) under the *Conservation and Land Management Act 1984*. DEC is obligated under the Act to prepare its management plans in consultation with the Department of Water and the Water Corporation and submit them to the Minister for Water Resources.

DEC manages indigenous state forest and timber reserves according to the *Forest management plan 2004–2013 (FMP)* (Conservation Commission, 2004). The purpose of state forest and timber reserves as outlined in the FMP includes conservation, recreation, timber production of a sustainable yield basis, water catchment protection and other purposes prescribed by the *Conservation and Land Management Regulations 2002* (for example, beekeeping).

#### *Prescribed burns*

The Department of Environment and Conservation uses prescribed burns to maintain the biodiversity of the wide range of ecosystems in the state, to reduce fuel loads so that wildfires are not as destructive or extensive, to rehabilitate vegetation after disturbance (such as timber harvesting and mining), and to undertake research on fire and its interaction with the environment.

Table 2 summarises land use activities contained within state forest and those hazards and management priorities associated with the identified land uses.

**Table 2** *State forest land use and potential water quality risks*

Land use/activity (State forest)	Potential water quality risks	
	Hazard	Management priority
Wildflower picking Off-road vehicle use	Pathogens Turbidity	Low Low
Prescribed burning	Turbidity	Low
Landfill (upgradient of production bores)	Chemicals Pathogens	Medium / High Medium / High
Sewerage disposal	Pathogens Nutrients	Low Low
Silviculture practices	Turbidity	Low

### 3.1.2 Private land

Private land contained within the water reserve is zoned 'Residential', 'General Farming Pastoral', 'Light Industrial' and 'Commercial' within the Shire of Donnybrook–Balingup Town Planning Scheme No. 4 (District Scheme) (Shire of Donnybrook, 2008b).

The Donnybrook townsite consists predominantly of 'Residential' zoned land, with 'General Farming Pastoral' zoned private land located further south of the townsite. Table 3 lists identified contamination risks for private land use activities.

**Table 3** *Private land use and potential water quality risks*

Land use/activity (Private land)	Potential Contamination Risks	
	Hazard	Management priority
Existing residential areas Private gardens	Pathogens Nutrients	High Medium
Residential development (Stormwater and drainage from residential developments is incorporated into Noneycup Creek) through the stormwater drainage system).	Chemicals (acid sulfate soils) Turbidity Pesticides Pathogens	Low Low Medium High
Domestic animals (horses and domestic animals)	Nutrients Pathogens	Medium High

Land use/activity (Private land)	Potential Contamination Risks	
	Hazard	Management priority
'General Farming Pastoral' zones in Local Planning Scheme Livestock access to Noneycup Creek Agricultural pesticide use Fertiliser application	Pathogens Pesticides Nutrients	Medium / High Low Low

### 3.1.3 Local Scheme Reserves

Local scheme reserves contained within the water reserve boundary consist of 'Parks and Recreation', 'Civil and Cultural Areas', 'Public Purposes' and 'Regional Road Reserves'. Current land use zonings and activity levels around the bores are not expected to change significantly in the foreseeable future. Future land use decisions should be made in accordance with this department's Water quality protection note: *Land use compatibility in public drinking water source areas*.

Table 4 Land use and potential water quality risks in local scheme reserves

Land use/activity (Local Scheme Reserves)	Potential water quality risks	
	Hazard	Management priority
Golf course (Donnybrook Country Club) Fertiliser application Pesticide application Septic sewerage system	Nutrients Pesticides Pathogens	Medium Low Medium
Lawn bowls Fertiliser application Pesticide application	Nutrients Pesticides	Low Low
Recreation centre (swimming pool and tennis courts) Fertiliser application Pesticide application Septic sewerage system	Nutrients Pesticides Pathogens	Low Low Medium
Football club and oval Fertiliser application Pesticide application Septic sewerage system	Nutrients Pesticides Pathogens	Low Low Medium
Egan Park (sporting complex and showgrounds) Fertiliser application Pesticide application Septic sewerage system	Nutrients Pesticides Pathogens	Medium Medium High
Scout hall Septic waste	Pathogens	High

Land use/activity (Local Scheme Reserves)	Potential water quality risks	
	Hazard	Management priority
<b>Services</b>		
Hospital and St. John Ambulance	Pathogens	High
Schools (3 primary; 2 secondary), Tuia Lodge (aged care home), churches (3) and public toilets Fertiliser application Pesticide application Septic sewerage system	Nutrients Pesticides Pathogens	Medium Medium Medium
Sewerage pumping station	Pathogens	High
South West Highway Contamination risks associated with vehicle transportation Stormwater runoff from roads Stormwater runoff from main roads, residential and light industrial areas is currently incorporated into Noneycup Creek.	Hydrocarbons Turbidity Chemical Heavy Metals	High High High High
<b>Light Industry</b>		
Machinery yards Stormwater runoff from machinery yards may transport hydrocarbons, heavy metals and turbidity into Noneycup Creek and into close proximity to production bores. A 1 in 100 year flood event may increase the transport and risk of contaminants to the production bores. Septic sewerage system	Hydrocarbons Nutrient Turbidity Heavy Metals  Pathogens	Medium Medium Medium Medium  Medium
Tyre centres Hydrocarbons and heavy metals can leach from disposed tyres within landfill site and tyre centres into Noneycup Creek. Septic sewerage system	Heavy Metals Hydrocarbons ( <u>benzene</u> , <u>toluene</u> , <u>ethylbenzene</u> , and <u>xylenes</u> –( BTEX)) Pathogens	Low Low  High
Auto-electrics/ transport companies Heavy metals and hydrocarbons associated with above-ground fuel storage Septic sewerage system	Heavy metals (lead and copper) Hydrocarbons Pathogens	Low  Medium High
General light industry and metal fabrication/ veterinary Stormwater runoff may transport hydrocarbons and chemicals into Noneycup Creek. Septic sewerage system	Hydrocarbons Chemicals Pathogens	High High High

Land use/activity (Local Scheme Reserves)	Potential water quality risks	
	Hazard	Management priority
<b>Commercial</b>		
Taverns/ motel Septic sewerage system	Pathogens	Low
Fuel stations (4) Hydrocarbons including heavy metals	Hydrocarbons Heavy Metals	Low Low

### 3.1.4 Aboriginal sites of significance

Aboriginal sites of significance are those areas which 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. In Western Australia the *Aboriginal Heritage Act 1972* protects all Aboriginal sites.

There are three Aboriginal sites of significance within the Donnybrook Water Reserve. Those sites are the Donnybrook (S00270) site, Preston River (lodged) site and the Donnybrook Camp Site (further information required). Refer to Appendix D for a map depicting Aboriginal Sites of Significance in relation to the Donnybrook Water Reserve. Note that the status regarding these Sites of Significance was current as of the date of this publication. For further information on Aboriginal Sites of Significance, see the Department of Indigenous Affairs website at < [www.dia.wa.gov.au](http://www.dia.wa.gov.au) > > Heritage & Culture > Aboriginal sites.

### 3.1.5 Native title

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

There is a native title claim within the Donnybrook Water Reserve. This claim is the Gnaala Karla Booja (WAD6274/98) (accepted for registry at the time of this plan).

## 3.2 Proposed land uses and activities

Proposed land uses and activities that may pose a contamination risk to the Donnybrook town water supply need to be considered through the Western Australian Planning Commission's Statement of planning policy No. 2.7: *Public drinking water source policy* (2003). The Shire of Donnybrook–Balingup's *Townsite Expansion Strategy* (Shire of Donnybrook, 2008) and the *Local Rural Strategy* (Shire of Donnybrook, 2007) should also address this statement of planning policy and the public drinking water source area (PDWSA) protection strategies contained within this document.

### 3.2.1 Townsite Expansion Strategy

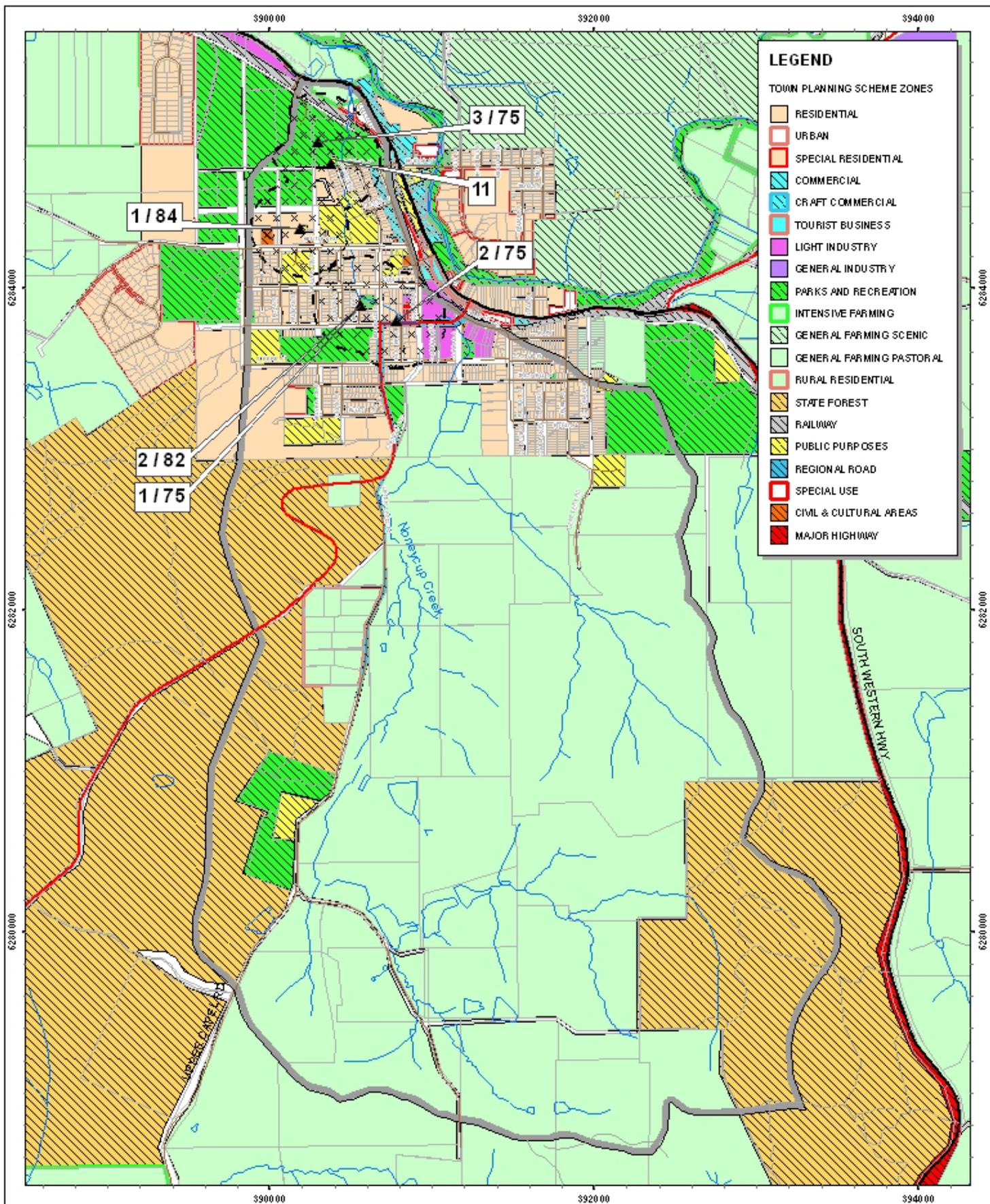
The Shire of Donnybrook–Balingup 's *Townsite Expansion Strategy* (consultation draft published June 2008) has defined planning precincts based on the General Townsite Strategy 2 (GS2) for the Donnybrook townsite.

The Donnybrook Water Reserve encompasses the *Central, Parks and Recreation, Living Streams, South Park* and *Residential East* precincts.

Drinking water quality protection initiatives in this drinking water source protection plan (DWSP) should be included in the key strategies for each precinct. Implementation of recommendations within this plan should be used to guide the water management plan that is to be actioned as part of the *Townsite Expansion Strategy* (Shire of Donnybrook, 2008).

### 3.2.2 Local Rural Strategy

Drinking water quality protection initiatives in this DWSP should coincide with the objectives of the Shire of Donnybrook–Balingup *Local Rural Strategy* (Shire of Donnybrook, 2007) published August 2008. In particular, recommendations within the DWSP should be incorporated into the water sensitive design approach noted as a key objective of the planning strategy.



**SOURCE DATA**

Department of Water acknowledges the following datasets and their custodians in the production of this map:

Dataset Name - Custodian - Metadata Date  
 Production bores - Water Corporation - 2008  
 Cadastre land tenure - Landgate - 2008  
 Roads and towns - Landgate - 2006  
 Town planning schemes - WAPanning Commission - 2007

**LEGEND**

- ▲ Water Corporation Production Bores
- Hydrography
- Cadastre
- ▭ Wellhead Protection Zone
- ▭ Donnybrook Water Reserve

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Metres



Water Resource Management Division  
 Water Source Protection Branch

Project officer: C. Roberts  
 Drawn by: H. Wallace  
 Date: 6/11/2009  
 File path: J:\gisprojects\Project6\_Series\B2010\0057\_Donnybrook.mxd  
 File name: Donnybrook\_Fig 3\_A4p Colour.mxd  
 Coordinate system: MGA94 Zone 50



**FIGURE 3** CURRENT LGA SCHEME ZONING IN DONNYBROOK WATER RESERVE

## 4 Catchment protection strategy

### 4.1 Protection objective

The objective of water source protection in the Donnybrook Water Reserve is to preserve water quality at its current level and where practical, achieve an improvement.

The plan recognises the right of existing approved land uses to continue to operate in the water reserve. However, avoidance, minimisation and management of risks to water quality (in that order) are imperative for the protection of public health and ongoing availability of a reliable, safe, good quality drinking water to consumers.

### 4.2 Proclaimed area

The water reserve for the Donnybrook drinking water source area has been defined using the location of the wellfield and the catchment area of Noneycup Creek. The Donnybrook Water Reserve is recommended to be proclaimed under the *Country Areas Water Supply Act 1947* to ensure the appropriate protection of this water supply source (Figure 2 and 3).

### 4.3 Priority areas

The protection of PDWSAs relies on the integration of 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 mitigation.

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 the existing approved land uses or activities.

The priority areas for the Donnybrook Water Reserve have been determined in accordance with current Department of Water policy. These areas are described below and displayed in Figure 4. Within each priority area, guidance on appropriate land uses is provided in the Department of Water's water quality protection note: *Land use compatibility in public drinking water source areas*.

## Priority 1

Land use management within those areas of Wellington location 5024 and State forest 27 timber reserve contained within the water reserve boundary, should be consistent with water source protection policies and protection strategies for the P1 area. However, a sewerage disposal area and landfill located within the Wellington location 5024 timber reserve is to be managed as a P3 area (Figure 4).

## Priority 2

Areas zoned 'General Farming Pastoral' determined by the Shire of Donnybrook–Balingup Town Planning Scheme No. 4 (District Scheme), within the water reserve boundary are recommended to be managed as a P2 area (Figure 4).

The P2 area will not affect existing approved land use practices in the General Farming Pastoral zone, such as broad acre cropping, orchards, wineries and vineyards and stock grazing.

Subdivision potential compatible with the Shire's Town Planning Scheme No. 4 will not be affected as result of the P2 area.

Best management practice for existing land uses is recommended to minimise the risk of contamination to the drinking water source. This includes preventing stock access to Noneycup Creek and implementing best practice regarding the storage and use of fertilisers and pesticides.

## Priority 3

Management of urban areas zoned 'Residential', 'Commercial' and 'Light Industrial', including local scheme reserves determined through the Donnybrook–Balingup Town Planning Scheme No 4 (District Scheme) located within the Donnybrook townsite and water reserve to be conducted through a P3 area (Figure 4).

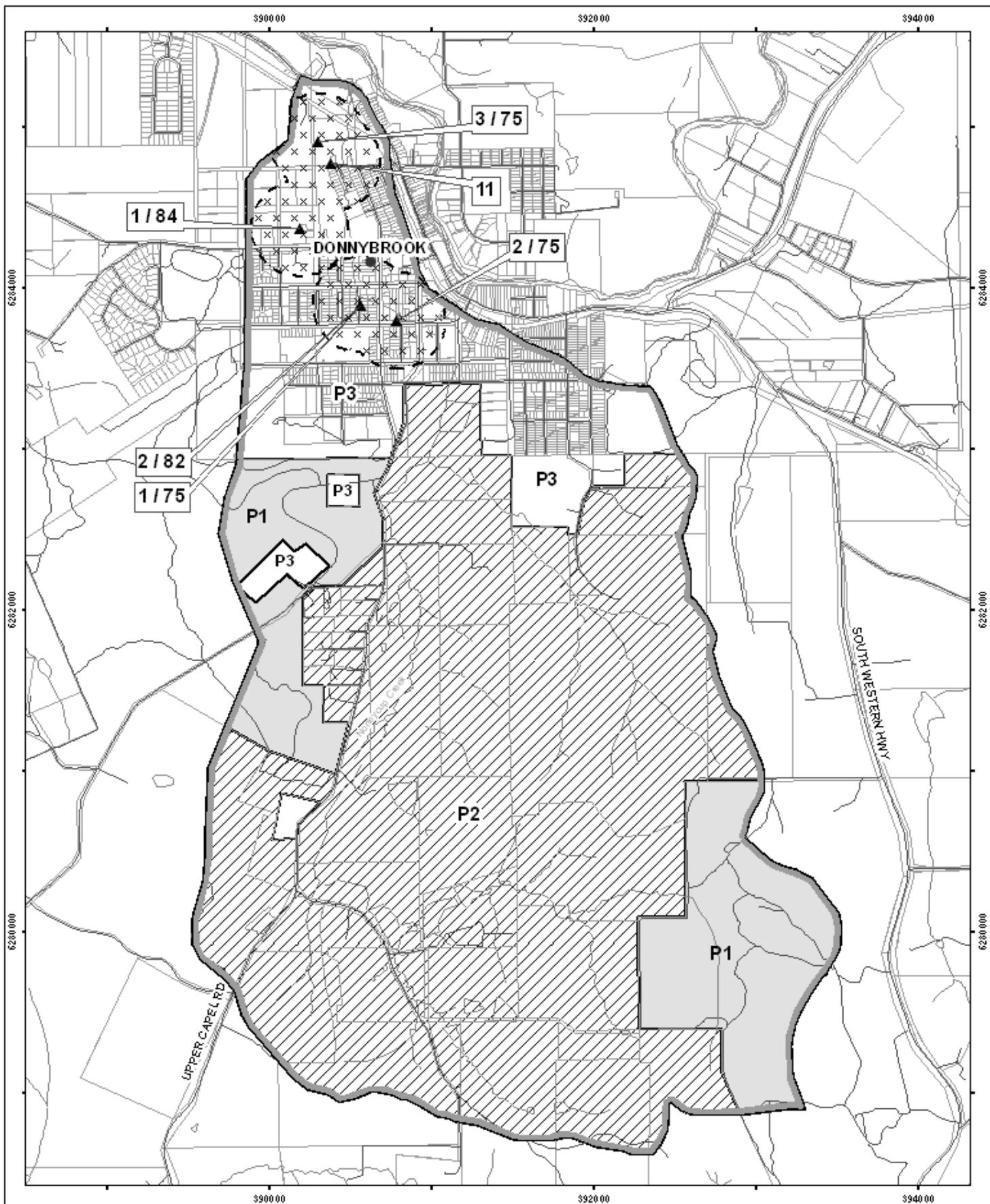
Those areas zoned as 'Residential', 'Commercial' and 'Light Industrial' will be managed to prevent the risk of contamination. However, existing approved land uses will not change as a result of the P3 area.

## 4.4 Protection zones

In addition to P1, P2 and P3 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 (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.

For each production bore that supplies the Donnybrook town water supply, a WHPZ of 300 m radius will apply (Figure 4).



**SOURCE DATA**  
 Department of Water acknowledges the following datasets and their custodians in the production of this map:  
 Dataset Name - Custodian - Metadata Date  
 Production bores - Water Corporation - 2008  
 Cadastre land tenure - Landgate - 2008  
 Roads and towns - Landgate - 2006  
 Town planning schemes - WAPanning Commission - 2007

**LEGEND**

● Toams	□ Cadastre
▲ Water Corporation Production Bores	— Roads
■ Donnybrook Water Reserve	— Hydrography
▨ Wellhead Protection Zone	
▩ P1 Priority One Area	
▨ P2 Priority Two Area	
▩ P3 Priority Three Area	

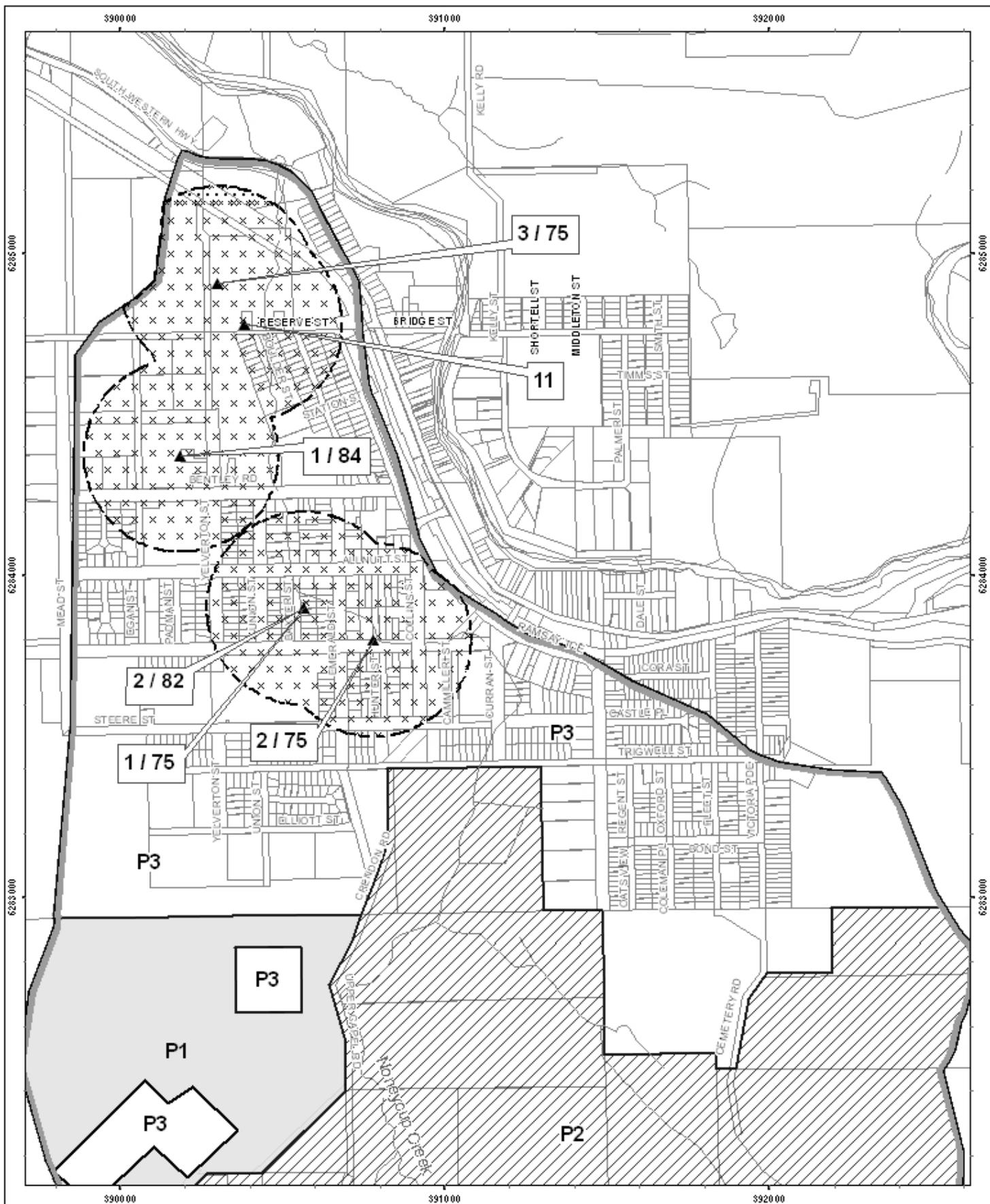
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Water Resource Management Division  
 Water Source Protection Branch

Project officer: C Roberts  
 Drawn by: H Wallace  
 Date: 10/12/2008  
 File path: J:\gisprojects\Project6\_Series/  
 B2010\0057\_Donnybrook\mxd/  
 File name: Donnybrook\_Fig 4\_A4p.mxd  
 Coordinate system: MGA94 Zone 50

**FIGURE 4 DONNYBROOK WATER RESERVE PRIORITY AREAS AND PROTECTION ZONES**

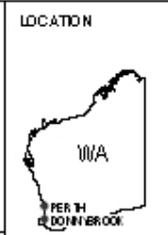


**SOURCE DATA**  
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 Town planning schemes - WAPanning Commission - 2007

**LEGEND**

- ▲ Water Corporation Production Bores
- Donnybrook Water Reserve
- Wellhead Protection Zone
- ▨ P1 Priority One Area
- ▧ P2 Priority Two Area
- ▩ P3 Priority Three Area
- Cadastre
- Hydrography

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Water Resource Management Division  
 Water Source Protection Branch

Project officer: C. Roberts  
 Drawn by: H. Wallace  
 Date: 19/12/2008  
 File path: J:\gisprojects\Project6\_Series\B2010.0057\_Donnybrook.mxd  
 File name: Donnybrook\_Fig 5\_A4p.mxd  
 Coordinate system: MGA94 Zone 50

Government of Western Australia  
 Department of Water

**FIGURE 5 DONNYBROOK TOWN SITE**

## 4.5 Land use planning

Under the *State planning strategy* (Western Australian Planning Commission 1997) the establishment of appropriate protection mechanisms in statutory land-use planning processes is 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 Donnybrook Water Reserve priority areas and protection zones be recognised in the *Shire of Donnybrook–Balingup town planning scheme* (Shire of Donnybrook, 2008b). Any development proposals within the Donnybrook 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 for advice. For further information on the integration of land use planning and water source protection, please refer to the Department of Water's water quality protection note: *Protecting public drinking water source areas*.

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 which 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.

## 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 water sources.

There are guidelines 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 this department's water quality protection notes *Nutrient and irrigation management plans* and *Light Industry near sensitive waters*, which are listed in the *Bibliography* section of this document.

These guidelines help managers reduce the water quality impacts of their operations and are the recommended practice to ensure the protection of water quality.

Community education and creating awareness (for example, through signage and information) are also key mechanisms for protecting the quality of water, especially among people visiting the area.

A brochure will be produced once this plan is finalised, describing the Donnybrook 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 water in public drinking water source areas within country areas of the state is protected under the *Country Areas Water Supply Act 1947*. 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, 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. This plan recommends that surveillance and by-law enforcement for the Donnybrook Water Reserve be delegated to the Water Corporation.

## 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 Donnybrook–Balingup Local Emergency Management Committee, through the South West Emergency Management District, should be familiar with the location and purpose of the Donnybrook Water Reserve. A locality plan should be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) Emergency Advisory Team.

DEC is the lead agency for wildfire control management for the majority of the water reserve that is outside of the gazetted fire emergency response zone. Water Corporation should have an advisory role to the HAZMAT team for incidents in the Donnybrook 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 Donnybrook 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

This plan identifies potential water quality risks associated with existing land uses in the Donnybrook Water Reserve and recommends protection strategies to deal with those risks.

Following completion of the final *Donnybrook Water Reserve drinking water source protection plan*, an implementation strategy will be drawn up based on its recommendations.

## 5 Recommendations

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

- 1 The Donnybrook Water Reserve should be proclaimed under the *Country Areas Water Supply Act 1947* (Department of Water).
- 2 An implementation strategy should be developed for the recommendations in this plan (including the recommended protection strategies detailed in Appendix B) (Department of Water, applicable stakeholders).
- 3 The *Donnybrook–Balingup local rural strategy and townsite expansion strategy* should incorporate this plan and reflect the identified Donnybrook Water Reserve boundary, Priority 1, 2 and 3 areas and protection zones in accordance with Statement of planning policy No. 2.7: *Public drinking water source policy* (Shire of Donnybrook–Balingup).
- 4 The Shire of Donnybrook–Balingup Town Planning Scheme should incorporate this plan and reflect the identified Donnybrook Water Reserve boundary, Priority 1, 2 and 3 areas and wellhead protection zones in accordance with Statement of planning policy No. 2.7: *Public drinking water source policy* (Shire of Donnybrook–Balingup).
- 5 All development proposals within the Donnybrook 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 plan should be referred to the Department of Water for advice and recommendations (Department for Planning and Infrastructure, Shire of Donnybrook – Balingup, proponents of proposals).
- 6 Incidents covered by WESTPLAN–HAZMAT in the Donnybrook Water Reserve should be addressed through the following:
  - the Donnybrook Local Emergency Management Committee should be aware of the location and purpose of the Donnybrook Water Reserve;
  - the locality plan for the Donnybrook Water Reserve is provided to the Fire and Rescue headquarters for the HAZMAT Emergency Advisory Team;
  - the Water Corporation provides an advisory role during incidents in the Donnybrook Water Reserve; and
  - personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Donnybrook Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality (Department of Water; Water Corporation).

- 7 The Water Corporation's existing monitoring and surveillance program for the town wellfield should be maintained to identify any incompatible land uses or potential contamination threats.
- 8 The Water Corporation's infill sewerage programme should be prioritised for the completion in those areas contained within the Wellhead Protection Zones for the Donnybrook production bores.
- 9 The Water Corporation should investigate alternative drinking water sources for Donnybrook.
- 10 Pursuant to Section 13(1) of the *Water and Rivers Commission Act 1995*, the Department of Water should delegate responsibility for surveillance and enforcement measures within the Donnybrook Water Reserve to the Water Corporation (Department of Water, Water Corporation).
- 11 Signs should be erected along the boundary of the Donnybrook Water Reserve to define the location and promote awareness of the need to protect drinking water quality (Water Corporation).
- 12 A review of this plan should be undertaken after five years (Department of Water).



# Appendices

## Appendix A : Water quality

The Water Corporation has monitored the raw (source) water quality from Donnybrook 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:

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

The following data is representative of the quality of raw water from the Donnybrook bore field. In the absence of specific guidelines for raw water quality, the results have been compared with ADWG values set for drinking water which define the quality requirements at the customer's tap. Results that exceed ADWG have been shaded to indicate potential raw water quality issues associated with this source.

It is important to appreciate that this raw water data does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of ADWG. For more information on the quality of drinking water supplied to Donnybrook, refer to the most recent Water Corporation Drinking Water Quality Annual Report at [www.watercorporation.com.au/W/waterquality\\_annualreport.cfm](http://www.watercorporation.com.au/W/waterquality_annualreport.cfm).

### **Aesthetic-related characteristics**

Aesthetic water quality analyses for raw water from Donnybrook borefield are summarised in Table 5.

The values are taken from ongoing monitoring for the period November 2003 to October 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 highlighted yellow.

Table 5 Aesthetic-related characteristics detected for Donnybrook

Parameter	Units	ADWG Aesthetic Guideline Value*	Donnybrook Treatment Plant Raw Water Sample	
			Range	Median
Aluminium acid soluble	mg/L	0.2	0.016–0.26	0.23
Aluminium unfiltered	mg/L	na	0.016–0.42	0.19
Chloride	mg/L	250	160–175	167.5
Colour–True	TCU	15	<1–2	<1
Conductivity at 25°C	mS/m	na	51–78	64
Copper	mg/L	1	0.019–0.15	0.045
Hardness as CaCO <sub>3</sub>	mg/L	200	60–70	65
Iron unfiltered	mg/L	0.3	<0.003–0.6	0.012
Manganese unfiltered	mg/L	0.1	0.002–0.055	0.02
pH	NO UNIT	8.5	4.78–6.85	5.13
Sodium	mg/L	180	82–95	90
Sulfate	mg/L	250	11–14	14
Total filterable suspended solids (TFSS)	mg/L	500	318–335	323.5
Turbidity	NTU	5	<0.1–11	<0.1
Zinc	mg/L	3	<0.02–0.06	<0.02

\*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 Donnybrook is analysed for health-related characteristics 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 October 2008 are summarised in Table 6. Any parameters that have on occasion exceeded ADWG are shaded.

Table 6 Health-related characteristics detected for Donnybrook

Parameter	Units	ADWG Health Guideline Value*	Donnybrook Raw Inlet WTP SP	
			Range	Median
Barium	mg/L	0.7	0.035-0.13	0.09
Boron	mg/L	4	<0.02-0.03	0.02
Cadmium	mg/L	0.002	<0.0002–0.0004	<0.0002
Chromium	mg/L	0.05	<0.0005–0.0045	<0.0005
Copper	mg/L	2	0.019–0.15	0.045
Lead	mg/L	0.01	<0.002–0.015	0.004
Manganese unfiltered	mg/L	0.5	0.002–0.055	0.02
Nickel	mg/L	0.02	<0.002–0.05	<0.002
Nitrate as nitrogen	mg/L	11.29	1.1–6.7	2.2
Nitrite as nitrogen	mg/L	0.91	<0.002–0.004	<0.002
Nitrite plus nitrate as N	mg/L	11.29	1.2–4.2	1.5
Sulfate	mg/L	500	11–14	14
Tributyltin oxide	ug/L	1	<0.002–0.003	<0.002

\* 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 Donnybrook 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 from warm-blooded animals. A count less than 20 most probable number (MPN) per 100 ml is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark of the raw water (World Health Organisation 2004). Counts less than 20 MPN are seen as an indication of raw water that has not been recently contaminated with faecal material.

During the review of November 2003 to October 2008 no positive *Escherichia coli* counts were recorded.

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

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Golf course (Donnybrook Country Club)	Nutrients Pesticides Pathogens	Medium Low Medium	Distance to production bores 1/84, 3/75 and 11 is 20 m (low).	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul> <p>Department of Health (DoH) Public Sector Circular No. 88 (PSC 88) and Statewide policy No. 2: <i>Pesticide use in public drinking water source areas</i> should be considered by golf course management and contractors.</p>	<p>DoW to proclaim water reserve under Country Areas Water Supply Act 1947 (CAWS).</p> <p>Implement protection strategies recommended in this DWSPP (WHPZ; P3).</p> <p>Advise facility operators of best management practice (BMP) through relevant water quality protection note(s) (WQPN).</p> <p>PSC 88</p> <p>Statewide policy No. 2: <i>Pesticide use in public drinking water source areas</i>.</p>

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Recreation centre (swimming pool and tennis courts)	Nutrients	Low	Distance to production bore 3/75 is 500 m.	<ul style="list-style-type: none"> <li>• Water quality monitoring</li> <li>• Treatment</li> <li>• Surveillance</li> <li>• Signage</li> </ul> DoH PSC 88 and Statewide policy No. 2: <i>Pesticide use in public drinking water source areas</i> should be considered by the recreation centre management and contractors.	Department of Water to proclaim water reserve under CAWS.  Implement protection strategies recommended in this DWSPP (WHPZ; P3).  PSC 88  Implement BMP through WQPN <i>Swimming pools</i>  Statewide policy No. 2: <i>Pesticide use in public drinking water source areas</i>  Implement WQPN: <i>Nutrient and irrigation management plans for Parks and Recreation Local Scheme Reserves.</i>
	Pesticides	Low			
	Pathogens	Medium			

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Football club and oval	Nutrients	Low	Distance to production bores 1/75 and 2/82 is 500 m.	<ul style="list-style-type: none"> <li>• Water quality monitoring</li> <li>• Treatment</li> <li>• Surveillance</li> <li>• Signage</li> </ul> DoH PSC 88 and Statewide policy No. 2: <i>Pesticide use in public drinking water source areas</i> should be considered by the football club and oval management and contractors.	Department of Water to proclaim water reserve under CAWS.  Implement protection strategies recommended in this DWSPP (WHPZ; P3).  PSC 88  Statewide policy No. 2: <i>Pesticide use in public drinking water source areas</i>  Implement WQPN: <i>Nutrient and irrigation management plans for Parks and Recreation Local Scheme Reserves.</i>
	Pesticide	Low			
	Pathogens	Medium			

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Egan Park (sporting complex and showgrounds)	Nutrients Pesticides Pathogens	Medium Medium High	Distance to bore 11 is 100 m. Bore 3/75 is also in Water Corporation Catchment management Strategy).	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul> <p>DoH PSC 88 and Statewide policy No. 2: <i>Pesticide use in public drinking water source areas</i> should be considered by the football club and oval management and contractors.</p>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Implement protection strategies recommended in this DWSPP (WHPZ; P3).</p> <p>Statewide policy No. 2: <i>Pesticide use in public drinking water source areas</i></p> <p>Implement WQPN: <i>Nutrient and irrigation management plans for Parks and Recreation Local Scheme Reserves.</i></p>
Scout hall septic waste	Pathogens	High	Within WHPZ. Distance to production bore 1/84 is >100 m.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Implement protection strategies recommended in this DWSPP (WHPZ; P3).</p> <p>Advise facility operators of BMP through WQPN: <i>Wastewater treatment - onsite domestic systems.</i></p>

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
<b>Services</b>  Hospital and St. John Ambulance	Pathogens	High	Despite some protection afforded by the depth of the bore and clay sedimentation, production bore 1/84 is at risk from the existing hospital sewerage pit.	<ul style="list-style-type: none"> <li>• Water quality monitoring</li> <li>• Treatment</li> <li>• Surveillance</li> <li>• Signage</li> </ul>	Department of Water to proclaim water reserve under CAWS.  Implement protection strategies recommended in this DWSPP (WHPZ, P3).  Advise facility operators of BMP through WQPNs: <i>Wastewater treatment - onsite domestic systems; Contamination spills - emergency response.</i>  Ensure bore remains sealed.  Ensure surface runoff is directed away from the bore.

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Schools (3 primary; 2 secondary), Tuia Lodge (aged care home), churches (3) and public toilets	Pathogens Nutrients Pesticides	Medium	Distance to production bores is 300 m.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Implement protection strategies recommended in this DWSPP (WHPZ; P3).</p> <p>Advise facility operators of BMP through WQPN: <i>Wastewater treatment - onsite domestic systems.</i></p>
Sewerage disposal (within state forest area)	Pathogens Nutrients	Low	<p>Distance to production bores is 1000 m.</p> <p>Sewerage disposal site is contained within state forest and surrounded by a vegetation buffer.</p> <p>Non-conforming land use within PDWSA</p>	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Implement protection strategies recommended in this DWSPP (WHPZ; P3).</p> <p>Advise facility operators of BMP through WQPN: <i>Wastewater treatment - onsite domestic systems</i></p>
Sewerage pumping station	Pathogens	High	The sewerage pumping station is located upgradient and within 100 m of a production bore.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul>	DoW to liaise with Water Corporation to ensure contamination risks are negligible.

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
<i>Light Industry</i> Machinery yards	Hydrocarbons Nutrients Turbidity Heavy Metals Pathogens	Medium Medium Medium Medium Medium	Distance to production Bore 2/75 is 500 m.	<ul style="list-style-type: none"> <li>• Water quality monitoring</li> <li>• Treatment</li> <li>• Surveillance</li> <li>• Signage</li> </ul>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Advise facility operators of BMP through WQPNs: <i>Wastewater treatment - onsite domestic systems; Mechanical servicing and workshops; Tanks for elevated chemical storage.</i></p> <p>Implement protection strategies through regional office including public awareness.</p>

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Tyre centres (disposal at landfill site)	Heavy metals	Low	Quantities – Low (<100 tyres at any one time) Distance to production bore 2/75 is 500 m (medium).  60 m→500 m distance due to stormwater drainage system	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul> <p>Should be managed as a prescribed premises as per Schedule 1 of the Environmental Protection Regulations 1987, category 56.</p>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Advise facility operators of BMP through WQPNs: <i>Wastewater treatment - onsite domestic systems; Mechanical servicing and workshops; Tanks for elevated chemical storage.</i></p> <p>Implement protection strategies through regional offices of DoW including public awareness.</p>
	Hydrocarbons (BTEX)	Low			
	Pathogens	High			
Auto-electrics/ Transport companies (above-ground fuel storage)	Heavy metals (lead and copper)	Low	<p>Distance to production bore 2/75 is 500 m.</p> <p>Medium risk due to quantities - (4 x &lt;2000 L tanks)</p> <p>Distance to production bore 2/75 is 500 m.</p> <p>60m→500 m is low risk due to stormwater drainage.</p>	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> <li>HAZMAT</li> <li>Bunding and reporting of spillages</li> </ul>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Advise facility operators of BMP through WQPNs: <i>Wastewater treatment - onsite domestic systems; Mechanical servicing and workshops; Tanks for elevated chemical storage.</i></p> <p>Implement protection strategies through regional offices of DoW including public awareness.</p>
	Hydrocarbons	Medium			
	Pathogens	High			

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
General light industry Metal fabrication/ Veterinary Septic waste Stormwater runoff	Hydrocarbons Chemicals Pathogens	High High High	Stormwater runoff from mechanical facilities enters Noneycup Creek in close proximity to production bores (>25 m).	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> <li>HAZMAT</li> <li>Bunding and reporting of spillages</li> </ul>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Advise facility operators of BMP through WQPNs: <i>Wastewater treatment - onsite domestic systems; Mechanical servicing and workshops; Tanks for elevated chemical storage.</i></p> <p>Implement protection strategies through regional offices of DoW including public awareness.</p>
<b>Commercial</b> Taverns/ motel Septic waste (see residential septic tank systems)	Pathogens	Low	Distance to production bores is >500 m.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Implement protection strategies recommended in this DWSPP (WHPZ; P3).</p> <p>Advise facility operators of BMP through WQPN: <i>Wastewater treatment - onsite domestic systems.</i></p>

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
<b>Infrastructure</b> Contamination risks associated with vehicle transportation Stormwater runoff from roads Stormwater runoff from main roads, residential and light industrial areas currently runs into Noneycup Creek.	Hydrocarbons Turbidity Chemical Heavy Metals	High High High High	Distance to production bores is varies, however stormwater runoff from roads needs to be addressed.  Due to shallow bores located close to the drainage channel, contamination risks from well-stream interference and hydraulic continuity of Noneycup Creek with the Leederville aquifer system can occur.  Contamination from chemical spills could transport contaminants in high flows to close proximity within the draw down area of production bores.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> <li>HAZMAT</li> </ul>	Department of Water to proclaim water reserve under CAWS.  Liaise with Shire of Donnybrook–Balingup on stormwater management and rehabilitation of Noneycup Creek as described in <i>Draft Noneycup Creek Management Plan 2008–2013</i> (Shire of Donnybrook, 2007a)  Advise Shire of Donnybrook–Balingup of BMP through WQPN: <i>Contamination spills and emergency response</i> .
Fuel stations (4) Hydrocarbons including heavy metals	Hydrocarbons Heavy Metals	Low Low	Distance to production bores is 500 m.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> <li>HAZMAT</li> </ul>	Department of Water to proclaim water reserve under CAWS.  Implement protection strategies recommended in this DWSPP (WHPZ; P3).  Liaise with facility operators and advise operators of BMP through WQPN: <i>Service stations</i> .

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Landfill Leachate associated with putrescible landfills including acidity contamination to groundwater	Chemicals	Medium	Distance to production bores is 1.5 km. Leachate may be entering groundwater and flowing north-west.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul> Landfill licensing and regulation under the <i>Environmental Protection Act 1986</i> , WA.	Department of Water to proclaim water reserve under CAWS.  Implement protection strategies recommended in this DWSPP (WHPZ; P3).  Liaise with facility operators and advise operators of BMP through WQPN: <i>Landfills used for putrescible materials near sensitive water resources (draft)</i> .
<b>Residential areas</b>					
Residential areas (including public conveniences) Septic waste Private gardens and fertiliser use	Pathogens Nutrients	High Medium	Distance from production bores is <150 m.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul>	Department of Water to proclaim water reserve under CAWS.  Advise residential properties of BMP through WQPN: <i>Wastewater treatment - onsite domestic systems</i> ,  Implement protection strategies through regional office including public awareness.

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Urban land uses (including horses and domestic animals)	Nutrients Pesticides Pathogens	Medium Medium High	Distance from production bores is <150 m.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul>	<p>Department of Water to proclaim water reserve under CAWS.</p> <p>Implement protection strategies recommended in this DWSPP (WHPZ; P3).</p> <p>Advise facility operators of BMP through WQPN: <i>Wastewater treatment - onsite domestic systems.</i></p> <p>Department of Water to proclaim water reserve under CAWS.</p> <p>Liaise with Shire of Donnybrook–Balingup regarding stormwater management and the rehabilitation of Noneycup Creek as described in <i>Draft Noneycup Creek Management Plan 2008–2013</i>. (Shire of Donnybrook, 2007a).</p> <p>Ensure new developments are consistent with Planning bulletin 92: <i>Urban water management</i> (WAPC, 2008) and Statement of planning policy No. 2.7.</p>
Residential development Stormwater and drainage from new residential development will run off into Noneycup Creek. Turbidity and possible acid sulfates (if disturbed) and associated chemicals can enter the creek with the potential to contaminate production bores from well-stream interference.	Chemicals (acid sulfate soils) Turbidity Pesticides Pathogens	Low Low Medium High	Distance from production bores is 500 m.	<ul style="list-style-type: none"> <li>Water quality monitoring</li> <li>Treatment</li> <li>Surveillance</li> <li>Signage</li> </ul>	

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
<b>Rural Land Uses</b>					
Agriculture 'General Farming Pastoral' zones identified in Local Planning Scheme	Nutrients Pesticides Pathogens	Low Low Medium	Hydrological surveys conducted by DoW determined a recharge area of the Leederville Formation (used for drinking water supply) which includes Noneycup Creek. The creek runs through private land used for agriculture.  Agricultural land use includes orchards, livestock, broadacre farming and hobby farming. Surface water dams on Noneycup Creek are used for water supply and irrigation.  Contaminants (from livestock access, agricultural runoff and disturbance to bed and banks) which enter Noneycup Creek can be transported to production bores in high flows.	<ul style="list-style-type: none"> <li>• Water quality monitoring</li> <li>• Treatment</li> <li>• Surveillance</li> <li>• Signage</li> </ul> <p>Allocation and licensing under RIWI Act, WA</p>	Department of Water to proclaim water reserve under CAWS.  Liaise with Shire of Donnybrook–Balingup on stormwater management and rehabilitation of Noneycup Creek as described in <i>Draft Noneycup Creek Management Plan 2008–2013</i> (Shire of Donnybrook, 2007a).  Advise Shire of Donnybrook–Balingup of BMP through WQPNs <i>Orchards in sensitive environments; Dam construction and operation in rural areas; Vegetation buffers to sensitive water resources.</i>  BMP through the implementation of relevant WQPN(s).
Livestock access to Noneycup Creek		High (if livestock enter river which is hydrogeologically connected to aquifer / water supply)			
Agricultural pesticide use					
Fertiliser application					

Land use/activity (Local Scheme Reserves)	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
<p><b>State forest - Recreation</b></p> <p>Wildflower picking, off-road vehicle use</p> <p>Public access with regard to off-road vehicle use and wildflower picking</p>	<p>Pathogens</p> <p>Turbidity</p>	<p>Low</p> <p>Low</p>	<p>Two state forest areas are contained within the recommended water reserve. Public access and recreation impacts will be managed by the DEC.</p>	<ul style="list-style-type: none"> <li>• Water quality monitoring</li> <li>• Treatment</li> <li>• Surveillance</li> <li>• Signage</li> </ul>	<p>DEC management process through permit and licensing.</p> <p>DoW Statewide Policy No 13 (Water and Rivers Commission, 2003) is recommended to guide recreation in public drinking water source areas.</p>



## Appendix C : Photographs



*Figure C1 Production bore 2/75*



*Figure C2 Production bores 1/75 and 2/82*



*Figure C3 Production bore 1/84*



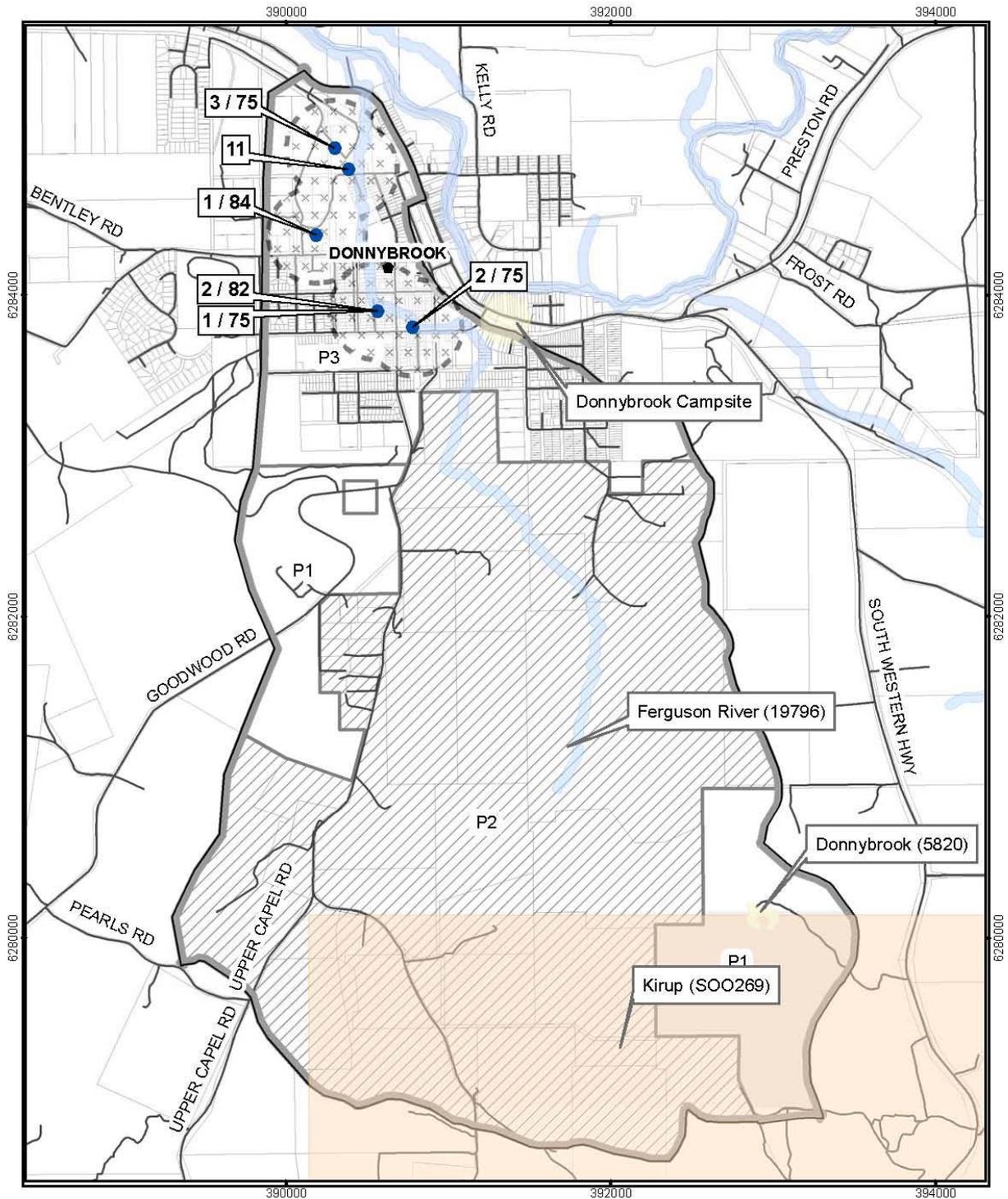
*Figure C4 Production bore 11*



*Figure C5 Production bore 3/75*



# Appendix D : Aboriginal Sites of Significance



<p><b>SOURCE DATA</b>                  Department of Water acknowledges the following datasets and the custodians:                   Production bores Water Corporation 2008                  Public drinking water source areas DoW 2008                  Cadastre land tenure Landgate 2008                  Roads &amp; towns Landgate 2006                  Town planning schemes WA Planning Commission 2007</p>	<p><b>LEGEND</b></p> <p>Legend                  ● Towns  <b>Aboriginal Sites of Significance STATUS</b>                  ■ Insufficient Information                  ■ Lodged                  ■ Permanent Site                  ■ Stored Data (mandatory)</p>	<p><b>LOCATION PLAN</b></p> <p>0 400 800 Metres</p>	<p><b>Water Resource Management Division                  Water Source Protection Branch</b></p> <p>Project officer: C Roberts                  Drawn by: L Ye Date: 24/10/2008                  B2010/0057/Donnybrook_Fig4_A4p.mxd                  Coordinate system MGA94 Zone 50</p> <p>Government of Western Australia                  Department of Water</p>
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FIGURE 4 DONNYBROOK WATER RESERVE AND ABORIGINAL SIGHT OF SIGNIFICANCE AREAS



## List of shortened forms

<b>ADWG</b>	Australian drinking water guidelines
<b>AHD</b>	Australian height datum
<b>ANZECC</b>	Australian and New Zealand Environment Conservation Council
<b>ARMCANZ</b>	Agriculture and Resource Management Council of Australia and New Zealand
<b>CA</b>	catchment area
<b>CFU</b>	colony forming units
<b>DEC</b>	Department of Environment and Conservation
<b>EC</b>	electrical conductivity
<b>GL</b>	gigalitre
<b>ha</b>	hectare
<b>HAZMAT</b>	hazardous materials
<b>kL</b>	kilolitre
<b>km</b>	kilometre
<b>km<sup>2</sup></b>	square kilometre
<b>LEMC</b>	Local Emergency Management Committee
<b>m</b>	metres
<b>mg/L</b>	milligram per litre
<b>mL</b>	millilitre
<b>ML</b>	megalitre
<b>mm</b>	millimetre
<b>MPN</b>	most probable number
<b>mSv</b>	millisievert
<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>PSC 88</b>	Public Sector Circular No. 88
<b>PDWSA</b>	public drinking water source area
<b>RPZ</b>	reservoir protection zone
<b>TCU</b>	true colour units
<b>TDS</b>	total dissolved solids
<b>TFSS</b>	total filterable solids by summation
<b>WESTPLAN- HAZMAT</b>	Western Australian plan for hazardous materials
<b>WHPZ</b>	wellhead protection zone

# Glossary

<b>abstraction</b>	Pumping groundwater from an aquifer or removing water from a waterway or water body.
<b>adsorb</b>	To accumulate on the surface of something, for example, micro-organisms can adsorb onto soil particles.
<b>Australian drinking water guidelines (ADWG)</b>	Acceptable criteria for the quality of drinking water taken from <i>National water quality management strategy: Australian drinking water guidelines</i> (NHMRC & NRMMC 2004a).
<b>aesthetic guideline value</b>	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, for example, appearance, taste and odour (NHMRC & NRMMC 2004a).
<b>Australian height datum (AHD)</b>	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
<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>Anisotropic</b>	Having different properties in different directions, for example, an aquifer with variations in hydraulic conductivity horizontally and vertically, or different grain sizes in all directions.
<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 bore is a narrow, lined hole drilled into the ground to monitor or draw groundwater (also see 'well').
<b>Bore field</b>	A group of bores to monitor or withdraw groundwater is referred to as a borefield (also see '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>Confined aquifer</b>	An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure.
<b>Department of Environment and Conservation</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>Diffuse source</b>	A diffuse source of contamination originates from a widespread non-specific area (for example, urban stormwater runoff, agricultural infiltration) as opposed to a particular source (see 'point source').
<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.
<b>Electrical conductivity</b>	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.
<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>Gigalitre</b>	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.
<b>Hectare</b>	A hectare is a measurement of area, equivalent to 10 000 square metres.
<b>Health guideline value</b>	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>Millisievert</b>	A millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2 mSv/yr.
<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>Nutrient load</b>	The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area.
<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>Perched</b>	An unconfined aquifer, often ephemeral or seasonal, perched on top of an impermeable horizon near the land surface and separated from deeper groundwater by an unsaturated zone.
<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>Point source</b>	Contamination originating from a specific localised source, for example, sewage or effluent discharge; industrial waste discharge.

<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 that is equipped to deliver water to a user.
<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 contamination 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>Reservoir</b>	A reservoir, dam, tank, pond or lake that forms part of any public water supply works.
<b>Reservoir protection zone</b>	A buffer measured from the high water mark of a drinking water reservoir, and inclusive of the reservoir (usually 2 km). This is referred to as a prohibited zone under the <i>Metropolitan Water Supply, Sewerage and Drainage Act By-laws 1981</i> .
<b>Run-of-the-river scheme</b>	A scheme that takes water from a flowing river. Water is taken directly from the source and there is no detention (storage) time.
<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>Semi-confined aquifer</b>	A semi-confined or leaky aquifer is saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.
<b>Spore</b>	A germ, germ cell, seed or the like.

<b>Storage reservoir</b>	A major reservoir of water created in a river valley by building a dam.
<b>Stormwater</b>	Rainwater which has run off the ground surface, roads and paved areas, and is usually carried away by drains.
<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 & NRMCC 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 <u>discarded</u> . Wastewater usually contains significant quantities of contamination  Wastewater is the used water from a community containing dissolved and suspended matter which is usually treated before reuse or discharge to the environment.

<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>Wellfield</b>	A wellfield is 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</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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