



Government of Western Australia
Department of Water

Angove Creek Catchment Area

Drinking water source protection plan

*Albany, the Lower Great Southern
town water supply scheme*



Looking after all our water needs

Water resource protection series
Report WRP 133
December 2012

Angove Creek Catchment Area drinking water source protection plan

Albany and Mount Barker,

Lower Great Southern Town Water Supply Scheme

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Department of Water

Water resource protection series (WRP)

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Contents

Preface	v
Summary	vii
1 Overview.....	1
1.1 The drinking water supply system	1
1.2 Water management.....	1
1.2.1 Licence to take water.....	1
1.2.2 Water planning	2
1.2.3 Future water needs.....	2
1.3 Characteristics of the catchment	2
1.3.1 Physical environment	2
1.3.2 Climate	3
1.3.3 Hydrology	3
1.4 How is this drinking water source currently protected?	3
2 Common contamination risks	5
2.1 Microbiological risks	5
2.2 Physical risks.....	6
2.3 Chemical risks	6
3 Contamination risks in this drinking water source.....	8
3.1 Water quality	8
3.2 Land uses and activities	8
3.3 Possible future contamination risks.....	10
4 Protecting your drinking water source	10
4.1 Proclaiming public drinking water source areas	10
4.2 Defining priority areas	10
4.3 Defining protection zones.....	11
4.4 Planning for future land uses.....	12
4.5 Using best management practices	12
4.6 Enforcing by-laws and surveying the area	13
4.7 Responding to emergencies.....	13
4.8 Putting this plan into action	13
5 Recommendations.....	14
Appendices.....	15
List of shortened forms.....	33
Glossary	35
References and further reading.....	39
Appendices	
Appendix A — Figures	15
Appendix B — Water quality data	19

Appendix C — Land use, potential water quality risks and recommended protection strategies 23

Appendix D — Photographs 29

Preface

How do we protect public drinking water source areas?

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

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

A preventive risk-based approach means that we look at all the different risks to water quality, to determine what risks can reasonably be avoided and what risks need to be minimised or managed. This approach means that the inherent risks to water quality are as low as possible. A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system.

The first and most important barrier is protecting the catchment. If we get this barrier right, it has a flow-on effect that can result in a lower cost, safer drinking water supply. Other barriers against contamination include storage of water to help reduce contaminant levels, disinfecting the water (e.g. chlorination to inactivate pathogens), maintenance of pipes and testing of water quality. Another community benefit from catchment protection is that it complements the state's conservation initiatives.

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

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

The *Metropolitan Water Supply Sewerage and Drainage Act 1909* and the *Country Areas Water Supply Act 1947* provide us with important tools to protect water quality in proclaimed PDWSAs. These Acts allow us to assess and manage the water quality contamination risks from different land uses and activities. We work cooperatively with other agencies and the community in the implementation of this legislation.

This drinking water protection plan has been developed to achieve elements two and three of the 12 elements recommended for the protection of drinking water in the ADWG. It shows where the PDWSA is located, its characteristics, existing and potential water quality contamination risks, and recommendations to deal with those

risks. Our regional offices then work with the community, other government agencies and landowners to put these recommendations into practice.

An important step in maximising the protection of water quality in PDWSAs is to define catchment and recharge area boundaries, priority areas and protection zones to help guide land use planning and to identify where legislation applies. There are three different priority areas. Priority 1 (P1) areas (e.g. crown land) are defined and managed to ensure there is no degradation of the quality of the drinking water source using the principle of risk avoidance. Priority 2 (P2) areas (e.g. rural zoned land) are defined and managed to maintain or improve the quality of the drinking water source using the principle of risk minimisation. Priority 3 (P3) areas (e.g. urban or commercial zoned land) are defined and managed to maintain the quality of the drinking water source for as long as possible using the principle of risk management. Protection zones surround drinking water abstraction reservoirs or groundwater bores, so that the most vulnerable areas are protected from contamination.

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

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

Stages in development of a report		Comment
1	Prepare drinking water source protection assessment document. 2004	Prepared after initial catchment survey and preliminary information gathering.
2	Conduct preliminary stakeholder consultation. March- April 2012	Advice sought from key stakeholders using the assessment document as a tool for information and discussion. Draft protection plan is prepared.
3	Consult draft drinking water source protection plan. May 2012	Draft protection plan provided to key stakeholders including the farmers on crown land leases, Department of Regional Development and Lands, Water Corporation and the Shire of Albany.
4	Publish approved drinking water source protection plan. December 2012	Final protection plan published. Includes recommendations on how to protect water quality. Proclamation of the proposed Angove Creek Catchment Area can now be progressed.

Summary

The Angove Creek Catchment Area is located within the City of Albany and contributes to the Lower Great Southern Town Water Supply Scheme (which supplies drinking water in the south of WA - to Albany, Mount Barker and small communities along Water Corporation's pipeline).

The Department of Water has prepared this drinking water source protection plan to help protect the quality of water being extracted from pipe-head dams in the Angove Creek Catchment Area, to ensure the supply of safe drinking water. This plan:

- shows the location, size and significance of the drinking water source
- identifies the risks to water quality from surrounding land uses and activities
- outlines the catchment boundary that needs protecting
- outlines priority areas and protection zones (special areas that need protecting) within the proposed catchment boundary
- recommends strategies to address risks to water quality
- guides future land use planning and development in the Angove Creek Catchment Area.

This plan is consistent with the *Australian drinking water guidelines* (ADWG) (NHMRC & NRMCC 2011) and State planning policy no. 2.7: *Public drinking water source policy*.

The Angove Creek Catchment Area was proclaimed in 1959 under the *Country Areas Water Supply Act 1947*. The *Angove Creek Catchment Area drinking water source protection assessment* (Water Corporation, 2004) presented information about the catchment, identified risks to water quality and recommended protection strategies.

The most important recommendations in this 2012 drinking water source protection plan (which updates the 2004 assessment) are to:

- change the catchment area boundary to better reflect the physical size and shape of this catchment, and proclaim it under the *Country Areas Water Supply Act 1947*
- continue to manage the Crown reserve land in the proposed catchment area as Priority 1 for the maximum protection of water quality
- manage the remainder of the catchment area (Crown leases) as Priority 2 to support farming subject to best practice management for water quality protection
- include the boundary, priority areas and protection zone in the City of Albany's local planning scheme and strategies
- refer any subdivision and development applications in the Angove Creek Catchment Area that are not consistent with our Water quality protection note no. 25: *Land use compatibility in public drinking water source areas*, or this protection plan, to the Department of Water for advice.

Key information about the Angove Creek Catchment Area

Local government authority	City of Albany
Locations supplied	The Lower Great Southern Town Water Supply Scheme (which supplies water to Albany, Mount Barker and small communities along Water Corporation's pipeline from the Reservoir Hill tank to the Mount Clarence reservoir).
Volume of water taken	Annual abstraction of 854 807 kL during 1 July 2010 to 30 June 2011.
Date of dam completion	Two weirs constructed on Angove Creek about 90 years ago, form the current two pipe-head dams
Date of Angove Creek Catchment Area drinking water source protection assessment	2004
Date of Angove Creek Catchment Area drinking water source protection plan	2012
Proclamation status	Proclaimed in 1959 under the <i>Country Areas Water Supply Act 1947</i> . If the 2012 drinking water source protection plan is approved an updated Angove Creek Catchment Area boundary will need to be proclaimed.

1 Overview

1.1 The drinking water supply system

The Angove Creek Catchment Area surface water source (also referred to as the Two Peoples Bay source in some publications) has two pipe-head dams located on Angove Creek, about 30 km east of the town of Albany (Figure A1).

Angove Creek (also referred to as Angove River) is one of a number of water sources operated by the Water Corporation as part of the Lower Great Southern Town Water Supply Scheme (LGSTWSS), which supplies public drinking water to Albany and surrounding localities. In 2010 Angove Creek provided about 20 per cent of the water for Albany and Mount Barker (Water Corporation 2010).

Groundwater is the dominant water source used for the LGSTWSS. The water is sourced from Water Corporation's South Coast Groundwater system located south-west of Albany. Groundwater sources may be expanded in the future. (See Department of Water, 2007, 2008 and 2010; and Water and Rivers Commission, 2001.)

The raw water from Angove Creek's pipe-head dams (Figures D1, D2 and D3), is treated at the Two Peoples Bay Water Treatment Plant by clarification, pH correction and filtration. It is also disinfected with chlorine to ensure the microbiological quality of drinking water supplied to customers.

The treated water is pumped to a summit tank on nearby Reservoir Hill and then goes to the Mt Clarence and Mt Melville water storage tanks in Albany, servicing local farmlands and Albany's north-east corridor en route (see Figure D8) . At Mt Clarence and Mt Melville it is blended with water from the South Coast borefields and distributed into the town reticulation system.

It should be recognised that although treatment and disinfection are essential barriers against contamination, catchment management is the first step in protecting water quality and ensuring a safe drinking water supply. This approach is endorsed by the *Australian drinking water guidelines* (ADWG) (NHMRC & NRMCC 2011) and reflects a risk-based, multiple-barrier approach for providing safe drinking water to consumers. This combination of catchment protection and water treatment will deliver a more reliable, safer and lower-cost drinking water to consumers than either approach could achieve individually.

For more information on why it is so important to protect our catchments, read the preface at the front of this plan.

1.2 Water management

1.2.1 Licence to take water

Water resource use and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914*.

Under this Act, the right to use and control water is vested with the Crown. This means that a licence is required for altering the beds and banks of waterways and for abstracting water (pumping water from a river or creek) within proclaimed surface water areas throughout the state. Exemptions may apply such as abstracting water for domestic purposes only.

The Two People's Bay surface water area (Angove Creek) was proclaimed in 1997 under the *Rights in Water and Irrigation Act 1914* to allocate surface water resources within its boundaries and to manage its sustainable use (see the Department of Water 2009 map *Surface water proclamation areas 2009, Rights in Water and Irrigation Act 1914*). Water Corporation's licence enables the Corporation to draw up to 1600 ML per year from the Angove Creek source on Crown Reserve 13802.

Water Corporation's annual water abstraction for 1 July 2010 to 30 June 2011 was 854,807 kL. The current licence (SWL 107619(6)) expires on 30 June 2013.

1.2.2 Water planning

The *Lower Great Southern Water resource development strategy* (Department of Water, 2010) and *Water forever: Lower Great Southern* (Water Corporation, 2010) discuss the components of the LGSTWSS, current and future water usage, source capacity and future sources.

1.2.3 Future water needs

Water forever: Lower Great Southern (Water Corporation, 2010) discusses future growth and demand projections. It predicts that the lower great southern towns' annual water demand will more than double by 2050. A number of options to provide this increased amount of water are being investigated and are outlined in the Water Corporation's document. The Department of Water is also preparing a water supply strategy for the lower great southern that will identify future source options to balance supply and demand scenarios.

1.3 Characteristics of the catchment

1.3.1 Physical environment

The Angove Creek catchment is part of the low plateau that slopes gently from the base of the Stirling Range to the Southern Ocean. Drainage across the plateau is influenced by series of granite outcrops that form rounded hills about 200 m high. River systems in the region drain onto low-lying coastal plains which contain a series of groundwater-dependent swamps and lakes that have formed between the coastal dune systems and granite headlands.

The creek dissects sediments of the Pallinup Siltstone that mainly consist of fine-grained sandstone and siltstone. Streamlines are well defined in lower and middle reaches where the creek passes through native bushland, but drainage is poorly defined in the upper reaches where only a few groundwater-dependent swamps exist.

1.3.2 Climate

The area has a Mediterranean-type climate, characterised by warm, dry summers and cool, wet winters. The long-term mean annual rainfall over the catchment is about 930 mm. Most of rain falls between May and September. Annual average evaporation is about 1400 mm.

1.3.3 Hydrology

The hydrology of the Angove Creek Catchment Area is discussed in the *Angove Creek Catchment Area drinking water source protection assessment* (Water Corporation, 2004). The catchment upstream of the pipe-head dams has an area of 29 km² and is located within the Albany Coast Drainage River Basin. Elevation varies from about 25 m AHD at Lower Pool to about 100 m AHD at the head of the catchment. The highest point in the catchment is just over 120 m on the western boundary.

Water inflow is maintained throughout the year over the entire catchment through subsurface flow in the Pallinup Siltstone sediments. Review of streamflow records suggests subsurface flow contributes more than half the water inflow to the source. Should investigation of the subsurface flow be required, it will be undertaken in the next review of this drinking water source protection plan.

Stream flow resulting mainly from surface runoff in the lower and middle catchment can be peaky, responding quickly to high rainfall events during the winter months. The average monthly flow in late winter and spring is significantly greater than in the late summer and autumn.

1.4 How is this drinking water source currently protected?

Angove Creek Catchment Area (Figure A1) was proclaimed in 1959 under the *Country Areas Water Supply Act 1947* to ensure protection of the water source from potential contamination. Proclamation identifies the location of the catchment area and ensures that its drinking water value is considered in land use planning decisions. It also allows by-laws to be applied to protect water quality.

In 2004 an *Angove Creek Catchment Area drinking water source protection assessment - Lower Great Southern Town Water supply scheme* was prepared by the Water Corporation and supported by the Department of Water. This document presented information about the catchment, identified risks to water quality and recommended strategies to manage those risks. This *Angove Creek Catchment Area drinking water source protection plan* replaces it, as it provides more up-to-date information and recommended protection strategies.

A proposed new Angove Creek Catchment Area is shown in Figure A2. A large – portion—the area immediately upstream of the pipe-head –extraction—is in Reserve 13802. Reserve 13802 is vested with the Department of Water and protected by Water Corporation surveillance. The *City of Albany Town Planning Scheme no. 3* (as

amended up to 17/01/12) indicates this area is zoned as a reserve for public purposes. The types of development supported in this area are described in the Department of Water's Water quality protection note (WQPN) no. 25: *Land use compatibility in public drinking water source areas*.

The rest of the proposed Angove Creek Catchment Area—the area in the north furthest from the dams—consists of four crown leases, zoned for rural use. We support the current land uses to continue.

2 Common contamination risks

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

Some contaminants in drinking water can affect human health. Other impurities can affect the water's aesthetic qualities, including its appearance, taste, smell and 'feel' but are not necessarily hazardous to human health. For example, cloudy water with a distinctive odour or strong taste may not be harmful to health, but clear, pleasant-tasting water may contain harmful, undetectable microorganisms (NHMRC & NRMCC 2004). Contaminants can also interfere with water treatment processes, and damage water supply infrastructure (such as iron corroding pipes).

The ADWG outline criteria for acceptable drinking water quality to protect human health, manage aesthetics and maintain water supply infrastructure. For more information about water quality in this drinking water source, see section 3.

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

2.1 Microbiological risks

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

Pathogens can enter drinking water supplies from faecal contamination in the catchment. When people (e.g. while fishing, marroning or swimming) or domestic animals come into contact with a body of water, pathogens may enter that water source. This occurs through the direct transfer of faecal material (even a very small amount can cause contamination) into the water. Contamination can also occur indirectly through surface run-off moving faecal material into the water, or infiltrating through the soil, such as from septic tanks or animal manure in paddocks.

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. salmonella, *Escherichia coli* and cholera), protozoa (e.g. *Cryptosporidium*, *Giardia*) and viruses. *E. coli* counts provide an indication of the level of faecal contamination.

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

infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia* (Geldreich 1996).

The ability of pathogens to survive in 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 2011).

When people consume drinking water contaminated with pathogens the effects vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes even death. During 2000, seven people died in Walkerton, Canada, because the town's water supply was contaminated by a pathogenic strain of *E. coli* and campylobacter (NHMRC & NRMCC 2011). Where possible, avoiding the introduction of pathogens into a water source is the most effective way to protect public health.

2.2 Physical risks

Erosion is the mobilisation of soil particles that are released into the air and water. Activities like off-road driving and uprooting vegetation can cause erosion. Erosion increases the turbidity ('cloudiness') of a water body. This increased turbidity can result in cloudy or muddy-looking water, which is not aesthetically appealing to consumers. Turbidity can also reduce the effectiveness of treatment processes (such as disinfection). Pathogens can adsorb onto soil particles and may be shielded from the effects of disinfection. Chemicals can also attach to suspended soil particles. Increased turbidity also impacts on other environmental constituents. It smothers riparian vegetation and reduces the transfer of light within the water column which affects plant growth.

Some physical properties of water such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes. Other properties such as iron and dissolved organic matter can affect the colour and smell of water. Although not necessarily harmful to human health, coloured or 'hard' water will not be as appealing to consumers. Salinity can affect the taste of drinking water.

2.3 Chemical risks

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

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

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

Drinking water sources can also be contaminated by nutrients (such as nitrogen) from fertiliser applications, faulty septic systems, leach drains and from domestic and feral animal faecal matter that washes through or over soil and into a water source. Nitrate and nitrite (forms of nitrogen) can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMCC 2011).

Other chemicals and heavy metals can be associated with land uses such as industry and landfill. These may enter drinking water sources and could potentially be harmful to human health.

3 Contamination risks in this drinking water source

3.1 Water quality

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

A water quality summary for the Angove Creek Catchment Area for the period 1 January 2007 to 31 January 2012 is presented in Appendix B. This data shows the quality of water in the catchment. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at <www.watercorporation.com.au> What we do > Water quality > Water quality publications > Click on the most recent *Water quality annual report*.

3.2 Land uses and activities

The proposed Angove Creek Catchment Area is located over Crown land. Current land uses and activities and their risks to the drinking water source are described below. Appendix C displays a more detailed risk assessment, and includes recommended protection strategies to address water quality risks.

3.2.1 Crown land

Crown reserve 13802 is vested with the Department of Water for water supply catchment purposes and is managed by the Water Corporation. The reserve is predominantly native vegetation (see Figure A2). The reserve contains several tracks and there is evidence of unauthorised entry into the catchment. Existing fencing has been unable to entirely prevent illegal entry to the reserve. Good buffers around waterways (see Figures D1, D3 and D4) limit threats to water quality.

The long-term recognition of the area for water supply purposes by the local community through its historical reservation, has probably been significant in maintaining its integrity. Native wildlife has been sighted in the reserve and in the surrounding area. Native fauna have unrestricted access to the pools and streamlines.

3.2.2 Crown leases

The most northern portion of the proposed catchment area is mainly cleared land used for a mixture of grazing, cropping and agroforestry, and some native vegetation. These non-intensive pastoral uses pose a low threat to water quality. Use of best management practices (Appendix C) will help ensure there is no increased risk of

contamination from the Crown lease land. Local council land planning controls will also support this outcome.

The Crown leases are located in the upper catchment where there is predominantly subsurface flow and very little in the way of defined streamlines. It is well buffered from the main mid-catchment streamline by the extensive forested Reserve 13802.

3.2.3 Roads and tracks

There are utility and fire-management tracks in the forested Crown Reserve 13802 and the Crown leases. South Coast Highway crosses the upper catchment where any spill of fuel or chemicals that may result from a road accident, is likely to have little impact on catchment water quality.

3.2.4 Recreation

Official roads and tracks in Crown reserve 13802 have signage informing the public that entry is not permitted (Figures D5 and D8). The entry road into that reserve (leading off Moyle Rd) has a locked gate, fencing and signage. Yet indications of illegal entry have been observed in the past, with signs of fishing, marroning, human and animal waste, fire sites, four-wheel driving and trail bikes, hunting, rubbish dumping and vegetation clearing (see Figure D6).

3.2.5 Aboriginal sites of significance and Native title claims

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

There is an Aboriginal site of significance registered within the Angove Creek Catchment Area named *Albany*, site number S00574.

Native title is the recognition in Australian law that some Aboriginal people continue to hold Native title rights to lands and water arising from their traditional laws and customs.

There are two native title claims over the larger south coast area, where Angove Creek lies. The *National Native Title Tribunal (NNTT) Map for WA* lists the Southern Noongar (NNTT file number WC96/109) and the Wagyl Kaip (NNTT file number C98/70).

The Department of Water is committed to working with Aboriginal people in its planning and management activities. The department recognises that Native title provides an important framework for water management.

4 Protecting your drinking water source

4.1 Proclaiming public drinking water source areas

Angove Creek Catchment Area was proclaimed in 1959 under the *Country Areas Water Supply Act 1947*. The *Angove Creek Catchment Area drinking water source protection assessment* (Water Corporation, 2004) presented information about the catchment, identified risks to water quality and recommended protection strategies. Based on the 2004 report, we are proposing to change the boundary of the Angove Creek Catchment Area, to better represent the physical size and shape of the surface water catchment.

This plan recommends abolition of the 1959 proclaimed boundary and proclamation of the proposed Angove Creek Catchment Area under the *Country Areas Water Supply Act 1947* (see Figure A2).

Once the catchment area is amended the City of Albany should incorporate the public drinking water source area (PDWSA) into their planning schemes consistent with State planning policy no. 2.7: *Public drinking water source policy*. PDWSAs are commonly shown in planning schemes as special control areas. This provides guidance for state and local government planning decision makers and developers.

Proclamation of a PDWSA will not change the zoning of land. All existing, approved land uses and activities in a proclaimed area can continue. However, we recommend that best management practices are employed in PDWSAs to protect the quality of the drinking water source. New developments or expansion of existing land uses or activities need to consider the recommendations in this plan, local council planning requirements and lease conditions.

For more guidance on appropriate land uses and activities please refer to our WQPN no. 25: *Land use compatibility in public drinking water source areas*.

4.2 Defining priority areas

The protection of PDWSAs relies on statutory and non-statutory measures for water source management and land-use planning. The Department of Water's policy for the protection of PDWSAs includes a system that defines three specific priority areas:

- Priority 1 (P1) areas have the fundamental water quality objective of risk avoidance (e.g. state forest and other crown land).
- Priority 2 (P2) areas have the fundamental water quality objective of risk minimisation (e.g. land that is zoned rural).
- Priority 3 (P3) areas have the fundamental water quality objective of risk management (e.g. areas zoned urban or light/general industrial).

The determination of priority areas is based on the strategic importance of the land or water source including risks to water quality and quantity, the local planning-scheme zoning, the form of land tenure and existing approved land uses or activities.

The proposed priority areas for the Angove Creek Catchment Area have been determined in accordance with current Department of Water policy. These areas are described below and displayed in Figure A3. Our WQPN no. 25: *Land use compatibility in public drinking water source areas* outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas. For an explanation of the background and support for protection of PDWSAs, please refer to WQPN no. 36: *Protecting public drinking water source areas*.

The proposed Angove Creek Catchment Area currently consists entirely of Crown land. It has been noted that some of this land may be sold in the future and become private land. This protection plan can be applied to both private and Crown land. We propose to assign the major portion of the proposed Angove Creek Catchment Area (in Crown reserve 13802) as P1 because:

- the water from this source contributes to the LGSTWSS
- the current land uses on the Crown reserve 13802 are considered acceptable in P1
- Crown reserve 13802 is zoned as a local scheme reserve for public purposes in the current *City of Albany Town Planning Scheme no. 3*.

The rest of the proposed Angove Creek Catchment Area (further away from the extraction point) consists of Crown leases, and we proposed to assign this as P2 because:

- current farming land uses are considered compatible with conditions provided best management practices are applied
- the land is zoned rural in the current *City of Albany Town Planning Scheme no. 3* (see Figure A4).

4.3 Defining protection zones

In addition to priority areas, protection zones are defined in PDWSAs to protect water from contamination in the immediate vicinity of water extraction facilities (e.g. reservoirs). Specific conditions may apply within these zones such as restrictions on the storage of chemicals or public access.

Reservoir protection zones (RPZs) are assigned over the most vulnerable part of the catchment. They include the water storage body but do not extend outside the catchment or downstream of a dam wall. RPZ that occur in the *Metropolitan Water Supply Sewerage and Drainage Act 1909* are legislatively set at a distance of 2 km from the high water level of a reservoir.

For consistency, and where reasonable, we also apply RPZs to country sources. In proposed new water resource management legislation, the Department of Water has recommended that a 2 km RPZ, or other distance approved by the Minister for Water following development of a drinking water source protection plan, should apply across the whole state.

A RPZ has been defined for the Angove Creek Catchment Area to protect the portion of the PDWSA most vulnerable to water contamination. The RPZ is shown on Figure A3, and is delineated as follows:

A RPZ has been defined as the area of land encompassed by a linear distance of 2 km measured at 90 degrees outward from the top water level of the reservoir (i.e. the spillway AHD level). The RPZ includes the reservoir water body and the beaches below the top water level.

4.4 Planning for future land uses

It is recognised under the Western Australian Planning Commission's (WAPC) *State planning strategy* (1997) that appropriate protection mechanisms in statutory land-use planning processes are necessary to secure the long-term protection of drinking water sources. As outlined in the WAPC's *State planning policy no. 2.7: Public drinking water source policy* (2003) it is appropriate that the Angove Creek Catchment Area, its priority areas and protection zone be recognised in the City of Albany's local planning schemes and strategies. Any development proposals within the Angove Creek Catchment Area that are inconsistent with advice in our WQPN no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this plan, need to 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 our WQPN no. 36: *Protecting public drinking water source areas*. This protection note describes the findings of two Parliamentary Committee reviews (1994 and 2000) instrumental in the integration of water quality protection and land use planning in Western Australia.

The department's protection strategy for PDWSAs provides for approved developments to continue even if those facilities would not be supported under current water quality protection criteria. In these instances, the department can provide advice to landowners or operators on measures they can use to reduce water quality contamination risks (see section 4.5: *Using best management practices*).

4.5 Using best management practices

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

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 (WQPNs). They outline the recommended practices to ensure the protection of water quality and can thus help managers reduce any detrimental effects of their operations. These guidelines have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government

agencies and technical advisers. See this plan's *References and further reading* section.

Education and awareness-raising (from signs and publications) are also key mechanisms for protecting water quality, especially for people visiting the area.

4.6 Enforcing by-laws and surveying the area

The quality of water in PDWSAs within country areas of the state is protected under the *Country Areas Water Supply Act 1947*. Proclamation of PDWSAs allows 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 will be erected on the boundaries of this catchment area to educate and advise the public about activities that are prohibited or regulated. This plan recommends that the Water Corporation should continue surveillance and by-law enforcement under the current delegation.

4.7 Responding to emergencies

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The City of Albany local emergency management committee (LEMC), through the Great Southern emergency management district, should be familiar with the location and purpose of the Angove Creek Catchment Area. A locality plan will be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. The Water Corporation should have an advisory role to the HAZMAT team for incidents in the Angove Creek 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 Angove Creek Catchment Area. These personnel should have an adequate understanding of the potential impacts of spills on this drinking water source.

4.8 Putting this plan into action

Appendix C identifies potential water quality risks associated with existing land uses in the Angove Creek Catchment Area, and recommends protection strategies to deal with those risks.

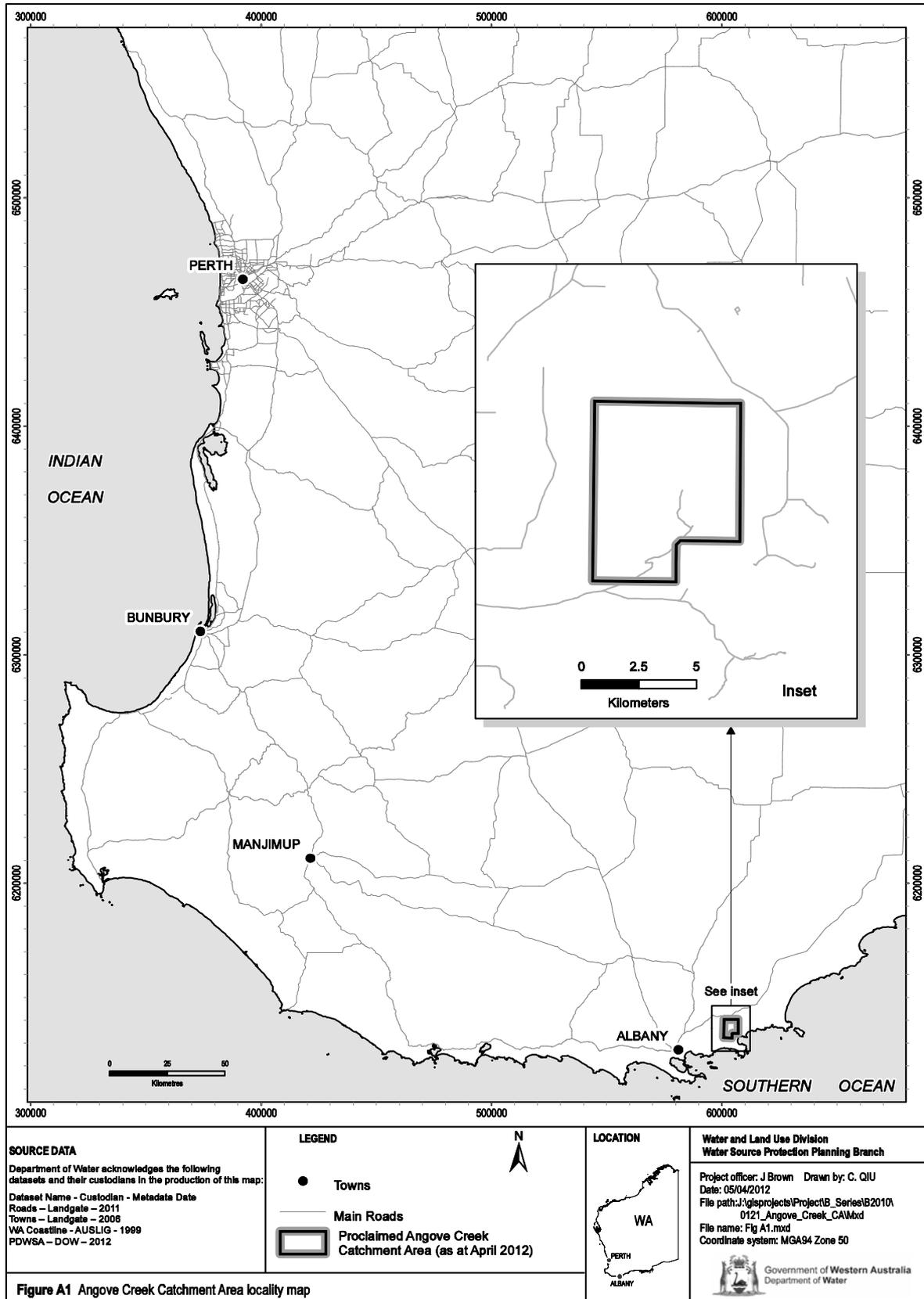
The Department of Water will follow up on the recommendations made in this plan with stakeholders. This plan will be subject to a five year review period to ensure it remains current.

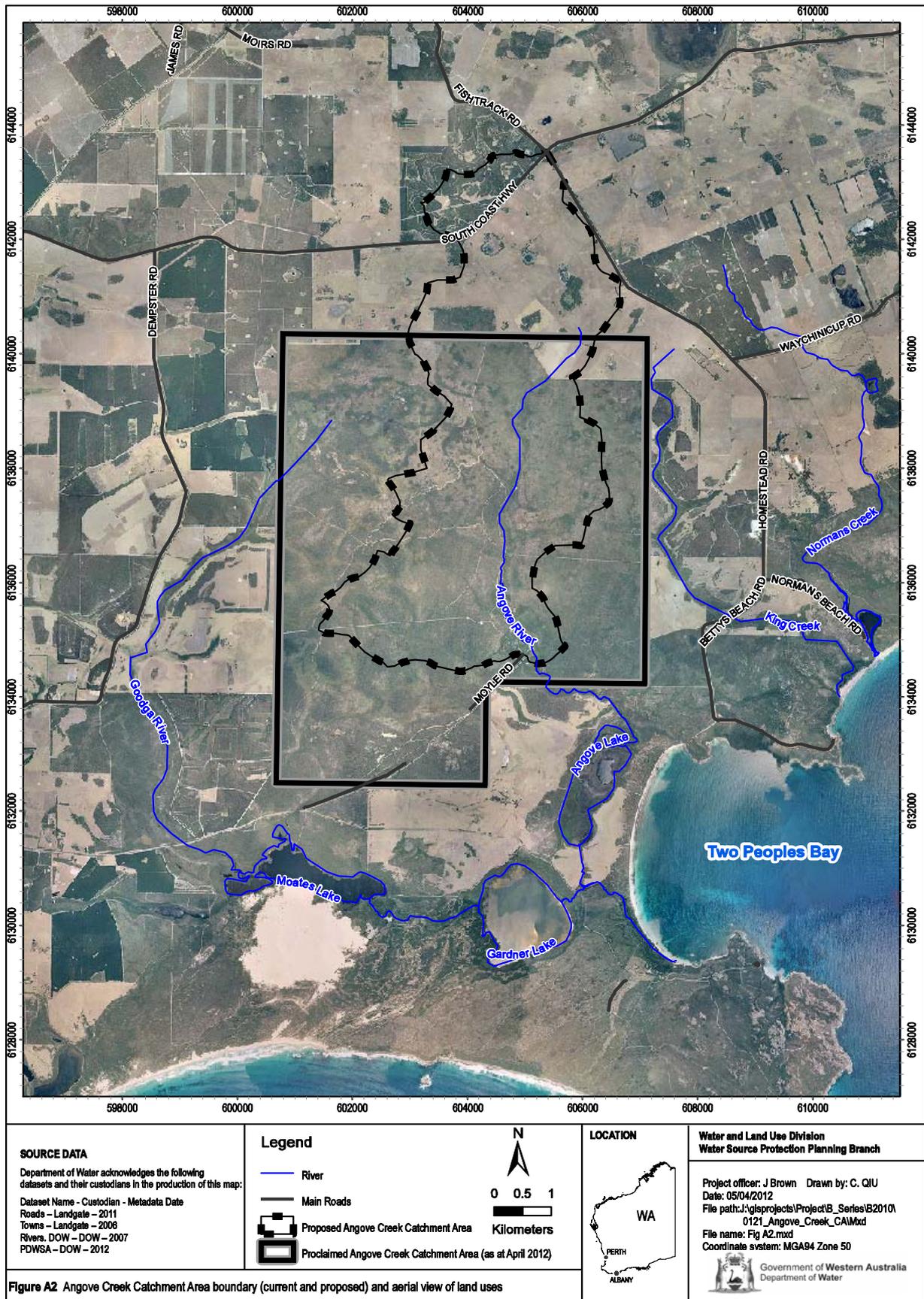
5 Recommendations

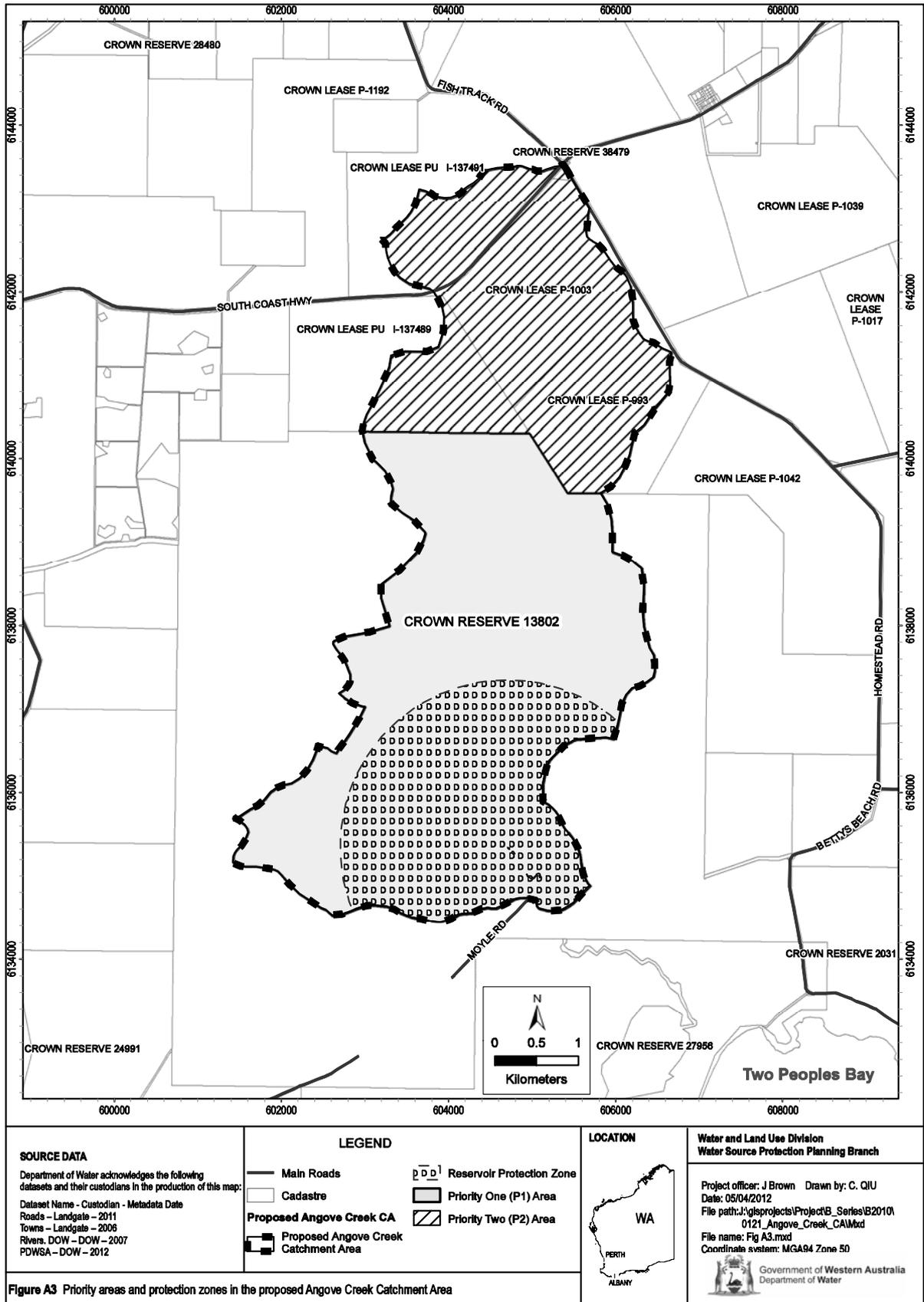
The following recommendations apply to the Angove Creek Catchment Area. The bracketed stakeholders are those expected to have a responsibility for, or an interest in implementing that recommendation.

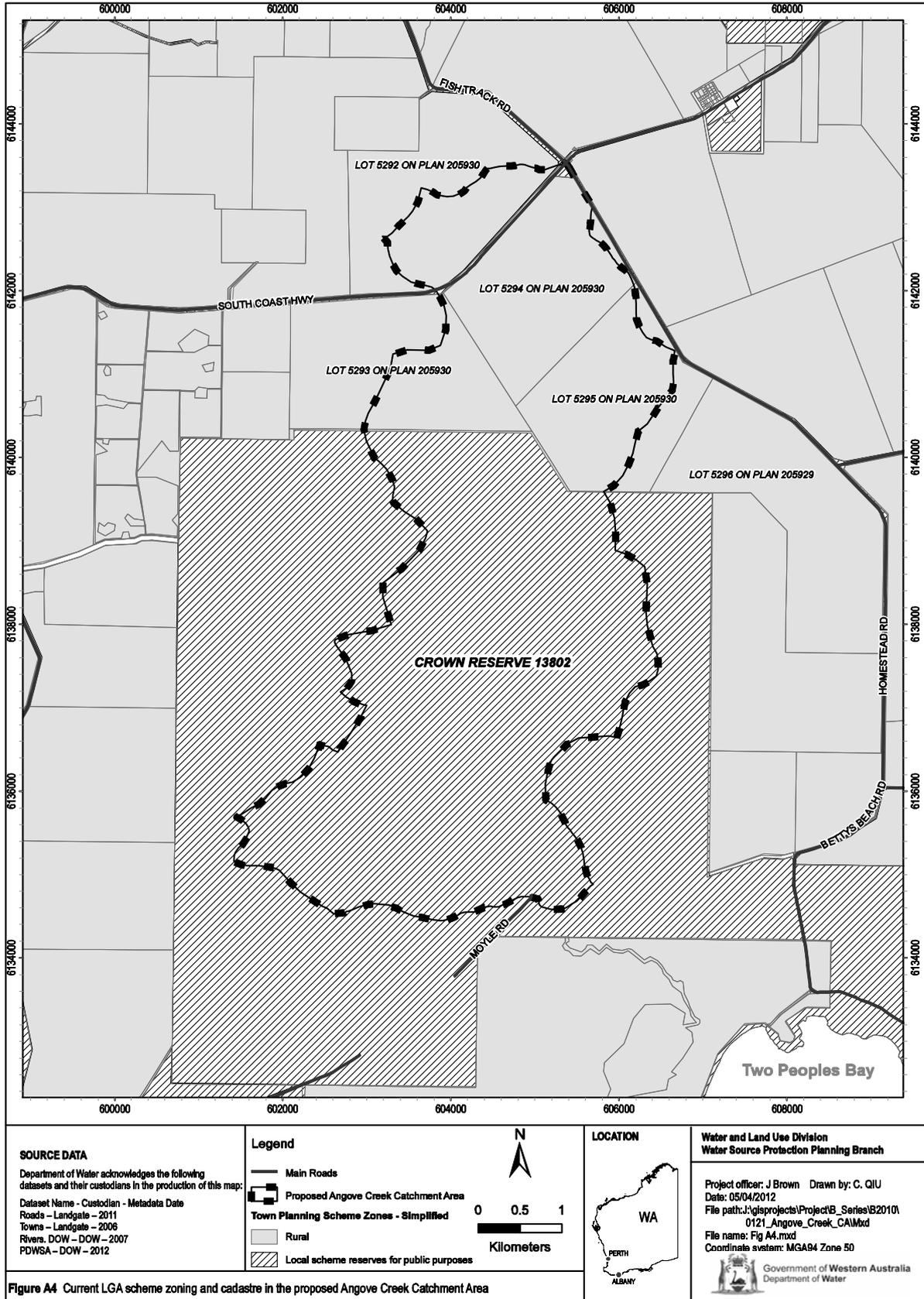
1. Amend the boundary of the Angove Creek Catchment Area as recommended in this plan (Figure A3) under the *Country Areas Water Supply Act 1947*. (Department of Water)
2. Incorporate the findings of this plan and location of the Angove Creek Catchment Area (including its priority areas and protection zone) in the City of Albany's local planning schemes and strategies in accordance with the WAPC's State planning policy no. 2.7: *Public drinking water source policy*. (City of Albany)
3. Refer development proposals within the Angove Creek Catchment Area that are inconsistent with the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this plan, to the Department of Water for advice. (Department of Planning, City of Albany, proponents of proposals)
4. Ensure incidents covered by WESTPLAN–HAZMAT in the Angove Creek Catchment Area should be addressed by ensuring that:
 - the City of Albany LEMC is aware of the location and purpose of the Angove Creek Catchment Area
 - the locality plan for the Angove Creek Catchment Area is provided to the Fire and Emergency Services Authority headquarters for the HAZMAT emergency advisory team
 - the Water Corporation acts in an advisory role during incidents in the Angove Creek Catchment Area
 - personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Angove Creek Catchment Area and information to help them recognise the potential impacts of spills on drinking water quality. (Department of Water and Water Corporation).
5. Erect signs along the boundary of the Angove Creek Catchment Area including an emergency contact telephone number. (Water Corporation)
6. Water Corporation continues to undertake surveillance and by-law enforcement under the existing delegation arrangement. (Water Corporation)

Appendix A – Figures









Appendix B – Water quality data

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

The Water Corporation has monitored the raw (source) water quality from Angove Creek in accordance with the ADWG, 2011 and interpretations agreed to with the Department of Health. This data shows the quality of water in the catchment. The raw water is regularly monitored for:

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

The following data represents the quality of raw water from the two pipe-head dams located on Angove River, which is one of four water sources operated by the Water Corporation as part of the LGWTWSS, providing drinking water to Albany and surrounding locations. In the absence of specific guidelines for raw-water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customer's tap. Any water quality parameters that have been detected are reported. Those that on occasion have exceeded the ADWG are in bold and italics to give an indication of potential raw-water quality issues associated with this source. The values are taken from ongoing monitoring for the period 1 January 2007 to 31 January 2012.

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

For more information on the quality of drinking water supplied to Albany refer to the most recent Water Corporation drinking water quality annual report at watercorporation.com.au > What we do > Water quality > Water quality publications > annual reports.

Aesthetic characteristics

Aesthetic water quality analyses for raw water from Angove Creek are summarised in the following table.

Aesthetic detections for Angove Creek

Parameter	Units	ADWG aesthetic guideline value*	Two Peoples Bay Angove Creek Lower Pool		Two Peoples Bay Angove Creek Clear Pool	
			Range	Median	Range	Median
Chloride	mg/L	250	190 [^]	190 [^]	155–165 [^]	160 [^]
True colour	TCU	15	<1–> 200	52.5	5–> 200	10
Hardness as CaCO ₃	mg/L	200	50–55 [^]	52.5 [^]	40 – 41 [^]	40.5 [^]
Iron unfiltered	mg/L	0.3	0.16– 1.6	0.42	0.026– 0.74	0.065
pH (measured in lab)	No unit	6. –8.5	5.06 –6.55	6.07	5.42 – 6.45	5.85
Sodium	mg/L	180	105 [^]	105 [^]	88–89 [^]	88.5 [^]
Total filterable solids by summation	mg/L	500	39 –400 [^]	399 [^]	335–349 [^]	342 [^]
Turbidity	NTU	5	0.7– 11	1.9	<0.1– 9.6	0.8

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

[^] Less than five sampling occasions

Health-related chemicals

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

Health-related detections for Angove Creek

Parameter	Units	ADWG health guideline value*	Two People Bay Angove Creek Lower Pool		Two People Bay Angove Creek Clear Pool	
			Range	Median	Range	Median
Barium	mg/L	0.7	0.01 [^]	0.01 [^]	0.011 [^]	0.011 [^]
Boron	mg/L	4	0.05 [^]	0.05 [^]	0.04 [^]	0.04 [^]
Manganese unfiltered	mg/L	0.5	<0.002–0.006	0.0025	<0.002–0.004	0.002
Nitrate as N	mg/L	11.29	<0.002–0.055	<0.002	0.016–0.09	0.018
Nitrite as nitrogen	mg/L	0.91	<0.002–0.037	<0.002	<0.002–0.003	<0.002
Nitrite plus nitrate as N	mg/L	11.29	-	-	<0.005–0.018	0.018
Sulfate	mg/L	500	18–19 [^]	18.5 [^]	16–17 [^]	16.5 [^]

* A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHRMC & ARMCANZ, 2011).

[^] Less than five sampling occasions

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

Microbiological contaminants

Microbiological testing of raw water samples from Angove Creek 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 (MPN) 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 five year review period, positive *E. coli* counts were recorded in 99.8 per cent of samples. Approximately 89 per cent of the samples taken from Lower Pool and 84 per cent of samples taken from Clear Pool had *Escherichia coli* counts greater than 20 MPN/100mL.

High *Escherichia coli* counts may be associated with the large numbers of native fauna observed within the catchment. Additionally, small, run-of-river sources have limited detention time for microbial die-off. It should also be noted that these sample points are dip samples, which tend to be taken from the dam wall where water quality may be lower than at the offtake.

The raw water is treated at the Two Peoples Bay Water Treatment Plant by means of raw water pH correction, clarification, filtration, treated water pH correction and

fluoridation. It is also disinfected with chlorine to ensure the microbiological quality of drinking water supplied to customers.

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

For brevity's sake the Water quality protection notes (WQPNs) and Water quality protection guidelines (WQPGs) of the Department of Water are listed only by number in this table. The References list describes how they can be accessed. WQPN no. 25 is relevant to all of the land uses discussed below.

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Extensive agricultural land uses: Grazing, forestry, cropping					
Rural living (areas zoned rural)	<p>Pathogens and nutrients from septic tanks, domestic animals and fertilisers.</p> <p>Nutrients from fertilisers.</p> <p>Pesticides and other chemicals stored, used and disposed.</p> <p>Hydrocarbons from roads/tracks, fuel storage, vehicle maintenance.</p>	Medium to Low	Extensive (i.e. non-intensive) agricultural pursuits are compatible with conditions in P2 areas.	<p>There is a large well-vegetated area between the Crown leases and the pools.</p> <p>The Water Corporation will continue to implement preventive measures within its assigned responsibility, such as monitoring, signage and surveillance. This PDWSA is delegated</p>	<p>Public sector circular (PSC) no. 2: <i>Pesticide use in public drinking water source areas.</i></p> <p>PSC no. 88: <i>Use of herbicides in water catchment areas.</i></p> <p>Department of Agriculture's <i>Stocking rate guidelines for small rural holdings.</i></p> <p>WQPNs nos 1, 6, 12, 17, 22, 32, 35, 56, 65, 80, 98, and 70.</p> <p><i>Fertiliser application on pasture or turf near sensitive water resources</i> (Department of Water, 2010)</p>

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
				to Water Corporation.	
Forestry	As above, also see <i>Roads and Tracks</i> below.	Medium to Low	There are forestry activities on the Crown lease in the northern tip of the proposed catchment area. Compatible with conditions in P2 area.	As above.	As above, and WQPNs nos 68 and 96.
Water treatment					
Drinking water treatment plant and other water supply infrastructure	Spills/leaks of treatment chemicals.	Low	Compatible with conditions in P1 area.	Water Corporation operating procedures and groundwater monitoring.	WQPNs nos 10, 56, 58, 61, 62, 65 and 83.
Roads and tracks					
The South Coast Highway crosses the upper catchment. Homestead Rd	Hydrocarbon and other chemical contamination from fuel and spills. Erosion caused by	Low	Existing roads are acceptable within the water reserve.		PSC no. 2: <i>Pesticide use in public drinking water source areas.</i> PSC no. 88: <i>Use of herbicides in water catchment areas.</i> WQPNs nos 10 and 44.

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<p>abuts the north-east corner of the catchment area.</p> <p>There are tracks within the Crown reserve as well as on the Crown leases.</p>	<p>vehicles can contribute to turbidity in water bodies.</p>				
Recreation					
Recreation	<p>Pathogen contaminants.</p> <p>Turbidity resulting from erosion.</p> <p>Chemical contaminants (e.g. hydrocarbons).</p> <p>Recreation can increase the occurrence of fire, which could have long-term effects on</p>	High	<p>Indications of illegal entry have been observed by Water Corporation's catchment rangers, with signs of fishing, marroning, human/animal waste, fire sites, four-wheel driving and trail bikes, hunting, rubbish dumping and vegetation clearing</p>	<p>The Crown reserve is fenced.</p> <p>Signage, locked gates.</p> <p>Ongoing Water Corporation surveillance and risk mitigation strategies.</p> <p>Water quality monitoring as discussed in</p>	<p>All recreational activities within the catchment area should be consistent with Statewide Policy no. 13: <i>Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land</i> (Department of Water, 2012)</p>

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
	vegetation buffers.		(see Figure D6).	Appendix B.	
Fire management					
<p>Fire suppression activities such as construction, use and maintenance of fire breaks and water points, and prescribed burning.</p> <p>Management of unplanned bushfires.</p>	<p>Chemical contaminants (e.g. fire retardants, pesticides used for firebreaks). Pathogen contaminants (e.g. decomposing animals).</p> <p>Turbidity (e.g. caused by ash and larger material).</p> <p>The loss of vegetation buffers surrounding the waterways during fire/ fire management could exacerbate the above hazards.</p>	Low	<p>Firebreaks are an established essential land management practice.</p> <p>See fire damage Figure D7.</p> <p>A major portion of the Crown reserve was burnt in the bushfire of 2000.</p>	<p>Water Corporation surveillance, attendance of fires and post fire management of catchment.</p>	<p>Best management practices (e.g. Department of Health PSC no. 88: <i>Use of herbicides in water catchment areas</i>; Statewide policy no. 2: <i>Pesticide use in Public Drinking Water Source Areas</i>, Water and Rivers Commission 2000 and protection of filtering vegetation buffers around the reservoirs and streams (WQPN no. 06).</p> <p>Close liaison between Water Corporation, the City of Albany Bush Fire Brigade, and WESTPLAN–HAZMAT personnel (as well as DEC, whom manages nearby reserves).</p> <p>Fire management within Angove Creek Catchment Area to be consistent with this drinking water source protection plan, and advice</p>

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
					of the Department of Water's South Coast Regional office to land managers on prescribed burning operations within the catchment area.
The control of nuisance animals					
Killing and trapping of feral and introduced nuisance animals by land manager.	<p>Pathogens (e.g. from carcasses).</p> <p>Chemical contaminants (e.g. from decomposing material, uneaten baits, pesticides).</p> <p>Turbidity (e.g. from erosion).</p>	Low		<p>Water Corporation surveillance.</p> <p>Illegal shooting, trapping or hunting is prohibited in the Crown reserve.</p>	<p>Accepted as a necessary activity, with control and best management practices as follows:</p> <ul style="list-style-type: none"> • WQPN no. 96 • maintain Crown reserve fence • PSC no. 2: <i>Pesticide use in public drinking water source areas</i> • ensure baits located away from the pools and tributaries • preferable hunting method is 'trap and shoot', without the use of dogs.

Appendix D – Photographs



Figure D1 The northern pipe-head dam known as Clear Pool.



Figure D2 Clear Pool weir



Figure D3 Spring north of Clear Pool



Figure D4 The southern pipe-head dam known as Lower Pool



Figure D5 Signage:

Left: within Crown reserve 13802

Right: at turnoff from Moyle Rd (road leading to the catchment area gate and Crown reserve).



Figure D6 Fencing flattened to circumvent a locked gate restricting entry to Crown reserve



Figure D7 Fire damage still evident many years after wildfire.



Figure D8 Water Corporation pipeline from water treatment plant in catchment area, to Albany.

List of shortened forms

ADWG	<i>Australian drinking water guidelines</i>
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CA	catchment area
CFU	colony forming units
DEC	Department of Environment and Conservation
GL	gigalitre
ha	hectare
HAZMAT	hazardous materials
kL	kilolitre
km	kilometre
km²	square kilometre
LEMC	local emergency management committee
LGSTWSS	Lower Great Southern Town Water Supply Scheme
m	metres
mg/L	milligram per litre
mL	millilitre
ML	megalitre
mm	millimetre
MPN	most probable number
mSv	millisievert
mS/m	millisiemens per metre
NHMRC	National Health and Medical Research Council

NNTT	National Native Title Tribunal
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
TDS	total dissolved solids
TFSS	total filterable solids by summation
WAPC	Western Australian Planning Commission
WESTPLAN- HAZMAT	Western Australian plan for hazardous materials
WQPN	water quality protection note

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.
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 2011).
Allocation	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
Australian drinking water guidelines	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2011</i> (NHMRC & NRMMC 2011) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's Bibliography).
Australian height datum	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
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.
Dip sample	Sample obtained by dipping a jar into water (sometimes using a pole, or equipment able to ensure sampling at a specific depth).
Drinking water source protection plan	This is a report on water quality hazards and risk levels within a public drinking water source area that includes recommendations to avoid, minimise, or manage those risks for the protection of the water supply in the provision of safe drinking water supply.
Effluent	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.
Gigalitre	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2011).

Hectare	A measurement of area, equivalent to 10 000 square metres.
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.
Hydrology	The science dealing with water on the land, its properties, laws, geographical distribution, etc.
Leaching/ leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
Millisievert	A millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2 mSv/yr.
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.
Nutrient load	The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i>), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i>) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
pH	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.

Point source pollution	Pollution originating from a specific localised source, e.g. sewage or effluent discharge; industrial waste discharge.
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 drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> and the <i>Country Areas Water Supply Act 1947</i> .
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	Recharge is the action of water infiltrating through the soil/ground to replenish an aquifer.
Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
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 2 km). This is referred to as a prohibited zone under the <i>Metropolitan Water Supply Sewerage and Drainage Act By-laws 1981</i> .
Run-of-river scheme	A scheme that takes water from a flowing river. Water is taken directly from the source and there is no detention (storage) time.
Runoff	Water that flows over the surface from a catchment area, including streams.
Scheme supply	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
Storage reservoir	A major reservoir of water created in a river valley by building a dam.
Stormwater	Rainwater that has run off the ground surface, roads, paved areas etc., and is usually carried away by drains.

Total dissolved solids	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMCC 2011).
Total filterable solids by summation	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 ₄ equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO ₂ (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
True colour units	True colour units are a measure of degree of colour in water.
Turbidity	The cloudiness or haziness of water caused by the presence of fine suspended matter.
Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
Water quality	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.

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