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

Looking after all our water needs

Millstream Catchment Area (Bridgetown) drinking water source protection plan

Bridgetown Region Water Supply Scheme

Water resource protection series

REPORT NO. WRP 104
June 2009

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All maps in this publication were produced by the Department of Water (for the Water Resource Management Division) with the intent that they be used for the Millstream Catchment Area (Bridgetown) at the scale shown on the maps.

While the Department of Water has made all reasonable efforts to ensure the accuracy of the data used in this report, 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 Millstream Catchment Area (Bridgetown) 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 6, 2004* (NHMRC & NRMMC 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, the hazards and hazardous events that can compromise drinking water quality. The development of preventative strategies and operational controls is needed 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 Bridgetown Region Water Supply Scheme. It discusses existing and future use of the water source, describes the water supply system, identifies risks and recommends management approaches to address these risks and protect the water source.

This plan has been prepared to help guide state and local government land-use planning decisions. It should be recognised in the local planning schemes of the shires of Donnybrook-Balingup and Nannup, consistent with the Western Australian Planning Commission's *Statement of planning policy No. 2.7: Public drinking water source policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the proposed Millstream Catchment Area (Bridgetown).

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. (2004)	Prepared after initial catchment survey and preliminary information gathering. This document may not be required if a drinking water source protection plan already exists or alternative documents provide suitable information.
2	Conduct stakeholder consultation. (2008/09)	Advice sought from key stakeholders using the assessment document as a tool for information and discussion.
3	Prepare draft drinking water source protection plan. (2008/09)	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 Millstream Catchment Area (Bridgetown) was proclaimed in 1961 under the *Country Areas Water Supply Act 1947* (WA). This plan recommends an amendment to the existing proclaimed boundary of the catchment area to more accurately reflect its physical boundaries.

Millstream Dam is located approximately 260 km south-east of Perth and 20 km west-north-west of Bridgetown in Western Australia's south-west corner. It is the principal supply for the Water Corporation's Bridgetown Region Water Supply Scheme, which supplies drinking water to the towns of Bridgetown, Hester and Boyup Brook. Bridgetown is the closest town. It has a population of about 4000 and acts primarily as a regional service centre for the surrounding farming, horticultural and timber industries.

Most of the Millstream Catchment Area is located in state forest, which is vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation (DEC). The DEC and the Water Corporation are the only owners of freehold land in the catchment. Priority 1 source protection is recommended for the entire catchment to protect water quality.

The Millstream Dam catchment has an area of about 11 km^2 and is located partially in the Shire of Donnybrook-Balingup and partially in the Shire of Nannup. The Millstream Catchment Area should be reflected in the local planning schemes for both these shires.

The most common land uses in the Millstream Catchment Area include timber harvesting, roads and recreation. These activities pose contamination risks to the water source and this plan outlines strategies to manage those risks.

The Bibbulmun Track passes through the catchment adjacent to the reservoir and along a major tributary. Bushwalking on the Bibbulmun Track will continue; however realignment of the track outside the reservoir protection zone and away from feeder streams should be investigated. Various unauthorised recreational activities are known to occur in the catchment. These activities will need to be managed consistent with legislation and policy prepared by the DEC and the Department of Water.

The Department of Water has developed this plan in consultation with the Water Corporation, local shires and other relevant state government departments and stakeholders.

1 Drinking water source overview

1.1 Existing water supply system

Millstream Dam is located within the Blackwood River basin in the south-west corner of Western Australia, approximately 260 km south-east of Perth and 20 km west-north-west of Bridgetown (see Figure 1). It is operated by the Water Corporation as part of the Bridgetown Region Water Supply Scheme (BRWSS), which supplies public drinking water to the towns of Bridgetown, Hester and Boyup Brook.

Bridgetown is the closest regional centre and has a population of about 4000. The town acts primarily as a service centre for the surrounding farming, horticultural and timber industries – with a growing enthusiasm in the area for retirement lifestyles and tourist development.

The Millstream Dam catchment has an area of about 11 km^2 and is located partially in the Shire of Donnybrook-Balingup and partially in the Shire of Nannup (see Figure 2).

Millstream Dam is the principal supply for the BRWSS. The dam was constructed in 1962 and consists of a 17-m-high earth wall. The reservoir covers an area of almost 10 ha and currently has a storage capacity of 452 ML. During dry periods in recent years, several local emergency water sources have been harnessed to supplement Millstream reservoir. These sources include Camp Creek Dam, Kate's Dam, Gregory Brook and Ellis Creek.

Water from Millstream Dam is disinfected and pumped to a roofed, concrete-lined, excavated reservoir with a capacity of 4.5 ML in Bridgetown. Water flows under gravity from the reservoir to the Bridgetown low-level reticulation network into the Forrest Road tanks and the eastern high-level reticulation. Water also flows from the reservoir to the western pump station where it is pumped into the western high-level reticulation network and into the Peninsula Road tank.

In addition, water from Millstream Dam is pumped to Hester Dam and Boyup Brook Dam to augment local supplies for the towns of Hester and Boyup Brook. This is because natural annual inflows are typically insufficient to fill these reservoirs (Water Corporation 2004).

1.2 Water treatment

Water from Millstream Dam is disinfected (ultraviolet radiation and chlorination) and then pumped to the Bridgetown reservoir. This provides a disinfection barrier against possible microbiological contamination (Water Corporation 2004). The extremely low water-storage levels experienced in Millstream Dam in 2007 led to high turbidity when rain began falling again. High turbidity may require additional treatment.

It should be recognised that although treatment and disinfection are essential barriers against contamination, catchment management is the first step in protecting water quality and thus ensuring a safe, good quality drinking-water supply. This approach is endorsed by the *National water quality management strategy: Australian drinking water guidelines 6, 2004* (ADWG) (NHMRC & NRMMC 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 reliably safe, lower-cost drinking water to consumers than either could achieve individually.

1.3 Catchment details

1.3.1 Physiography

The Millstream Catchment Area (Bridgetown) is contained within the Darling Plateau, which consists of an undulating, dissected peneplain with gravelly, pale orange soils cloaked by extensive areas of tall jarrah forest. Deep, steep-sided valleys occur throughout the area, occasionally punctuated by impressive dome-shaped granite outcrops.

Soils are predominantly gravels with occasional block laterite outcrops and some elevated areas of sands and sandy loams. In the deeper valleys the soils are heavier alluvials.

1.3.2 Climate

The area has a temperate climate characterised by warm, dry summers and cool, wet winters. The long-term (1887–2008) average annual rainfall is 829 mm (Bureau of Meteorology 2008). Average annual rainfall for the period 1975–2002 has been estimated at 950 mm (Water Corporation 2004). However, the average annual rainfall between 2003 and 2008 was significantly lower (estimated at 750 mm with a low of about 523 mm in 2006).

1.3.3 Hydrology/hydrogeology

The Millstream Catchment Area has an elevation of 235 m AHD at the reservoir, rising to 370 m AHD at the head of the catchment. The annual flow at the reservoir for the period 1975–2002 was estimated at 1086 ML with inflow mainly from surface runoff and a minor contribution from groundwater (Water Corporation 2004). The latest estimated yield figure is 602 ML/year. In more recent years the amount of water available from the reservoir has been reduced (see also sections 1.4 and 1.6.1).

1.4 Future water supply requirements

The Water Corporation is currently developing a new water source plan for Bridgetown, Hester and Boyup Brook. The plan will assess reliable scheme draws and source development requirements to meet current and future demands.

In 2007 and 2008 inflow into Millstream reservoir was not sufficient to supply local demand (Appendix C, Figure C1) with water levels declining to only 9 percent of capacity in June. Emergency supplies had to be sourced from other sources in the region (Corbett's Dam, Saunders' Dam, Hester bores and others). The Water Corporation is currently investigating various short- and long-term options to supply drinking water to the greater Bridgetown region, including increasing Millstream reservoir's capacity and supplementing it with groundwater. When additional sources have been evaluated and licensed, drinking water source protections plans will need to be prepared for each new source.

1.5 Existing drinking-water source protection

Millstream Catchment Area (Bridgetown) was proclaimed (or gazetted) in 1961 under the *Country Areas Water Supply Act 1947* (WA) for the purpose of public drinking-water source protection. By-laws created under this Act enable the Department of Water to control potentially polluting activities, to regulate land use, inspect premises and take the necessary steps to prevent or clean up pollution.

The Department of Water has delegated monitoring and by-law enforcement powers to the Water Corporation for some public drinking water source areas (PDWSAs). Please refer to Section 4.7 for more information.

The current proclaimed (or gazetted) catchment area is shown in Figure 2. In the absence to date of assigned priority classification areas, the land has been managed for Priority 1 source protection. This plan recommends assigning Priority 1 source protection to the entire catchment. In addition, the current proclaimed catchment area does not accurately reflect its actual physical boundaries. One of this plan's key recommendations is to proclaim the Millstream Catchment Area with amended boundaries (Figure 2).

In 2004 the Water Corporation prepared the *Millstream Catchment Area (Bridgetown) drinking water source protection assessment* document, which outlined risks to water quality from land uses and activities in the Millstream Catchment Area. This drinking water source protection plan builds upon and replaces the assessment document.

1.6 Department of Water management

1.6.1 Current allocation licence

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

There is no separate water allocation licence for Millstream Dam. Instead, the Water Corporation is licensed to draw 772 ML/year from the BRWSS, which currently includes Millstream Dam, Hester Dam and Boyup Brook Dam, for public water supply purposes. Abstraction in 2007–08 was 424 ML, significantly less than the 2006–07 figure of 553 ML.

1.6.2 South West regional water plan

The *South west regional water plan* details several long-term water management objectives, one of which is to ensure protection of all drinking-water sources and timely provision of water supply and sewerage services in the region. It calls for long-term planning for public drinking-water sources to ensure the security of water supply for growing regional communities in a scenario of decreasing water availability. Two key strategies identified to help achieve this objective are the protection and maintenance of high-quality, safe drinking-water sources through water source protection and the upgrading of key town-water supply schemes.

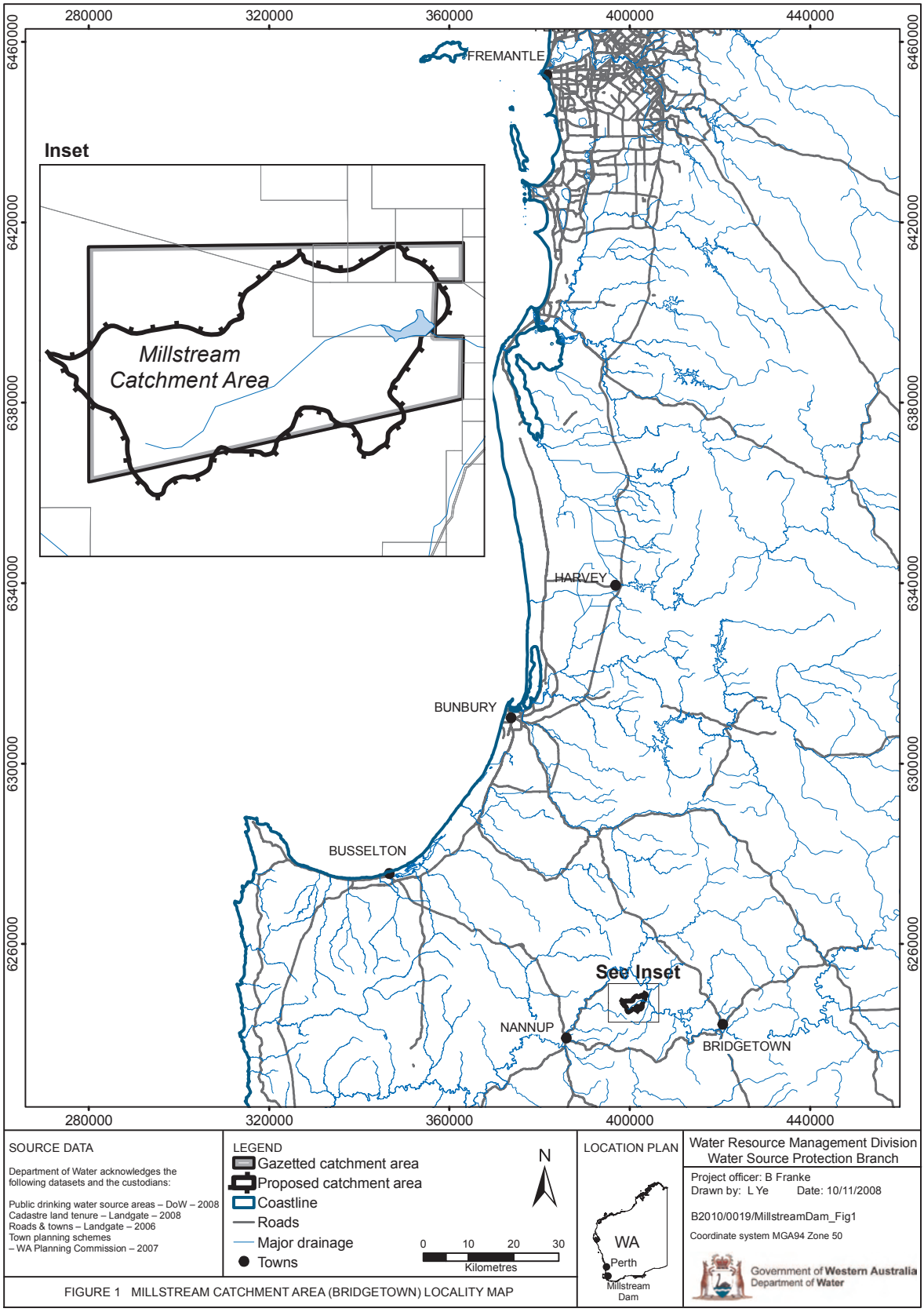

Figure 1 Millstream Catchment Area (Bridgetown) locality map

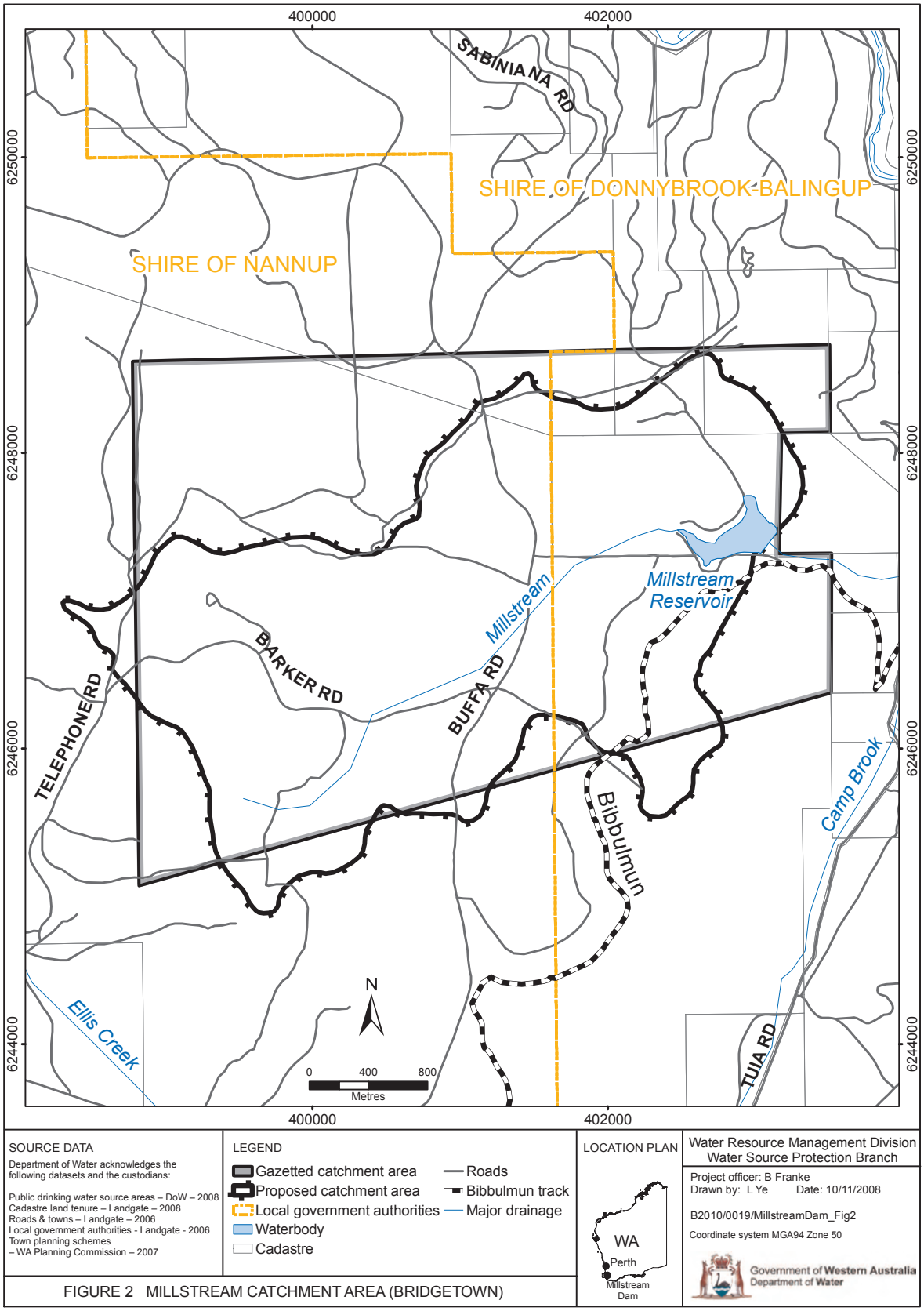

Figure 2 Millstream Catchment Area (Bridgetown)

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, quality, aesthetically acceptable drinking water to consumers.

The Water Corporation regularly monitors the quality of raw (untreated) water from the Millstream reservoir for microbiological, health-related and aesthetic (non-health-related) characteristics in accordance with the ADWG. Monitoring results from treated water are reviewed by an intergovernmental committee known as the Advisory Committee for the Purity of Water, which is chaired by the Department of Health.

A water quality summary for the Millstream reservoir from June 2003 to June 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> Publications > Water quality > Water quality annual report.

Contamination risks relevant to the Millstream Catchment Area are described below.

2.1 Microbiological

Pathogens are micro-organisms that are capable of causing diseases and 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).

A number of pathogens are commonly known to contaminate water supplies around the world. These include bacteria (e.g. salmonella, *Escherichia coli*, cholera), protozoa (e.g. *Cryptosporidium*, *Giardia*) and viruses. *E. coli* counts are a way of measuring these pathogens and are an indicator of faecal contamination.

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

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 moving 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 freshwater (NHMRC & NRMMC 2004a).

When people consume drinking water contaminated with pathogens, the effects vary considerably. They can range from mild illness (such as stomach upset or diarrhoea) to death. In 2000 in Walkerton, Canada seven people died due to contamination of the town water source and supply by a pathogenic strain of *E. coli* and campylobacter (NHMRC & NRMMC 2004b, Hrudey & Hrudey 2004). Preventing the introduction of pathogens into the water source is the most effective barrier in avoiding this public health risk.

Between June 2003 and June 2008 7% of water samples from Millstream reservoir had *E. coli* counts greater than 20 most probable number (MPN) per 100mL. This is typical of a surface water source within a forested catchment.

2.2 Health related

Land- and water-based uses and activities within a catchment can directly affect water quality and treatment. For example, off-road driving contributes to erosion and the uprooting of vegetation, which can increase turbidity in water. This turbidity can subsequently reduce the effectiveness of treatment processes.

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 on other environmental constituents: for example, it smothers riparian vegetation and reduces the transfer of light within the water column, in turn affecting plant growth.

Chemicals attached to suspended material, such as soil particles, can occur in drinking water sources. This may occur as a result of natural leaching from mineral deposits or from different land uses (NHMRC & NRMMC 2004a). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

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

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 can occur in water supplies as a result of spills and leakage from vehicles (e.g. fuels, oils) and are potentially toxic to humans. Harmful chemical by-products may be formed when hydrocarbons are combined with chlorine, which is used in the water-treatment processes.

Raw water samples collected from Millstream reservoir between June 2003 and June 2008 did not exceed the health guideline values in the ADWGs.

2.3 Aesthetic

Impurities in drinking water can affect its aesthetic qualities, including its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, cloudy water with a distinctive odour or 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). The guideline values for aluminium, colour, turbidity and unfiltered iron and manganese have occasionally been exceeded in samples from Millstream reservoir.

3 Land-use assessment

3.1 Existing land uses and activities

The Millstream Catchment Area is located over a mixture of crown land and some freehold land. Current land uses and activities are outlined below. This information has been summarised in Table 1 at the end of this section. The table also identifies a recommended management priority for the hazards associated with each land-use activity. Appendix B of this plan uses data from this section and Table 1 to recommend protection strategies for consideration by key stakeholders.

3.1.1 State forest

Most of the Millstream Catchment Area is located in state forest (about 779 ha), which is 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* (WA). The 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.

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

Current land uses and activities undertaken in the catchment are outlined below.

Timber harvesting

Native forests on crown land are a source of timber and are managed by the DEC. Harvesting operations in the Millstream Catchment Area were last carried out during the 1990s. Existing timber plantations in the region currently do not overlap the catchment boundaries.

One of the major risks to water quality associated with timber harvesting activities and plantation establishment and management is turbidity. Turbidity is the presence of suspended solids such as soil and organic matter in water. These particles can aid the transport of some contaminants and mask the presence of others (e.g. pathogens), thereby reducing the effectiveness of treatment. The main sources of suspended solids are soil erosion and disturbance of the stream bed. Use of good management practices (e.g. the retention of vegetation buffers along watercourses) can reduce soil erosion and therefore reduce turbidity levels in the water.

Roads and tracks

Several tracks and unsealed roads (Appendix C, Figure C2) allow access to the Millstream Catchment Area. They are used by the following stakeholders:

- the DEC for state forest maintenance
- the Water Corporation to access Millstream reservoir and the pipes that transport water from emergency water sources to the reservoir
- the public for recreational purposes.

The reservoir itself is fenced, so that public access is restricted; however, catchment rangers have found evidence that illegal access does occur intermittently.

Some parts of the DEC-managed land in the Millstream Catchment Area (to the south and west of the reservoir) are gazetted as a Disease Risk Area (DRA). Pursuant to the *Conservation and Land Management Act 1984* (WA), Conservation and Land Management Regulations 2002 and Forest Management Regulations 1993, any person in a vehicle must obtain a DRA permit to enter DRA lands. Persons entering a DRA must comply with the conditions of the permit at all times while operating within the DRA.

The major risks to water quality associated with unsealed roads and tracks are turbidity (through soil erosion), hydrocarbons and other chemical substances from fuel and various liquids associated with motor vehicles, and pathogens from human activity in the catchment.

Illegal crops

Illegal crops such as cannabis are established in the region from time to time. Water Corporation rangers alert police when they become aware of such crops in the Millstream Catchment Area and the crops are removed.

The major risk to water quality associated with the establishment of illegal crops is the introduction of pathogens from human activity in the catchment.

Feral animal control

The Millstream Catchment Area is baited with 1080 poison for fox control by the DEC. The Department of Water recommends that baits are not placed within 100 m of watercourses or reservoirs. Feral pigs occur in the catchment, although not generally in great numbers. No formal pig control program is currently undertaken in the area.

Fire management

Recent wildfires in the Bridgetown region did not penetrate the Millstream Catchment Area. Wildfires can be caused by a combination of long dry summers, flammable vegetation and lightning strikes, as well as human activity (including arson).

The DEC carries out prescribed burns to reduce fuel loads and protect human lives and community assets such as townsites, and to achieve biodiversity outcomes. Prescribed burns are mainly carried out during October to December. The DEC aims for a 60 to 80 per cent burn leaving one to three tonnes of fuel per hectare, with no bare earth exposed. Six months after burning, there is significant regeneration and the forest floor has a high degree of coverage. Prescribed burning of this area is reviewed on a five- to seven-year rotation. Every second or third rotation, an autumn burn in April or May would also be prescribed. Fuel loads in the Millstream Catchment Area vary: prescribed burns were carried out four, five and 10 years ago in different parts of the catchment.

One of the major risks to water quality from fire (especially wildfire) is turbidity due to erosion and ash. Use of good management practices (e.g. the retention of vegetation buffers along watercourses) can reduce soil erosion and therefore reduce turbidity levels in the water.

Resource harvesting

Some resource harvesting activities occur in state forest, subject to licensing by the DEC. These include apiarist activities (beekeeping), wildflower picking, seed collection and firewood collection. There are no apiary sites or designated firewood collection areas in the Millstream Catchment Area; however, illegal private firewood collection may occasionally take place. Three wildflower pickers are currently licensed to operate in the region.

Risks to water quality from resource harvesting activities include the introduction of pathogens due to the presence of human beings in the catchment, contamination from waste disposal and turbidity.

Mining

The Millstream Catchment Area is subject to an exploratory mining tenement (E7002658); however, there have been no mining activities in the catchment to date.

Recreation

- Authorised recreation

  The Bibbulmun Track passes through the Millstream Catchment Area. It runs adjacent to the reservoir and along a major tributary in the south-west corner of the catchment and the reservoir is visible from some parts of the track (Appendix

C, Figure C3). There are no authorised campsites associated with the Bibbulmun Track within the Millstream Catchment Area.

The *Bibbulmun Track guide book* (Department of Conservation and Land Management 2002) advises walkers that they will pass through the catchment and to take precautions to protect water quality. Other tracks and gravel roads also provide access to areas close to the waterbody, which is undesirable.

Bushwalking on the Bibbulmun Track will continue in the Millstream Catchment Area; however, the Department of Water and the Department of Health are interested in investigating the potential for realignment of the track outside the reservoir protection zone (refer Section 4.4), away from feeder streams and downstream of the reservoir. Consultation with the relevant agencies and user groups regarding this proposal is recommended.

Wherever possible recreational tracks and trails should be located outside reservoir protection zones (RPZ – see Section 4.4) and away from streams feeding into the reservoir. Existing culverts and/or bridges to cross streams should be utilised wherever possible.

Public access to the RPZ represents a risk to water quality through the possible introduction of transmittable pathogens to the drinking water source.

- Unauthorised recreation

  Various unauthorised recreational activities are known to occur in the Millstream Catchment Area including bushwalking, off-road vehicle use such as four-wheel driving and trail-bike riding (away from designated roads, tracks or trails); swimming, fishing and marroning (in both the reservoir and its feeder streams); exercising dogs, illegal hunting and associated camping or picnicking activities at non-designated sites. Part of the catchment is in a Disease Risk Area (DRA) monitored by the DEC. Entry requires a permit and compliance with its conditions.

  The major risks to water quality posed by these activities include the possible introduction of pathogens from human beings, dogs and rotting animal carcasses or baits; turbidity due to soil erosion and ash from wildfires; and hydrocarbons from motorised vehicles.

3.1.2 Private land

Freehold land in the north-east corner of the Millstream Catchment Area (see Figure 3) is owned by the DEC. Another parcel of freehold land incorporates the reservoir and land to the immediate north and west of the reservoir – this is owned and managed by the Water Corporation for water production and the protection of water quality.

3.1.3 Native title

Native title is a form of land title that recognises the unique ties some Aboriginal groups have to land. Native title exists where Aboriginal people have maintained a traditional connection with their land and waters since sovereignty, and where acts of government have not removed it. There is one native title claim within the proposed Millstream Catchment Area. This claim is South West Boojarah 2 (WAD253/06, WC06/4).

3.2 Proposed land uses and activities

The catchment land uses and activities identified in this plan (Figure 4) are not expected to change in the short term. Potential future land uses should be assessed in accordance with the Department of Water's *Water Quality Protection Note: Land use compatibility in public drinking water source areas* and the Western Australian Planning Commission's *State planning policy No. 2.7 – Public drinking water source policy*. Recreation management in public drinking water source areas is guided by the Department of Water's publicly consulted *Statewide policy No. 13: Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003). This policy is subject to review by government and, once completed, any changes to the policy will be reflected in this plan.

Proposals and applications for new developments or land-use activities should be referred to the Department of Water for advice.

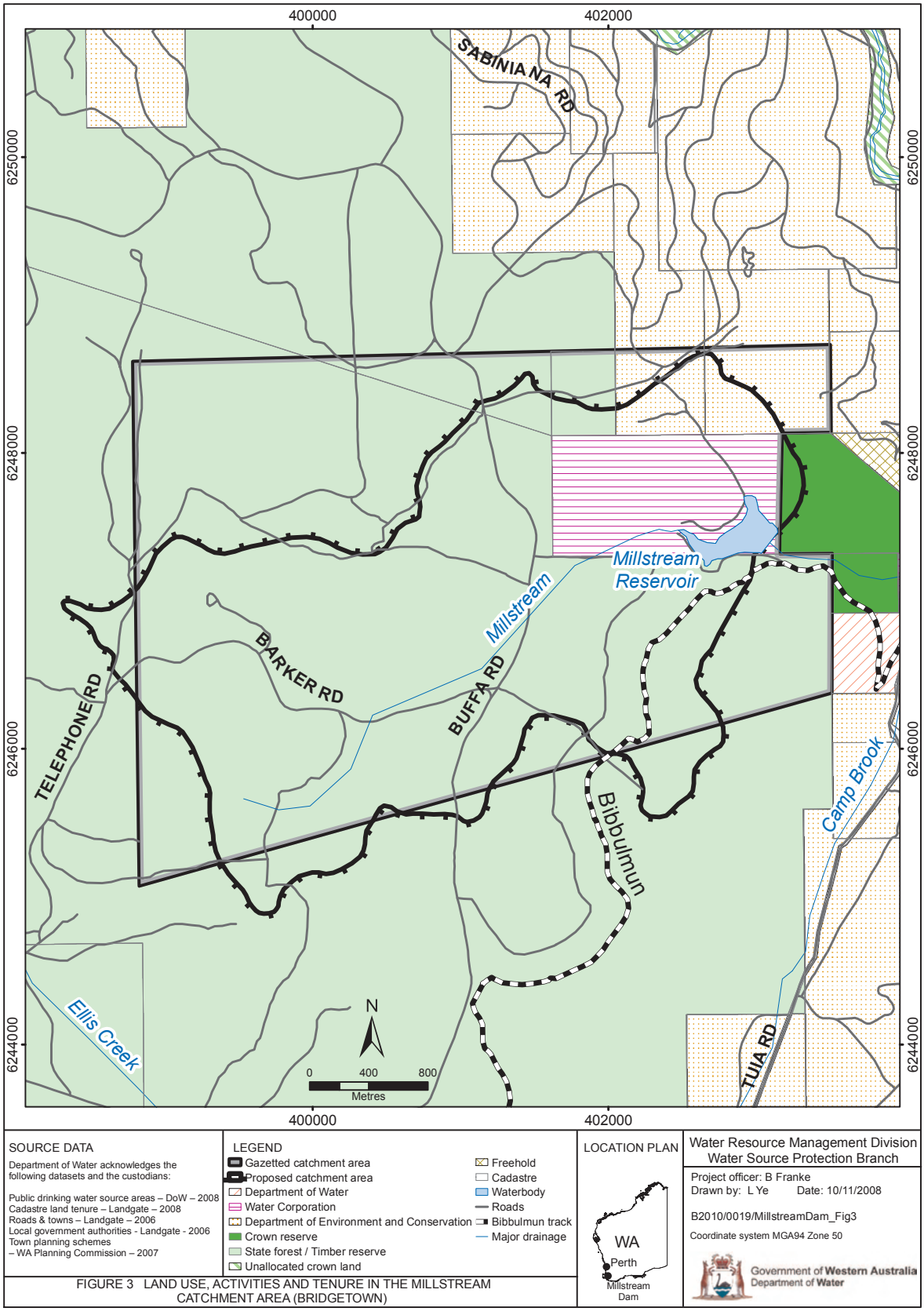

Figure 3 Land use, activities and tenure in the Millstream Catchment Area (Bridgetown)

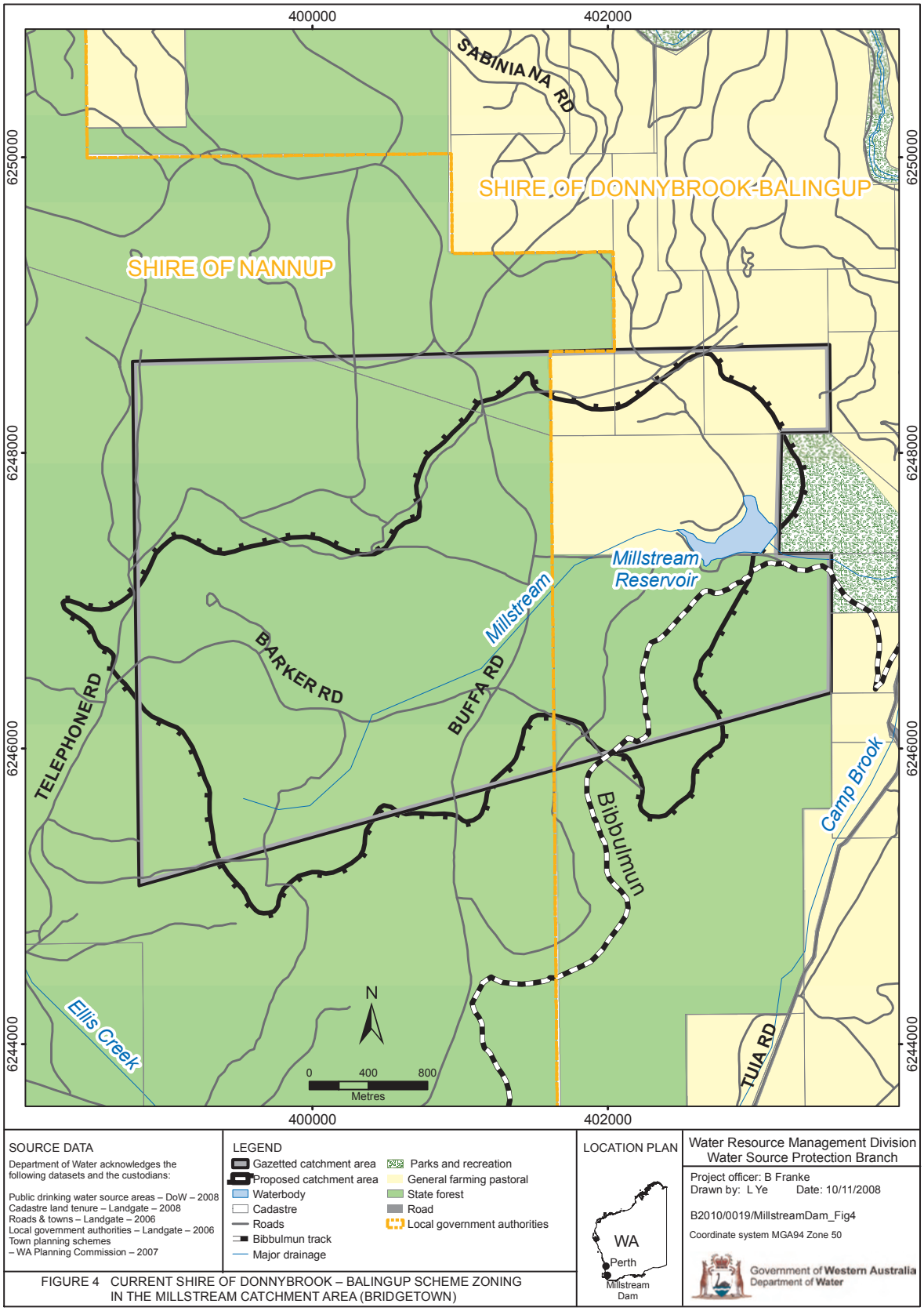

Figure 4 Current Shire of Donnybrook-Balingup scheme zoning in the Millstream Catchment Area (Bridgetown).

Table 1 Land use and potential water quality risks (see Appendix B for an expansion of this table and proposed management strategies).

Land use/activity	**Hazard**	**Management priority**	**Compatibility of land use/activity***
Timber harvesting: • native forest	Turbidity Hydrocarbons and other chemical substances Herbicides and pesticides	Medium Low Low	Compatible with conditions in a Priority 1 (P1) PDWSA.
Roads and tracks: • unsealed • construction	Turbidity Hydrocarbons and other chemical substances Pathogens	Medium Low Medium	Major roads incompatible in a P1 PDWSA (minor roads may be approved with conditions).
Illegal crops	Pathogens	Medium	Incompatible in a PDWSA.
Feral animal control (authorised): • foxes • pigs	Pathogens	Medium	Compatible with conditions in a P1 PDWSA.
Fire management: • wildfire • prescribed burns	Turbidity	Low	Prescribed burns – compatible with best-management practices in a P1 PDWSA.
Resource harvesting: • apiary • wildflower picking • seed collection • firewood collection	Pathogens	Medium	Compatible with conditions in a P1 PDWSA and outside the reservoir protection zone (RPZ).

Land use/activity	Hazard	Management priority	Compatibility of land use/activity*
Recreation			
Authorised recreation: • bushwalking – Bibbulmun Track	Pathogens	Medium	Compatible with conditions in a P1 PDWSA. Incompatible in the RPZ – acknowledged as an existing, non-conforming use.
Unauthorised recreation: • bushwalking (other than on designated tracks and trails)	Pathogens	Medium	Compatible with conditions in a P1 PDWSA. Incompatible in the RPZ.
• off-road vehicle use e.g. 4WD and trail bikes (away from public roads and tracks)	Pathogens Turbidity Hydrocarbons	Medium Low Low	Incompatible in a P1 PDWSA and the RPZ.
• swimming	Pathogens Turbidity	High Low	Incompatible in a P1 PDWSA and the RPZ.
• fishing and marroning	Pathogens Turbidity	High Low	Incompatible in a P1 PDWSA and the RPZ.
• Illegal hunting	Pathogens	Medium	Incompatible in a P1 PDWSA and the RPZ.
• camping / picnicking	Pathogens	Medium	Incompatible in a P1 PDWSA and the RPZ except in designated areas.

*Refer also to *Water quality protection note: Land use compatibility in public drinking water source areas* (Department of Environment 2004) and *Statewide policy 13: Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003), which is currently subject to review.

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to ensure that safe drinking water is available to consumers now and in the future. This objective needs to be achieved while recognising the rights of existing approved land uses to continue. The protection objectives for the Millstream Catchment Area are to:

- improve the quality of raw water abstracted from Millstream reservoir.
- ensure drinking water source protection is taken into account in land-use planning decisions (including recreation planning).
- identify land uses that pose a contamination risk and manage those land uses to avoid, minimise and/or manage the risk level.

4.2 Proclaimed area

The Millstream Catchment Area is proclaimed (gazetted) under the *Country Areas Water Supply Act 1947* (WA). As part of this plan's preparation, the boundary of the catchment area was reviewed to assess whether it reflected the physical characteristics of the catchment. Amendments are recommended based on the results of this review (see Figure 2 and Figure 3).

It should be noted that emergency water sources in the region, which have been used to supplement the Millstream reservoir, are not currently proclaimed as PDWSAs. Should it become necessary to use a supplementary source (e.g. the bore at Nannup) on a permanent basis, the new source will need to be proclaimed following the development of a drinking water source protection plan.

4.3 Priority areas

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

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

The determination of priority areas is based on the strategic importance of the land or water source, the local planning-scheme zoning, the form of land tenure and existing

approved land uses or activities. For further details, please refer to the Department of Water's *Water quality protection note: Land use compatibility in public drinking water source areas*.

The proposed priority area for the Millstream Catchment Area has been determined in accordance with current Department of Water policy. This area is described below and displayed in Figure 5. The department's *Water quality protection note: Land use compatibility in public drinking water source areas* outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas. For an explanation of the background and support for protection of PDWSAs, please refer to the aforementioned water quality protection note.

This plan proposes classifying the entire Millstream Catchment Area (freehold land and all crown land) as P1 for the following reasons:

- Water from this source constitutes a strategic supply to the BRWSS and should therefore be afforded the highest feasible level of protection.
- Existing authorised land uses are considered compatible with P1 source-protection objectives.
- The freehold land is considered to be strategically important because it lies within the reservoir protection zone (see Section 4.4).

4.4 Protection zones

In addition to priority areas, specific protection zones can be defined to protect drinking-water sources from contamination in the immediate vicinity of water extraction facilities. By-laws of the *Country Areas Water Supply Act 1947* (WA) may prohibit, restrict or approve defined land uses and activities to prevent water source contamination or pollution. Specific conditions may apply within these zones such as restrictions on the storage of chemicals.

Policy sets out that reservoir protection zones (RPZ) start at the high water mark of a reservoir and generally reach two kilometres back into the catchment. They include the water storage body and do not extend outside the catchment area. Legislation and policy dealing with the size of RPZs are currently being reviewed. The review is considering the adoption of legislation that will allow a protection zone to be established in a PDWSA based on the outcomes of a drinking water plan that has undergone a public consultation process.

The proposed RPZ for the Millstream Catchment Area (Figure 5) extends north and west from the dam wall over state forest and Water Corporation and DEC-owned freehold land, and south from the dam wall over state forest. The portion of the Bibbulmun Track that traverses the Millstream Catchment Area is located entirely within the RPZ and is acknowledged as an existing, non-conforming land use. Realignment of the track should be investigated, given its current close proximity to the reservoir and a feeder stream, and the associated risks to water quality.

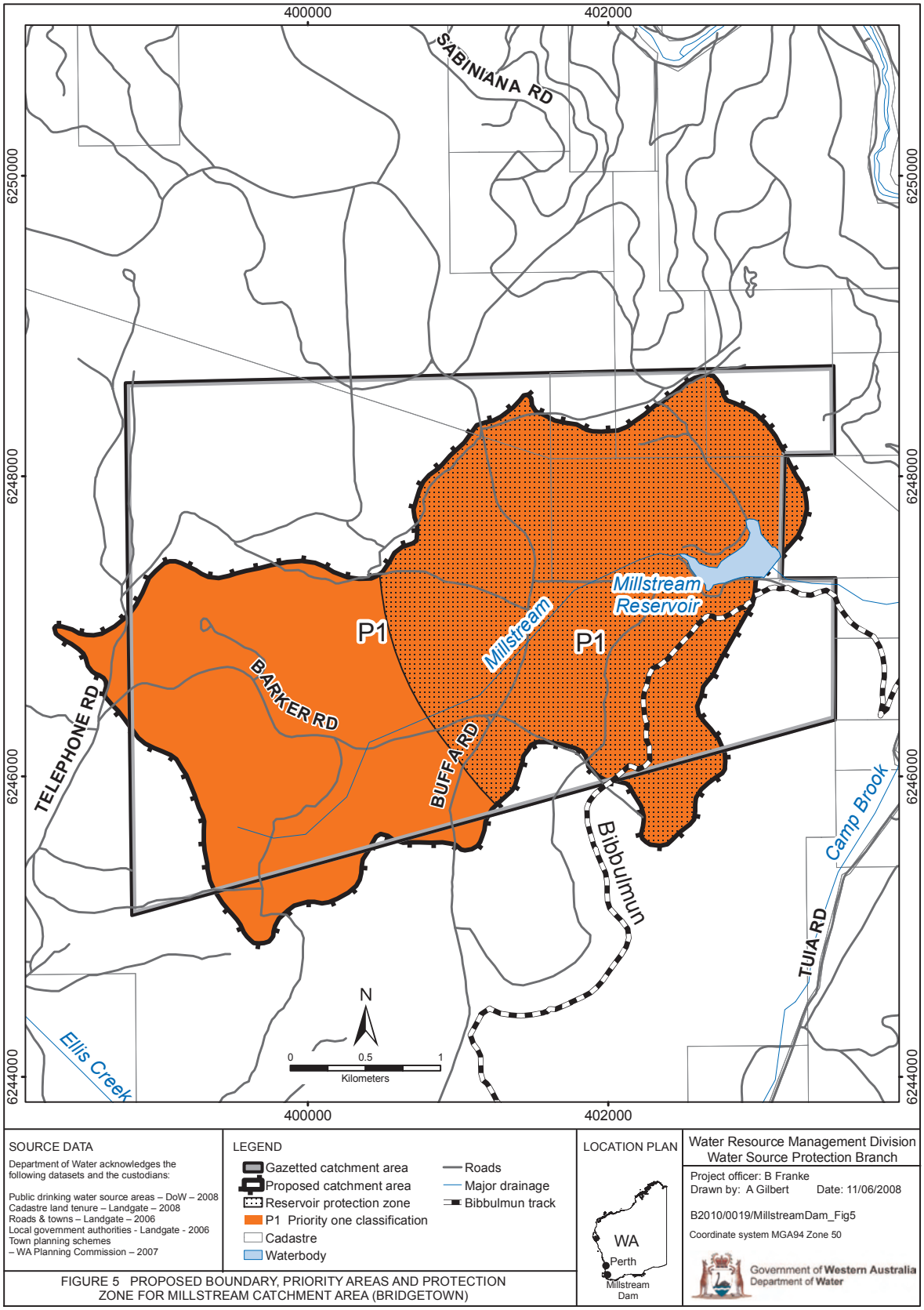

FIGURE 5 PROPOSED BOUNDARY, PRIORITY AREAS AND PROTECTION ZONE FOR MILLSTREAM CATCHMENT AREA (BRIDGETOWN)

Figure 5 Proposed boundary, priority areas and protection zone for the Millstream Catchment Area

4.5 Land-use planning

It is recognised under the *State planning strategy* (Western Australian Planning Commission 1997) that 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 the *State planning policy No. 2.7: Public drinking water source policy* (Western Australian Planning Commission 2003) and the *State planning policy No. 2.9: Water resources* (Western Australian Planning Commission 2006), it is appropriate that parts of the Millstream Catchment Area, priority areas and protection zone are recognised in the local planning schemes of the Donnybrook-Balingup and Nannup shires.

The Department of Environment and Conservation has responsibilities for management planning over the majority of this catchment area under the *Conservation and Land Management Act 1984* (WA).

Any development proposals within the Millstream Catchment Area that are inconsistent with advice in the Department of Water's *Water quality protection note: Land use compatibility in public drinking water source areas, Statewide policy No. 13: Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003) or recommendations in this plan, should be referred to the Department of Water. For further information 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 that would not be accepted for new developments. The department may negotiate with landowners/operators on measures to improve these facilities and reduce water quality contamination risks.

4.6 Best-management practices

There are opportunities to significantly reduce water contamination risks by carefully considering design and management practices. The Department of Water will continue to encourage the adoption of best-management practices for various land uses. On freehold land, the department aims to work with landowners by providing advice on achieving sound management practices for the protection of water quality.

Guidelines on best-management practices for many land uses are available in the form of industry codes of practice, environmental guidelines and water quality protection notes. These have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include the *Code of practice for timber plantations in Western Australia* (Forest Industries Federation (WA) Inc. 2006), *Statewide policy No. 13: Policy and guidelines for recreation within public drinking water source areas on*

crown land (Water and Rivers Commission 2003); *Policy Statement No.18:* Recreation, Tourism and Visitor Services (Department of Environment and Conservation 2007); *Statewide policy No. 2: Pesticide use in public drinking water source areas* (Water and Rivers Commission 2000); the Department of Health circular PSC 88: *Use of herbicides in water catchment areas* (2007); and the Department of Water's *Water quality protection note: Roads near sensitive water resources* (2006), which are listed in this report's Bibliography. The guidelines outline the recommended practices to ensure the protection of water quality and therefore help managers reduce any detrimental effects of their operations.

Education and creating awareness (e.g. signage and information) are also key mechanisms for protecting water quality, especially for those people visiting the area who are unfamiliar with the Millstream Catchment Area. A brochure will be produced once this plan is endorsed, describing the Millstream Catchment Area, 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 PDWSAs within country areas of the state is protected under the *Country Areas Water Supply Act 1947* (WA). Proclamation of PDWSAs allows existing by-laws to be applied to protect water quality.

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

Signs are erected on the boundaries of PDWSAs to educate and advise the public about activities that are prohibited or regulated (Appendix C, Figure C4). This plan recommends that surveillance and by-law enforcement 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 shires of Nannup and Donnybrook-Balingup local emergency management committees (LEMCs), through the South West emergency management district (State Emergency Management Committee 2005), should be familiar with the location and purpose of the Millstream Catchment Area. A locality plan should be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. The DEC is the lead agency for wildfire-control management for most of the catchment area that is outside of the gazetted fire emergency response zone. The Water Corporation's role should be to advise the HAZMAT team in relation to incidents in the Millstream Catchment Area.

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

4.9 Implementation of this plan

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

Following completion of the final *Millstream Catchment Area (Bridgetown) drinking water source protection plan*, an implementation strategy will be drawn up based on the recommendations in Table 1. It will provide an indicative time frame for the recommended protection strategies and identify stakeholders that could be involved in implementation actions.

5 Recommendations

The following recommendations apply to the entire Millstream Catchment Area (Bridgetown). The bracketed stakeholders are those expected to have an interest in implementing the relevant recommendation.

1 The boundary of the Millstream Catchment Area (Bridgetown) should be amended under the *Country Areas Water Supply Act 1947* (WA). *(Department of Water)*

2 An implementation strategy for the recommendations of this plan (including the recommended protection strategies as detailed in Appendix B) should be developed showing responsible stakeholders and planned timeframes. *(Department of Water, applicable stakeholders)*

3 The *Shire of Nannup* and *Shire of Donnybrook-Balingup local planning schemes* should incorporate this plan and reflect the identified Millstream Catchment Area (Bridgetown) boundary, priority 1 area and protection zone in accordance with *State planning policy No. 2.7: Public drinking water source policy*. *(Shire of Nannup, Shire of Donnybrook-Balingup)*

4 All development proposals within the Millstream Catchment Area (Bridgetown) that are inconsistent with the Department of Water's *Water quality protection note: Land use compatibility in public drinking water source areas*, *Statewide policy No. 13: Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003) or recommendations in this plan should be referred to the Department of Water for advice and recommendations. *(Department for Planning, Shire of Nannup, Shire of Donnybrook-Balingup, Department of Environment and Conservation, proponents of proposals)*

5 Incidents covered by WESTPLAN–HAZMAT in the Millstream Catchment Area (Bridgetown) should be addressed by ensuring that:

- the Shire of Nannup and Shire of Donnybrook-Balingup LEMCs are aware of the location and purpose of the Millstream Catchment Area (Bridgetown)
- the locality plan for the Millstream Catchment Area (Bridgetown) is provided to the FESA headquarters for the HAZMAT emergency advisory team
- the Water Corporation acts in an advisory role during incidents in the Millstream Catchment Area (Bridgetown)
- personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Millstream Catchment Area (Bridgetown) and information to help them recognise the potential impacts of spills on drinking water quality.

(*Department of Water, Water Corporation)*

6 The Department of Water should consider delegating responsibility for surveillance and enforcement measures within the Millstream Catchment Area

(Bridgetown) to the Water Corporation. The existing surveillance program should be maintained to identify any incompatible land uses or potential threats within the Millstream Catchment Area (Bridgetown). *(Department of Water, Water Corporation)*

7 Signs should be erected along the revised boundary of the Millstream Catchment Area (Bridgetown) to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number. *(Water Corporation)*

8 Any additional source such as the Nannup bore used to supplement Millstream reservoir should be proclaimed as a public drinking water source area and a drinking water source protection plan should be prepared. *(Department of Water, Water Corporation)*

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

Appendices

Appendix A Water quality data

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

The Water Corporation has monitored the raw (source) water quality from Millstream reservoir. This data shows the quality of water in the catchment. An assessment of the drinking water quality is also made in accordance with the *National water quality management strategy: Australian drinking water guidelines 6,* 2004 (ADWG) (NHMRC & NRMMC 2004a) and interpretations agreed to with the Department of Health. The raw water is monitored regularly for:

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

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

It is important to appreciate that the raw-water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of the ADWG. The values are taken from ongoing monitoring for the period June 2003 to June 2008.

For more information on the quality of drinking water supplied to the Bridgetown Regional Water Supply Scheme refer to the most recent Water Corporation drinking water quality annual report at <www.watercorporation.com.au> > Publications > Water quality > Latest annual report.

Aesthetic

The aesthetic quality analyses for raw water from Millstream reservoir are summarised in the following table. All values are in milligrams per litre (mg/L) unless stated otherwise. Any water quality parameters that have been detected are reported; those that on occasion have exceeded the ADWG are shaded.

Aesthetic detections for Millstream reservoir

Parameter	Units	ADWG aesthetic guideline value*	Bridgetown Millstream PS Raw SP	
			Range	Median
Aluminium (acid soluble)	mg/L	0.2	0.06 - 0.35	0.07
Chloride	mg/L	250	80 - 100	88
Colour	TCU	15	<1 - 16	5
Conductivity at 25℃	mS/m	-	31 - 105	38
Hardness as $CaCO_3$	mg/L	200	34 - 49	45
Iron unfiltered	mg/L	0.3	0.022 - 1	0.2
Manganese unfiltered	mg/L	0.1	<0.002 - 0.2	0.008
pH	pH	6.5 – 8.5	6.59 - 8.1	7.07
Sodium	mg/L	180	48 - 57	52
Sulfate	mg/L	250	16 - 29	22
Total filterable solids by summation	mg/L	500	182 - 230	203
Turbidity	NTU	5	0.2 - 22	1.8

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

Health related

Health-related chemicals

Raw water from Millstream reservoir is analysed for chemicals that are harmful to human health, including categories of chemicals such as inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that impact on water quality are summarised in the following table. Health related water quality parameters that have been measured at detectable levels in the source between June 2003 and June 2008 are summarised in the table below. Any parameters that have on occasion exceeded the ADWG are shaded.

Health-related detections for Millstream reservoir

Parameter	Units	ADWG health guideline value*	Bridgetown Millstream PS Raw SP	
			Range	Median
Barium†	mg/L	0.7	0.02 - 0.025	0.0225
Boron†	mg/L	4	0.03 - 0.04	0.035
Nitrite plus nitrate as N	mg/L	11.29	<0.05 - 0.055	<0.05
Sulphate	mg/L	500	16 - 29	22
Uranium†	mg/L	0.02	<0.001 - 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 (NHMRC & NRMMC 2004a).*

† Water quality data observed from 3 or less sampling occasions

Microbiological contaminants

Microbiological testing of raw-water samples from Millstream reservoir is currently conducted on a weekly 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 of less than 20 MPN (most probable number) per 100 mL sample is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark of the raw water (WHO 2004). As such, counts less than 20 MPN are seen as being an indication of raw water that has not been recently contaminated with faecal material.

During the reviewed period of June 2003 to June 2008, positive *Escherichia coli* counts were recorded in approximately 40% of samples, of which 7% had *Escherichia coli* counts greater than 20 MPN/100mL. This is typical of a large surface water source within a forested catchment.

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

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

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Timber harvesting: • native forest	• Turbidity due to log handling; the construction, use and upgrading of unsealed roads and tracks; and runoff from cleared areas. • Hydrocarbons from vehicle and machinery fuel spills. • Contamination from other chemical substances such as fertilisers, herbicides and pesticides.	Medium Low Low	• Turbid runoff from unsealed roads and tracks has been noted on occasion, contributing to elevated turbidity levels in the reservoir. • The Forest Products Commission (FPC) operates in the region in accordance with the *Contractors' timber harvesting manual* (FPC 2003) and the *Code of practice for timber plantations in Western Australia* (FIFWA 2006) under an Environmental Management System (EMS). FPC activities are regulated by DEC. • DEC conduct blackberry control along roads in the catchment using approved herbicides as per PSC 88: *Use of herbicides in water catchment areas* (DoH 2006).	• FPC manual, code of practice and EMS. • Water Corporation surveillance. • Water quality monitoring. • DEC management under the *Forest Management Plan 2004–2013.* . • DoH PSC 88.	*Acceptable activity with best-management practices.* • Establish RPZ. • Review DEC harvesting plans during the planning phase to ensure water quality protection objectives are included. • Ensure timber harvesting activities are carried out in accordance with the relevant forestry codes and manuals and EMS are assessed by the Department of Water. • Ensure vegetation buffers along creek lines are maintained. • Pesticides are used in accordance with PSC 88 and *Statewide policy No. 2: Pesticide use in public drinking water source areas*.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Roads and tracks: • unsealed • construction	• Turbidity from erosion of unsealed roads and tracks. • Hydrocarbons from vehicle and machinery fuel spills. • Roads and tracks can provide public access to the waterbody and the catchment, which increases all associated risks including: - rubbish dumping - camping in non-designated areas - bushfires - pathogen contamination.	Medium Low Medium	• Turbid runoff from unsealed roads and tracks occasionally occurs, contributing to elevated turbidity levels in the reservoir. • Some roads and tracks are necessary for timber harvesting, fire management and general forest management. However, it is essential they are well maintained to minimise the risk of erosion, and hence the impact on water quality. • The catchment is in a Disease Risk Area (DRA) monitored by DEC. Entry into the DRA requires a permit and compliance with its conditions.	• Water Corporation and DEC surveillance. • Water quality monitoring. • DEC management of state forest roads and tracks. • Permit required from DEC for access into the DRA. • WESTPLAN–HAZMAT emergency response.	*Accepted as necessary for forest management, with best-management practices.* • Establish RPZ. • Use signage to promote awareness of water source. • Continue undertaking surveillance. • Review road/track network. Close and rehabilitate those not essential for forest operations and management or transport thoroughfare. • Construct sumps at major stream crossings. • Install gates on roads to prevent unauthorised public access to the RPZ. • Maintain roads/tracks to minimise water quality risks.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Illegal crops	• Pathogens from human presence in the catchment.	Medium	• Cannabis growing is known to occur in the area from time to time. Crops are removed when identified.	• Water Corporation and DEC surveillance. • Water quality monitoring.	*Incompatible activity.* • Establish RPZ. • Continue undertaking surveillance. • Water Corporation staff should liaise with police.
Feral animal control and illegal hunting: • pigs • foxes	Risks associated with the presence of feral animals include • pathogens from faeces and carcasses • turbidity from pigs wallowing • pathogens from human and domestic animal (dogs) presence (hunting, trapping) • 1080 baiting.	Medium Low Medium Low	• Pathogen contamination of waterbodies can result from animal carcases, faeces, uneaten baits, and pigs wallowing. DEC is carrying out fox control programs on DEC-managed land using 1080 poison. It is a naturally occurring poison that degrades quickly. Pigs are active in the catchment, but numbers are generally low. There is currently no formal pig control program in the area. • Illegal pig hunting with dogs is a popular recreational activity, and illegal release of pigs is known to have occurred in WA forests. This increases all risks associated with the animals and the presence of humans in the catchment.	• Water Corporation and DEC surveillance. • Water quality monitoring. • DEC baiting program – baits are generally not placed within 100 m of watercourses or reservoirs. • *Country Areas Water Supply Act 1947* (WA) by-laws.	*Incompatible activity (recreational hunting and introduction of game animals).* • Continue undertaking surveillance and by-law enforcement. • Control feral pigs through an authorised management program. • Follow recommendations in *WQPN: Pest animal management in public drinking water source areas* (in preparation)

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Fire management: • prescribed burns • fire access tracks • water points	• Turbidity due to ash and increased runoff and soil exposure after fuel reduction burns and the construction and maintenance of fire access tracks and water points. • Carbon and nutrient contamination. • Hydrocarbons from vehicle and machinery fuel spills. • Chemical contamination from pesticides and fire retardants. • Pathogens from human presence in the catchment.	Low Low Low Low Medium	• Fire management in state forest is undertaken by DEC in accordance with the *Forest Management Plan 2004–2013.* Water quality issues are considered in fire management operations. • Fire access tracks can be constructed with table drains to minimise erosion. • Loss of filtering vegetation due to fires increases the risk of pathogens being washed into the reservoir and feeder streams.	• Water Corporation and DEC surveillance. • Water quality monitoring. • DEC fire management. • Water Corporation advisory role.	*Accepted as necessary for forest management, with best management practices.* • Consider water quality protection in burning prescriptions (e.g. the siting and construction of fire access tracks to minimise turbid runoff into water bodies; construction and use of sumps and/or drains for sediment control; communication between agencies managing the catchment). • Stabilise soil excavated during construction of water points to prevent turbid runoff into water bodies. • Carry out post-fire water quality monitoring. • Manage and where necessary rehabilitate fire access tracks in burnt areas.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Wildfire	• Turbidity due to ash and increased runoff and soil exposure after wildfire and the construction of emergency fire access tracks. • Carbon and nutrient contamination from airborne or eroded ash. • Hydrocarbons from vehicle and machinery fuel spills. • Chemical contamination from pesticides and fire retardants. • Pathogens from human presence in the catchment. • Pathogens from decomposing carcasses.	Low Low Low Low Medium Medium	• Extensive burning from wildfires can be caused either naturally or following irresponsible human access. However, intense wildfires in the catchment are rare. • Intense wildfire can cause turbidity issues from ash made airborne during the fire, or through runoff when the fire is followed by rain. • A reduction of filtering vegetation and decomposing animal carcasses may result in an increase in nutrient and pathogen transport. • All transient public access to the catchment increases the risk of wildfires (e.g. unauthorised camping, bushwalking, picnicking, fishing, marroning).	• DEC fire management. • Water Corporation and DEC surveillance. • Water quality monitoring. • Water Corporation advisory role.	• Water Corporation staff should attend all fires in the catchment area. • Inspect sites following fire to assess the need for turbidity mitigation works (to be undertaken at the combined expense of Water Corporation and DEC). • Ensure that fire access tracks required on an ongoing basis are constructed to minimise soil disturbance. • Emergency fire access tracks should be immediately rehabilitated. • Ensure that post-fire water quality monitoring is carried out.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Resource harvesting: • apiary • wildflower picking • seed collection • firewood collection	• Pathogen contamination through the presence of people near the reservoir and tributaries, and associated camping (including overnight stays). • Increased turbidity due to use of unsealed roads. • Rubbish dumping as a consequence of public access.	Medium Low Low	• Activities and numbers are managed by DEC through the issuing of licences under the Forest Management Regulations 1993 (apiarists) and the Wildlife Conservation Regulations 1970 (flora) with three licensed pickers in the area. There are currently no permitted apiary sites in the catchment. • The collection of firewood is managed through a permit system operated by DEC. There are no designated public firewood collection sites in the catchment; however, illegal firewood collection occurs from time to time. • Some rubbish dumping associated with unauthorised firewood collection has been reported.	• DEC regulation of activities, including conditions to address water quality protection objectives. • Water Corporation and DEC surveillance. • Water quality monitoring.	*Acceptable activity with conditions/controls.* • Establish RPZ and restrict activities to areas outside RPZ and away from feeder streams. • Continue undertaking surveillance and applying licence conditions that address water quality protection objectives. • Water, if required on site, should not be sourced from the reservoir, but be trucked in. • Where possible, establish designated public firewood areas outside the RPZ and away from feeder streams. • Ensure public firewood areas are regularly patrolled and that any rubbish dumped is removed. • Where possible, direct these activities to areas outside the catchment.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Recreation					
Authorised recreation: • bushwalking – Bibbulmun Track	• Pathogens from human presence in the catchment, especially in close proximity to the reservoir. • Rubbish dumping.	Medium Low	• The Bibbulmun Track passes within 150 m of the reservoir and runs adjacent to a feeder stream. The track is reported to be well used, with most activity in autumn and spring. There are no toilets or camping facilities located in the catchment for walkers. The track notes and signage inform walkers of the importance of minimising contamination of any water source.	• Water Corporation and DEC surveillance. • Water quality monitoring. • Signage on reservoir access track. • Bibbulmun track notes.	*Acceptable activity with conditions on designated tracks or roads only.* • Increase signage to promote awareness of water source. • Increase autumn and spring surveillance. • Investigate possible closure of some roads to reduce public access to the catchment. • Promote the use of designated tracks and roads. • Investigate the potential for realignment of the track given current proximity to waterbody and associated risk of unauthorised access to the reservoir.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Unauthorised recreation: • bushwalking (away from designated tracks and trails)	• Pathogens from human presence in the catchment, especially in close proximity to the reservoir. • Rubbish dumping.	Medium Low	• Most bushwalking activities in the catchment centre on the Bibbulmun Track. However, several other roads and tracks allow access to the catchment. • Part of the catchment is in a Disease Risk Area (DRA) monitored by DEC. Entry into the DRA requires a permit and compliance with its conditions.	• Water Corporation and DEC surveillance. • Water quality monitoring. • Signage on reservoir access track.	*Incompatible activity in RPZ, conditional activity in P1 areas.* • Establish RPZ. • As for 'Authorised recreation: Bushwalking – Bibbulmun Track'
• off-road vehicle use, e.g. 4WD and trail bikes (away from public roads and tracks)	• Pathogens from human presence in the catchment, especially in close proximity to the reservoir and feeder streams. • Turbidity from erosion of unsealed roads and tracks. • Hydrocarbons from vehicle and machinery fuel spills.	Medium Low Low	• Unauthorised off-road use of 4WD vehicles and trail bikes occurs in the catchment, potentially close to the reservoir and feeder streams. • Part of the catchment is in a Disease Risk Area (DRA) monitored by DEC. Entry into the DRA requires a permit and compliance with its conditions.	• Water Corporation and DEC surveillance. • Water quality monitoring. • Signage and locked gate on reservoir access track.	*Incompatible activity.* • Establish RPZ. • Use signage to promote awareness of water source. • Continue undertaking surveillance. • Investigate possible closure of some roads to reduce public access to the catchment.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
• swimming	• Pathogens from human and animal contact with water. • Turbidity from erosion of reservoir banks.	High Low	• People and dogs have been observed swimming in the reservoir. Direct human or animal contact with the water is an immediate threat to water quality with the potential for *Cryptosporidium* contamination. It significantly reduces the effectiveness of detention time as a barrier. • Chlorination alone does not provide sufficient protection against *Cryptosporidium*.	• Swimming in the reservoir is prohibited • Water Corporation and DEC surveillance • Water quality monitoring • Signage and locked gate on reservoir access track	*Incompatible activity.* • Prohibited under *Country Areas Water Supply Act 1947* (WA) by-laws and Conservation and Land Management Act Regulations 2002 (WA). • Establish RPZ. • Use signage to indicate that swimming is not permitted. • Continue undertaking surveillance and by-law enforcement. • Maintain the fence around the reservoir.
• fishing and marroning	• Pathogens from human, animal and bait contact with water. • Turbidity from erosion of reservoir banks.	High Low	• Some fishing and marroning activity occurs in the reservoir throughout the year. These activities involve direct contact with the water. Direct human or animal contact with the water is an immediate threat to water quality with the potential for *Cryptosporidium* contamination. It significantly reduces the effectiveness of	• Fishing and marroning in the reservoir are prohibited. • Water Corporation and DEC surveillance. • Water quality monitoring. • Signage and	*Incompatible activity.* • Prohibited under *Country Areas Water Supply Act 1947* (WA) by-laws. • Establish RPZ. • Use signage to indicate that fishing and marroning are not permitted. • Continue undertaking surveillance and by-law

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
• fishing and marroning (cont.)			detention time as a barrier. • Chlorination does not provide sufficient protection against *Cryptosporidium*.	locked gate on reservoir access track.	enforcement. • Maintain the fence around the reservoir.
• camping / picnicking	• Pathogens from human and domestic animal presence in the catchment, especially in close proximity to the reservoir and feeder streams. • Turbidity from erosion of unsealed roads and tracks. • Hydrocarbons from vehicle and machinery fuel spills.	Medium Low Low	• There are no designated camping or picnicking sites in the catchment; however, illegal camping or picnicking associated with other unauthorised recreational activities is likely to occur. • Camping or picnicking activities increase the potential for wildfires and littering to occur. • The catchment is in a Disease Risk Area (DRA) monitored by DEC. Entry into the DRA requires a permit and compliance with its conditions.	• Water Corporation and DEC surveillance. • Water quality monitoring. • Signage and locked gate on reservoir access track.	*Incompatible activity.* • Prohibited under *Country Areas Water Supply Act 1947* (WA) by-laws. • Establish RPZ. • Use signage to indicate that fishing and marroning are not permitted. • Continue undertaking surveillance and by-law enforcement. • DEC promotes use of designated campsites and discourages illegal camping. • Investigate possible closure of some roads to reduce public access to the catchment.

Appendix C Photographs

Figure C1 Exposed banks at Millstream reservoir in January 2008 indicate lower inflows than in the past.

Figure C2 Unsealed road through state forest in the Millstream Catchment Area.

Figure C3 Millstream reservoir photographed from the gate adjacent to Millstream Road, which forms part of the Bibbulmun Track at this point.

Figure C4 Existing signage at Millstream Dam.

List of shortened forms

ADWG	*Australian drinking water guidelines*
AHD	Australian height datum
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
BRWSS	Bridgetown regional water supply scheme
DEC	Department of Environment and Conservation
ha	hectare
HAZMAT	hazardous materials
km	kilometre
km^2	square kilometre
LEMC	local emergency management committee
m	metres
mg/L	milligram per litre
mL	millilitre
ML	megalitre
mm	millimetre
MPN	most probable number
mS/m	millisiemens per metre
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
NTU	nephelometric turbidity units
PSC 88	public sector circular number 88
PDWSA	public drinking water source area
RPZ	reservoir protection zone
TCU	true colour units
WESTPLAN–HAZMAT	Western Australian plan for hazardous materials

Glossary

Abstraction The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.

Adsorb Adsorb means to accumulate on the surface of something. For example, micro-organisms can adsorb onto soil particles.

Australian drinking water guidelines The *National water quality management strategy: Australian drinking water guidelines 6,* 2004 (NHMRC & NRMMC 2004a) (ADWG) outline acceptable criteria for the quality of drinking water in Australia (see this report's Bibliography).

Aesthetic guideline value The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMMC 2004a).

Australian height datum Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.

Allocation The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).

Aquifer An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.

Augment Augment means to increase the available water supply, e.g. pumping back water from a secondary storage/reservoir dam.

Catchment The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.

Department of Environment and Conservation 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.

Electrical conductivity This estimates the volume of TDS or the total volume of dissolved ions in a solution (water) corrected to 25°C. Measurement units include millisiemens per metre and microsiemens per centimetre.

Hectare A hectare is a measurement of area, equivalent to 10 000 square metres.

Health guideline value The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption.

Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
Megalitre	A megalitre is equivalent to 1 000 000 litres or 1 000 kilolitres
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
Millisiemens per metre	Millisiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
Most probable number	Most probable number is a measure of microbiological contamination.
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
Pollution	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.

Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Public drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA)and the *Country Areas Water Supply Act 1947* (WA).
Reservoir	A reservoir, dam, tank, pond or lake that forms part of any public water-supply works.
Reservoir protection zone	A buffer measured from the high water mark of a drinking-water reservoir, and inclusive of the reservoir (usually two kilometres). This is referred to as a prohibited zone under the *Metropolitan Water Supply, Sewerage and Drainage Act By-laws 1981.*
Runoff	Water that flows over the surface from a catchment area, including streams.
Storage reservoir	A major reservoir of water created in a river valley by building a dam.
Supply scheme	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
True colour units	True colour units are a measure of degree of colour in water.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Water quality	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	A water reserve is an area proclaimed under the *Country Areas Water Supply Act 1947* or the *Metropolitan Water Supply Sewerage and Drainage Act 1909* for the purposes of protecting a drinking water supply.
Wellfield	A wellfield is a group of bores located in the same area used to monitor or withdraw groundwater.

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