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Government of Western Australia

Churchman Brook Catchment Area Drinking Water Source Protection Plan

Integrated Water Supply System

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Water Resource Protection Series

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Department of Water

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Acknowledgments

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Preface

The Department of Water has prepared this Drinking Water Source Protection Plan to report on the activities and risks to water quality within the Churchman Brook Catchment Area and to recommend management strategies to minimise the identified risks.

A safe drinking water supply is critical to the well-being of the community and catchment protection is necessary to help avoid, minimise or manage risks to water quality. The Department is committed to protecting drinking water sources to ensure the continued supply of 'safe, good quality drinking water' to consumers.

The *Australian Drinking Water Guidelines* recommend a 'catchment to consumer' risk based approach to protecting public drinking water sources. The protection and management of drinking water catchments is the 'first barrier', with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection includes understanding the catchment, the hazards and hazardous events that can compromise drinking water quality, and developing and implementing preventive strategies and operational controls to ensure the safest possible raw water supply.

This plan details the location and boundary of the drinking water catchment, which provides potable water to the Integrated Water Supply System. It discusses usage of the water source, describes the water supply system, identifies risks and recommends management approaches to maximise protection of the catchment.

This plan should be used to guide State and local government land use planning decisions. It should be recognised in the City of Armadale Town Planning Scheme, consistent with 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 this Public Drinking Water Source Area.

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	Assessment document prepared following catchment survey and preliminary information gathering from government agency stakeholders.
2	Conduct stakeholder consultation	Advice sought from key stakeholders using the assessment as a tool for background information and discussion.
3	Prepare Draft Drinking Water Source Protection Plan	Draft plan developed taking into account input from stakeholders and any additional advice received.
4	Release Draft Drinking Water Source Protection Plan for public comment	Draft plan released for a six week public consultation period.
5	Publish Drinking Water Source Protection Plan	Final plan published after considering advice received in submissions. Includes recommendations on how to protect the catchment.

Summary

The Churchman Brook Catchment Area is located approximately 30km south east of Perth in the City of Armadale. The reservoir is a strategic source of public drinking water for the Integrated Water Supply System. The Churchman Brook Catchment Area was proclaimed under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909* in 1923 to ensure protection of the water source from potential contamination.

This plan has been developed to protect drinking water quality for public health. The plan:

- identifies potential drinking water quality contamination risks from land use activities within the catchment; and
- recommends strategies to manage these potential risks whilst recognising current land use rights.

The majority of the catchment is State forest vested with the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation. Use of the State forest currently includes forest management, such as prescribed burning for biodiversity and fuel reduction, and an extensive range of recreation, including informal and unauthorised activities such as fishing, marroning, camping and off-road vehicle use. Rubbish and vehicle dumping are particularly prevalent in the catchment. A Special Mining Lease exists over the Crown land in the catchment enabling Alcoa World Alumina Australia to extract bauxite. No mining has been undertaken within the catchment and there are no plans to mine within the next 20 years. The Water and Rivers Commission (now operating as Department of Water) and Water Corporation own a large portion of land on the western side of the catchment . There is one privately owned property which partially crosses into the proposed new catchment area. This area remains undeveloped with mature stands of native vegetation.

The following strategies are recommended to protect water quality in the Churchman Brook Catchment Area:

- The gazetted catchment area needs to be re-gazetted to reflect the physical catchment boundary.
- The existing Reservoir Protection Zone for the catchment needs to be clearly identified.
- All Crown land in the catchment should be managed for Priority 1 source protection. The small area of private property should be managed for Priority 2 source protection.

- The catchment, including the Reservoir Protection Zone and the proposed priority classifications, should be recognised in relevant land planning strategies and schemes, including the City of Armadale's Town Planning Scheme and the Metropolitan Regional Scheme.

- Best management practices for the current land uses in the catchment should be implemented.

Priority classification areas and the Reservoir Protection Zone provide guidance for planning decisions on appropriate land uses and define areas where the *Metropolitan Water Supply, Sewerage and Drainage By-laws 1981* are available to protect this drinking water catchment. These areas and zones recognise established approved land uses but may constrain expansion of those uses, or development of alternative future land uses. Implementation of best management practices in the design, construction and operational stages are recommended for existing or approved land uses.

The Department of Water is responsible for the development of an implementation program for the recommended protection strategies. The implementation of protection strategies will be reviewed periodically. A review of this plan will be undertaken after five years.

1 Introduction

The Churchman Brook reservoir is situated approximately 30km south-east of Perth in the City of Armadale (refer to Figure 1). It is a strategic source of public drinking water for the Integrated Water Supply System (IWSS). The IWSS provides water to 1.5 million people in the Perth Metropolitan area, Mandurah, Pinjarra, Harvey, the Goldfields and agricultural regions.

1.1 Water storage system

Churchman Brook Dam was constructed across Churchman Brook between 1924 and 1928. The earthfill embankment dam is 231m long and 26m high. The reservoir has a capacity of 2.16GL and a full supply level of 205m AHD.

1.2 Protection and allocation

1.2.1 Existing water source protection

The Churchman Brook Catchment Area was proclaimed in 1923 under the *Metropolitan Water Supply, Sewerage and Drainage (MWSSD) Act 1909* to protect the water source from potential contamination.

Figure 2 shows the gazetted Churchman Brook Catchment Area in addition to the proposed amendment to the catchment boundary, which more accurately reflects the physical catchment.

1.2.2 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 (RIWI) Act 1914.* Under the Act, the right to use and control surface and groundwater is vested with the Crown. This Act requires licensing of surface water abstraction within proclaimed surface water areas.

The Churchman Brook Catchment Area is also proclaimed as the Churchman Brook Surface Water Area under the *RIWI Act*.

Water Corporation are currently licensed to draw 3.7GL per annum from Churchman Brook, under Surface Water Licence No. 0058563, for the purpose of providing potable water for public water supply. Due to reduced inflow, Water Corporation have reduced their draw to approximately 50% of their allocation over the last 5 years.

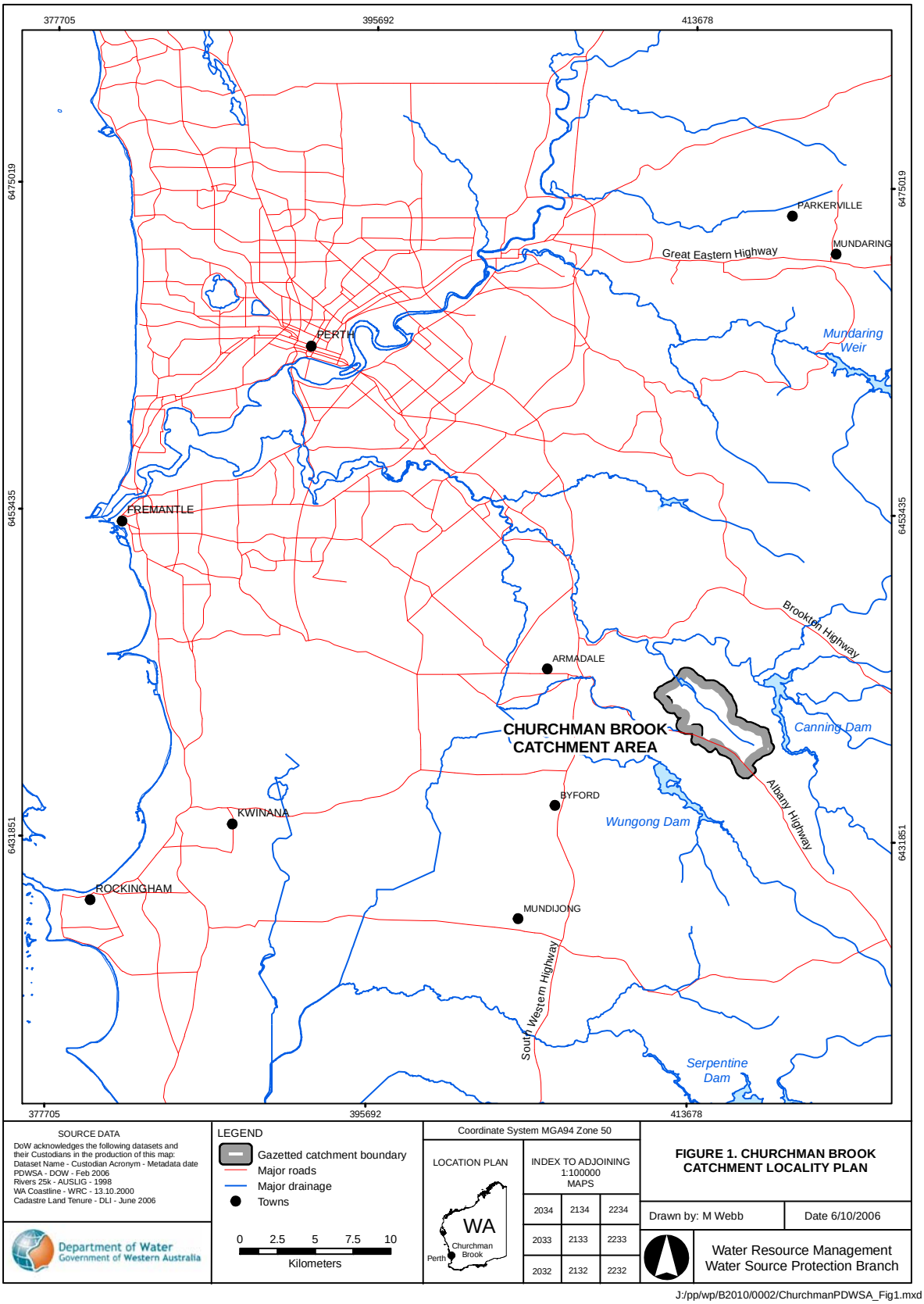

Figure 1 Churchman Brook Catchment Area locality map

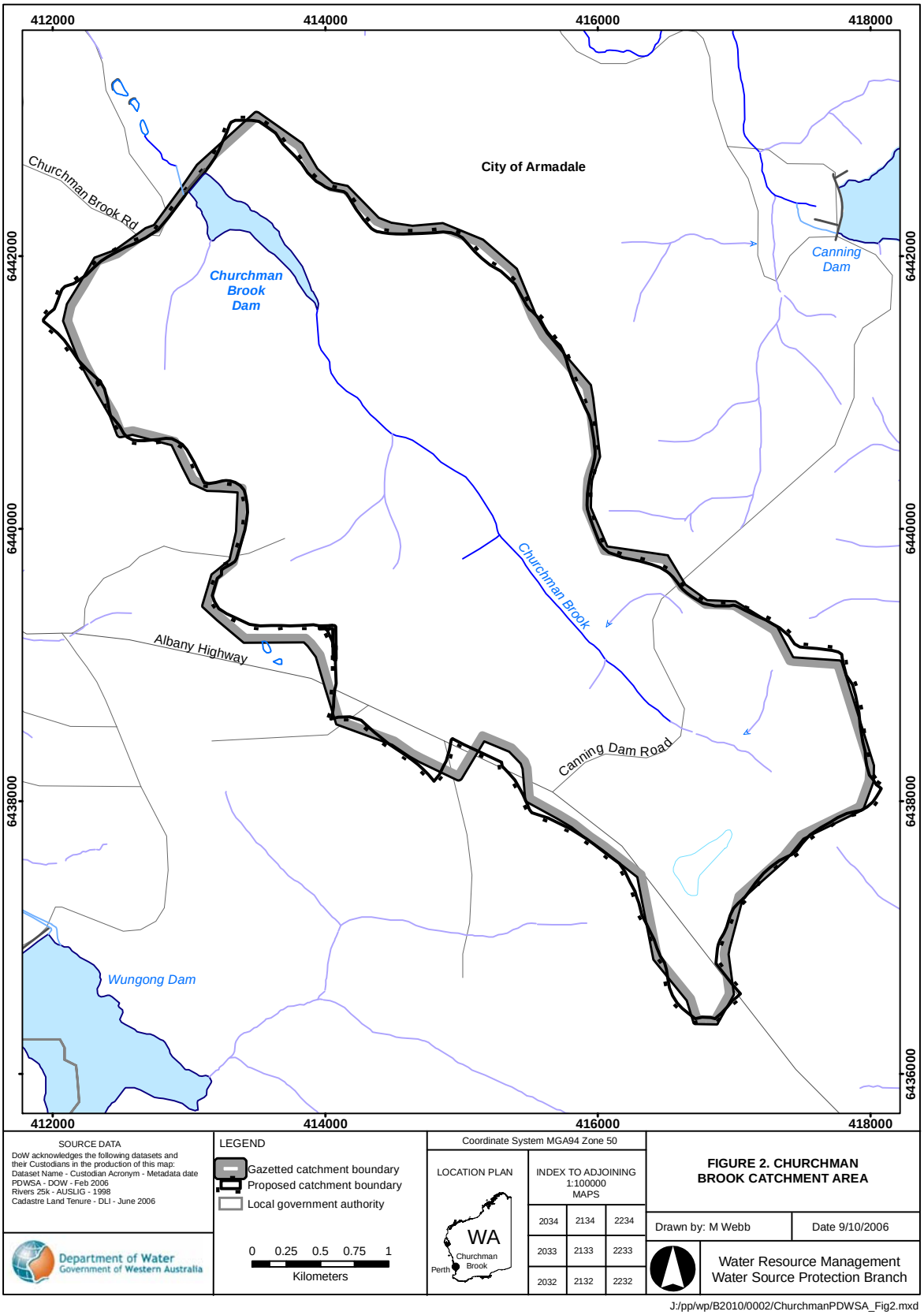

Figure 2 Churchman Brook Catchment Area, gazetted and proposed boundary

2 Catchment description

2.1 Climate

The region has a Mediterranean type climate characterised by warm dry summers and cool wet winters.

The majority of rainfall occurs during the winter months. Since the mid 1970s, the south west of Western Australia has experienced a 10 to 20% decline in its long term average rainfall. The average long term annual rainfall (1888 - 2004) for the catchment was approximately 1229mm, however from 1999 to 2004 the average rainfall was approximately 1035mm. The decline in rainfall has resulted in a reduction in runoff and streamflow.

2.2 Physiography and vegetation

The catchment is located in the Darling Scarp, which forms the western boundary of the Darling Range. This area forms part of the Archaean Yilgarn Block, which consists mainly of granite, gneisses, migmatite and doleritic intrusions (King and Wells, 1990).

The catchment comprises three major landform units: major valleys combining slopes and floors, lateritic uplands and minor valleys within the upland surface.

The major valleys of the catchment are defined as the Murray soil type and are deeply incised with red and yellow soils and duplex soils, which are susceptible to erosion (Croton and Dalton, 1999).

The minor valleys are characterised by the Yarragil soil type. The risk of erosion of these soils ranges from low to high.

The lateritic uplands are represented by the Dwellingup and Cook soil types, which form a gently undulating landscape. The Dwellingup soils consist of duricrusts and sandy gravel and have a relatively low risk of erosion (Croton and Dalton, 1999).

The majority of the catchment is covered by open forest or woodland, dominated by jarrah (*Eucalyptus marginata*) with some marri (*Corymbia calophylla*) (CALM, 1998). The vegetation has been decimated by dieback and historical overlogging throughout the catchment. As a result, the canopy and overstorey vegetation is patchy. A small portion of private land has been cleared.

2.3 Hydrology

The catchment has a total area of 16km^2. The major tributary to the Churchman Brook Reservoir is the Churchman Brook. The long-term average annual stream flow (1912 – 2003) entering the reservoir via Churchman Brook was 4.0GL, however due to a decline in rainfall, and a subsequent reduction in runoff, the average annual stream flow entering the reservoir between 1975-2003 was 2.8GL.

3 Water quality and treatment

A wide range of chemical, physical and microbiological properties can affect the safety and aesthetic quality of drinking water.

Water quality in the Churchman Brook dam is routinely monitored by Water Corporation to ensure compliance with the health related criteria of the *Australian Drinking Water Guidelines* (ADWG) (NHRMC & ARMCANZ, 2004). These guidelines are used in Western Australia by the Department of Health, Department of Water and Water Corporation to assess the quality of drinking water provided to consumers.

A summary of the results of a comprehensive water quality analyses of the raw water (ie pre treatment) carried out by Water Corporation between 1999 and 2004 is shown in Appendix A.

3.1 Microbiological contaminants

The microbiological quality of the water is monitored regularly. Thermotolerant coliforms (*Escherichia coli*) are measured as an indicator of the degree of faecal contamination of the raw water and the potential for pathogenic microbes. Thermotolerant coliforms were recorded in 70 per cent of raw water samples, 14 per cent of the positive samples had a colony count in excess of 20 colony forming units (cfu) per 100mL, which is the concentration used as a microbiological contamination benchmark by the World Health Organisation (1996). The presence of thermotolerant coliforms prior to treatment does not indicate the presence of pathogens in the water supplied to consumers.

3.2 Health related chemicals

Heavy metals and hydrocarbons have not exceeded the ADWG values. During the monitoring period, no pesticides were recorded above the detection limit or above the ADWG values.

3.3 Aesthetic characteristics

Turbidity within the reservoir was within the ADWG aesthetic value. Iron and aluminium concentrations periodically exceeded the aesthetic guideline, however the medium values were less than the guideline values of 0.3mg/L and 0.2mg/L respectively. The catchment soils are naturally high in these elements, therefore erosion from extensive off-road vehicle use within the catchment may be contributing to elevated levels of these metals and has been identified as a significant risk to water quality (refer to Table 1).

3.4 Water treatment

The water abstracted from the Churchman Brook dam is disinfected by chlorination and fluoridated before supplying the IWSS. Chlorination is an essential barrier to ensure good quality public drinking water (NHMRC & ARMCANZ, 2004).

It should be recognised that although reservoir storage and disinfection by chlorination generally removes microbiological contamination, treatment processes alone cannot be relied upon. Where possible, contamination can and should be prevented or reduced through appropriate land use or activity controls in the catchment area. This approach is endorsed by the ADWG and reflects a 'catchment to consumer' multiple barrier approach for the provision of safe drinking water to consumers.

4 Land use and contamination risks

Land uses within the catchment include forest and plantation management, recreation on Crown land, and remnant native vegetation on private land.

Land use and tenure are shown in Figure 3.

4.1 Potential water quality risks

The risks to water quality associated with activities in drinking water catchments include pathogen contamination, turbidity, pesticide and nutrient contamination. Pathogens pose the most significant risk to public health.

Pathogens may enter a reservoir through activities involving the direct contact of human and domestic animals with the reservoir or tributaries (ie illegal fishing, swimming), primarily through the transfer of faecal material, or indirectly through the presence of humans near the reservoir and its tributaries (and runoff transferring faecal material).

Pathogen contamination of a drinking water source is influenced by the existence of pathogen carriers (ie humans and domestic animals, such as dogs or cattle) and opportunity for their subsequent transfer to the water source, the ability of the pathogen to survive in the water source and the concentration required to cause illness.

There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (eg *Salmonella*, *Escherichia coli* and *Cholera*), parasites (eg *Cryptosporidium*, *Giardia*) and viruses. The percentage of humans in the world that carry various 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 differs between species. For example, *Salmonella* may be viable for two to three months, *Giardia* may infect after one month in the natural environment (Geldreich, 1996) and *Cryptospiridium* oocysts (cells containing reproductive spores) may survive weeks to months in freshwater (NHMRC & ARMCANZ, 2004).

The effects of pathogen contamination in drinking water varies significantly, ranging from illness to death, as was the case in Walkerton, Canada in 2000 where seven people died due to a pathogenic contamination of *Escherichia coli* in the town water source and supply. Preventing the introduction of pathogens into the water source is the most effective barrier in avoiding a public health risk.

Land use activities within the catchment can directly influence the effectiveness of water treatment. For example, off-road driving on unauthorised tracks contributes to erosion and the uprooting of vegetation. Erosion results in the mobilisation of soil particles, which are released into the air and tributaries and increase the turbidity within the reservoir. Pathogens adsorb onto these soil particles and may be shielded from the effects of disinfection. Increased turbidity also impacts upon other environmental constituents, ie smothering riparian vegetation and reducing light transfer within the water column which affects plant growth.

4.2 Private land

There is only one privately owned property within the proposed new catchment area. (refer to Figure 4). Approximately 0.7ha extends into the catchment along the south west boundary. The area is comprised of native vegetation and the adjoining house is outside the proposed catchment boundary.

The Department may consider purchasing the private land within the catchment if the owner proposes to sell the property.

4.3 Crown land

Approximately 50 per cent of the catchment is under Crown ownership as State Forest 22, national park (Crown Reserve) or unallocated Crown land (refer to Figure 3). State forest is vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation.

State forest is managed for the purposes identified in the *Forest Management Plan 2004-2013* as conservation, recreation, timber production on a sustainable yield basis, water catchment protection and other purposes prescribed by the regulations (Conservation Commission of Western Australia, 2004). The *Forest Management Plan 2004-2013* is a statutory document which is applicable to State forest for ten years. It recognises water catchment protection as a statutory purpose of indigenous State forest, and water extraction as a legitimate activity.

The Department of Environment and Conservation also has management responsibilities for unallocated Crown land, including the promotion of biodiversity, fire prevention, weed and animal control, harvesting of flora and forest produce and the management of recreation.

4.3.1 Forest and plantation management

The catchment has previously been used for forestry activities including native forest and plantation timber harvesting. There is no timber harvesting currently occurring in the catchment as there is minimal marketable material available from the current vegetation. There are currently no plans for harvesting in the State forest within the next 10 years.

Land management of State forest is undertaken by the Department of Environment and Conservation in accordance with the defined purpose of the forest. It includes fire management, such as prescribed burning and maintenance of firebreaks, fox control by 1080 baiting and the trapping and shooting of feral pigs.

Private resource harvesting in the State forest includes apiaries, wildflower picking and seed collection, although the occurrence is low due to the quality of the vegetation. A permit must be obtained from the Department of Environment and Conservation to undertake these activities.

Firewood collection by the public is only permitted in designated firewood areas in State forest and timber reserves. There are no designated firewood areas within the catchment. Firewood collection is not permitted within nature reserves, national parks or conservation parks except in recreation areas where signposted for such use.

The catchment and reservoir may occasionally be used for research projects, subject to approval from Water Corporation and the Department of Environment and Conservation.

4.3.2 Mining

A Special Mining Lease over the catchment, issued to Alcoa World Alumina Australia (Alcoa) under the *Alumina Refinery Agreement Act 1961, No. 3,* grants Alcoa rights to extract bauxite from Crown land with associated responsibilities to protect environmental values and rehabilitate mine sites. To date, no mining activity has occurred in the catchment and there are currently no plans to mine in the next 20 years.

4.3.3 Recreation

Informal, acceptable recreational activities include bushwalking and cycling, outside the Reservoir Protection Zone. Extensive unauthorised activities occur as a result of open access to the catchment. Unauthorised activities include fishing, marroning, hunting, horse riding, camping, off-road driving and rubbish dumping. In particular, marroning is prevalent in the reservoir and tributaries over the summer period. The proximity of the catchment to several horse stables and semi-rural properties makes it a favoured location for unauthorised horse riding.

Off-road driving (away from designated roads) is a prohibited activity that occurs extensively throughout the catchment, causing significant erosion problems. It occurs on an individual basis and in groups, typically involving vehicles such as four wheel drives (4WDs), motorcycles (including trail bikes) and unlicensed cars.

Unauthorised vehicle use frequently occurs in unused gravel pits. The dumping of stolen cars and rubbish often occurs at these sites.

Numerous tracks enter the catchment from Albany Highway providing access for unauthorised vehicles and the dumping of vehicles and rubbish. These activities are prohibited in the catchment under the *Metropolitan Water Supply Sewerage and Drainage by-laws 1981* to protect the quality of water within the catchment.

4.4 Water and Rivers Commission land and Water Corporation land

Almost 50 per cent of the catchment is owned freehold by either the Water and Rivers Commission (WRC), now operating as the Department of Water, or Water Corporation.

Several areas of land along the tributaries in the catchment are owned freehold by WRC. This area is mostly forested although some small sections of this land were previously cleared for agricultural use and have not been revegetated.

Water Corporation has freehold ownership of a large area of forested land surrounding the reservoir.

The land owned freehold by Water Corporation and WRC has prescribed fire regimes implemented by the Department of Environment and Conservation and Water Corporation. Feral animal control is also undertaken by both organisations on these properties. There may be some capacity to enforce trespassing laws to discourage illegal activity on these properties.

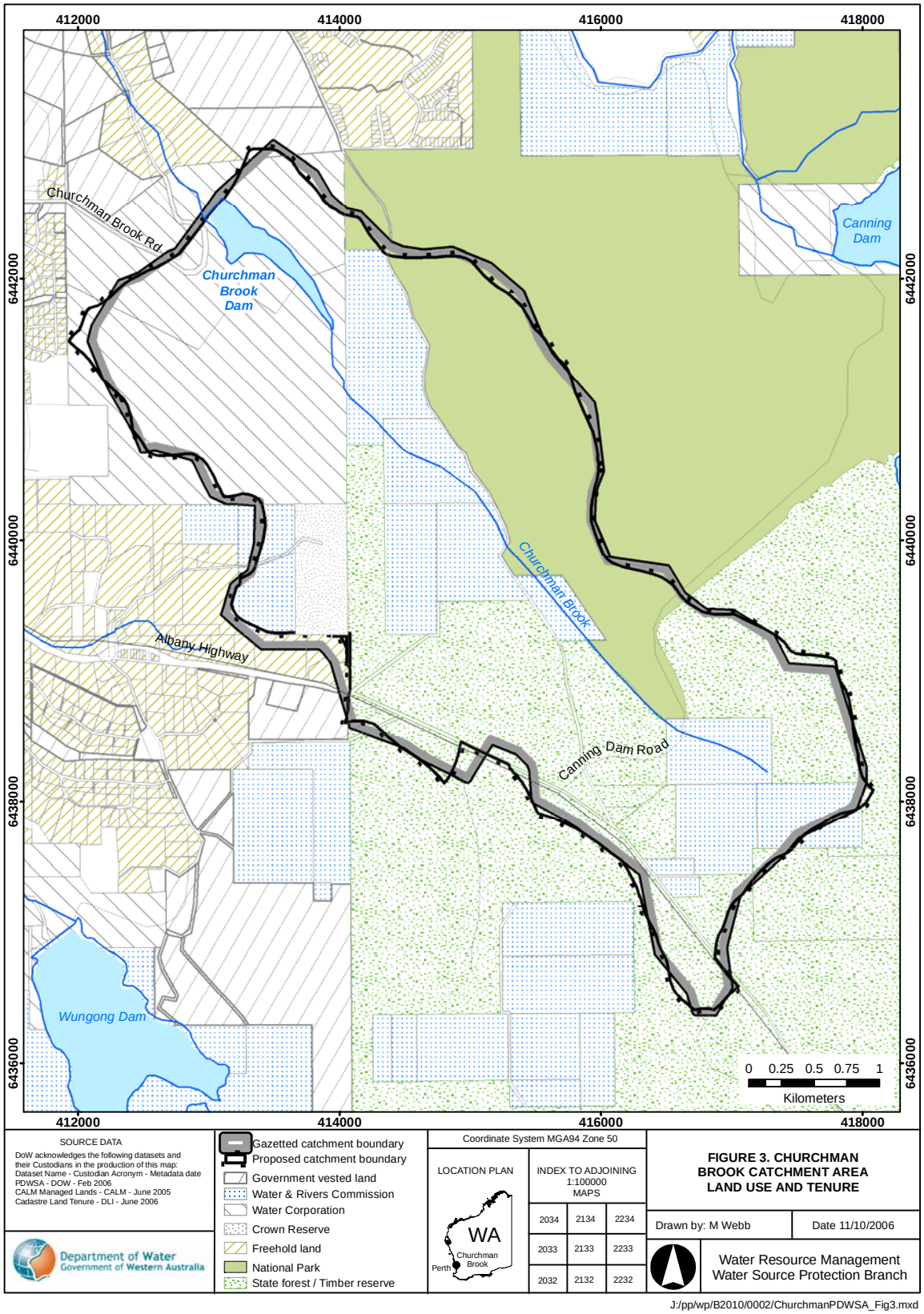

Figure 3 Land use and tenure in the Churchman Brook Catchment Area

5 Catchment protection strategy

5.1 Protection objectives

The objective of this plan is to protect drinking water quality for public health whilst acknowledging social and environmental requirements.

Prevention and the principle of the multiple barrier approach are essential features of effective drinking water quality management. If one barrier fails, the continuation of other barriers will reduce the risk of contamination being passed on to consumers. This approach has been endorsed within the ADWG (NHRMC & ARMCANZ, 2004).

Churchman Brook dam is a strategic source to the IWSS. Based on the potential risk posed by human contact with the water and the number of people that could potentially be affected, activities that involve contact with the reservoir or tributaries are considered unacceptable within this catchment.

The Priority 1 classification proposed for the majority of this catchment has the fundamental water quality objective of risk avoidance. The Priority 2 classification given to private land has the fundamental objective of risk minimisation to prevent any increased risk of contamination.

5.2 Proclaimed area

The Churchman Brook Catchment Area was proclaimed on 23 November 1923 under the *MWSSD Act 1909*. It is proposed to amend this boundary to more accurately represent the physical catchment boundary.

The proposed Churchman Brook Catchment Area and the existing catchment boundary are shown in Figures 2 to 4.

5.3 Priority classifications

All land in the catchment, excluding private property, should be managed for Priority 1 (P1) source protection (refer to Figure 4). The objective of this priority classification is to protect water quality in accordance with the principle of risk avoidance.

A P1 source protection classification is appropriate in the areas as:

- The Churchman Brook dam is a strategic source of public drinking water for the IWSS and should be afforded the highest level of protection.
- The land is State forest, national park or owned freehold by State Government agencies or Water Corporation.
- Existing, approved land use practices can be managed with the use of best management practices.

It is recommended that the private property in the catchment be managed for Priority 2 (P2) source protection. Existing land practices are compatible with P2 protection. Given the distance of the property from the reservoir and the absence of any development, the risk to water quality is low.

It is preferable for private land within the catchment area to be retained as native vegetation, and not be subject to subdivision.

An explanation of the priority classifications and details of land use compatibility within each priority classification is provided in the Department of Water's Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas*, which is available from the Department's website.

5.4 Reservoir Protection Zone

A prohibited zone, also known as a Reservoir Protection Zone (RPZ), has been established around the Churchman Brook dam under the provisions of the *MWSSD* by-laws to protect the reservoir from immediate risks to water quality. The RPZ is defined as that part of a catchment area which lies upstream of a dam and within 2km of the top water level of any reservoir in which water is or can be stored. The RPZ includes the reservoir itself, but does not extend outside the catchment area or downstream of the dam wall (refer to Figure 4).

The RPZ is a key barrier in the 'catchment to consumer' multiple barrier approach for protecting the reservoir and its drinking water quality (NHMRC & ARMCANZ, 2004).

Unauthorised public entry to the RPZ, other than on public or private roads, is prohibited under the provisions of the *MWSSD* by-laws. Entry to the RPZ requires specific approval from Water Corporation (as the agent with delegated responsibility from Department of Water).

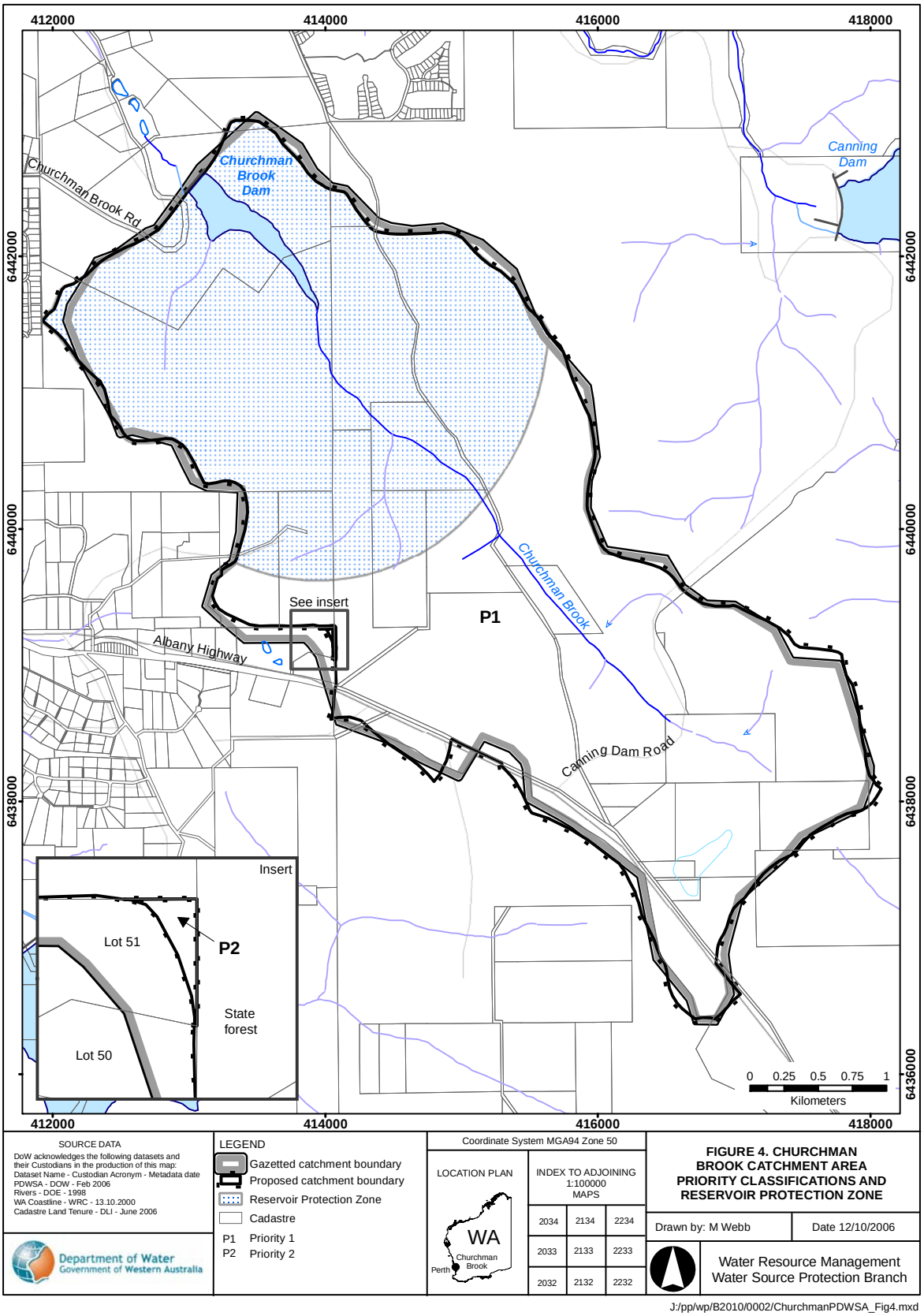

Figure 4 Proposed priority classifications and Reservoir Protection Zone for Churchman Brook Catchment Area

5.5 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 Statement of Planning Policy No.2.7 *Public Drinking Water Source Policy* (Western Australian Planning Commission, 2003) it is appropriate that the Churchman Brook Catchment Area, its priority classifications and the Reservoir Protection Zone be recognised in the City of Armadale's Town Planning Scheme and the Metropolitan Regional Scheme. Development proposals located within this catchment, or deemed likely to affect the protection objectives of the Churchman Brook Catchment Area should be referred to the Department of Water's Swan Avon Region for assessment and advice.

Further information on the strategies and policies applicable to both planning and drinking water catchments is provided in Water Quality Protection Note *Land use planning in Public Drinking Water Source Areas* (Department of Water, 2006).

5.6 Best management practices

There are opportunities to significantly reduce risks to water quality by carefully considering design and management practices. The adoption of best management practices for land uses will continue to be encouraged to help protect water quality. On freehold land, the Department of Water aims to work with landowners to achieve best management practices for water quality protection through the provision of management advice, and assistance to seek funding if required.

There are guidelines available for many land uses in the form of industry codes of practice, environmental guidelines or Water Quality Protection Notes. These have been developed in consultation with stakeholders such as industry groups, producers, state government agencies and technical advisers. These guidelines help managers reduce the risk of their operations causing unacceptable environmental impacts. They are recommended as best practice for water quality protection. Examples are listed in Appendix B.

Education and awareness (eg signage and information material) is a key mechanism for water quality protection, especially for those people visiting the area who may be unaware that it is a drinking water catchment. Signs are erected in drinking water catchments to educate the public and to advise of activities that are prohibited or regulated. A brochure will be produced once this Plan is endorsed, describing the Churchman Brook Catchment Area, its location and the main threats to water quality protection. This brochure will be made available to the community and will serve to inform people in simple terms about the drinking water source and its protection.

5.7 Surveillance and by-law enforcement

Public drinking water catchments within the metropolitan area are protected under the *MWSSD Act 1909*. Declaration of Catchment Areas, Underground Water Pollution Control Areas or Water Reserves allows *MWSSD* by-laws to be applied to land uses and activities within the catchment to protect water quality.

The Department of Water considers by-law enforcement, through on-ground surveillance of drinking water catchments as an important water quality protection mechanism. Surveillance is also important in raising the level of awareness of the need to protect water quality. Surveillance and by-law enforcement within this catchment has been delegated to the Water Corporation.

5.8 Emergency response

Escape of chemicals during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The City of Armadale's Local Emergency Management Advisory Committee (LEMAC), through the South East Metropolitan Emergency Management District, should be familiar with the location and purpose of the Churchman Brook Catchment Area.

A locality plan should be provided to the Fire and Rescue Services headquarters for the Hazardous Materials Emergency Advisory Team (HAZMAT). The Water Corporation and the Department of Environment and Conservation should have an advisory role to any HAZMAT incidents in the catchment.

Personnel who deal with WESTPLAN – HAZMAT (Western Australian Plan for Hazardous Materials) incidents within the area should have access to a map of the Churchman Brook Catchment Area. These personnel should receive training to ensure an adequate understanding of the potential impacts of spills on the water resource.

5.9 Recommended protection strategies

Table 1 identifies the potential water quality risks associated with existing land uses and activities in the Churchman Brook Catchment Area and recommends protection strategies to manage and minimise these risks.

The management priorities have been determined using a comprehensive risk analysis spreadsheet developed by Water Corporation, consistent with the ADWG recommendations for hazard identification and risk assessment (Water Corporation, 2006).

Hazards identified as high risk include pathogens from pigs wallowing, decomposition of hunted animal carcasses, horse riding and people swimming, fishing or marroning in the catchment; and turbidity / erosion associated with wildfires.

Table 1 Land use, potential water quality risks and recommended strategies

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Private land				
Rural residential	• Pathogen contamination from domesticated animals; • Increased turbidity as a result of vehicle use on unsealed roads and clearing; • Chemical contamination from fertilisers and pesticides applied to gardens, and inadequate disposal and storage of chemical containers.	Low Low Low	The portion of private property within the catchment boundary is native vegetation. There are guidelines that restrict the application of pesticides, and land use controls aimed at minimising fertiliser use within catchment areas. The land is dual zoned as Rural C and Water Catchment under the City of Armadale Town Planning Scheme. The minimum subdivision size is 4ha and the average is 5ha. The lot is 6.9ha therefore it is currently ineligible for subdivision.	*Existing land uses are acceptable.* • Encourage landowners to adopt best management practices, particularly with regards to fertiliser and pesticide application. • Ensure the water quality protection objectives of the Priority 2 classification are recognised in the town planning scheme of the City of Armadale. • Refer development proposals that are inconsistent with water quality protection advice to Department of Water for comment. • Oppose intensification of land use through the planning approval process.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
State forest				
Native forest timber harvesting *Currently no harvesting*	• Turbidity due to log handling practices and the use of unsealed roads and tracks; • Fuel spills from vehicles and machinery; • Pathogens due to human presence.	Low Medium Medium	No harvesting is planned in the near future as there is currently minimal marketable material available. Forestry operations are governed by the *Forest Management Plan 2004-2013.*	*Not recommended.* • Should native forest timber harvesting occur, ensure it is in accordance with the *Contractor's Timber Harvesting Manual – South West Native Forests* (FPC, 2003) and the *Code of Practice for Timber Harvesting* (CALM, 2004). • Update timber harvesting manuals and codes in accordance with FPC, Department of Environment and Conservation, Department of Water and Water Corporation requirements.
Private resource harvesting • Apiaries (2) • Wildflower picking • Seed collection	• Pathogen contamination through the presence of people near the reservoir and tributaries; • Increased turbidity due to the use of unsealed roads.	Low Low	The primary concern is the potential for people to be in close proximity to the reservoir or its tributaries. There are two apiary sites in the catchment but neither is currently in use. Department of Environment and Conservation licence a number of private wildflower pickers and seed collectors. However, the low quality of the vegetation in this area reduces the activity in this catchment.	*Acceptable activity with conditions*. • Ensure that if water is required at an apiary site it is not sourced from the reservoir but trucked in as per Department of Environment and Conservation licence conditions. • Continue to apply a condition of approval for apiarists, wildflower picking and seed collection licences that requires adherence to water quality protection objectives, including exclusion from the RPZ. • Inspect water quality protection measures on site.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Private resource harvesting (*contin…)*			The apiary permit conditions imposed by Department for Environment and Conservation include water quality protection objectives ie camping by apiarists requires the use of a chemical toilet and is not permitted in the RPZ.	
Fire management • Prescribed burning • Firebreaks • Water points	• Erosion and turbidity; • Carbon and nutrient contamination; • Chemical contamination from fuel spills; • Pathogens from direct contact of firefighters with the reservoir or tributaries, the death of animals and the loss of filtering vegetation.	Medium Low Low Medium	Prescribed burning for biodiversity and fuel reduction is an established land management practice in the catchment and should be managed to limit the potential for turbid runoff into the reservoir. Firebreaks are generally cut in the event of an emergency and are not cut on a routine basis. This may change in future if burning regimes need to be altered to meet biodiversity outcomes. Prescribed burning within the catchment is undertaken in accordance with the *Forest Management Plan 2004-2013.*	*Acceptable activity with best management practices.* • Liaise closely with Department of Environment and Conservation to ensure that specific guidelines related to water quality protection are incorporated into the burning prescription. • Ensure protocols are put in place for effective communication between agencies managing the catchment. • Ensure stabilisation of soil excavated during construction of water points to prevent turbid runoff into waterways. • Ensure that firebreaks required on an ongoing basis are constructed to minimise soil disturbance.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	Management priority		
Fire management *(contin…)*			Prescribed burning and the construction of firebreaks may increase turbidity in the short term, particularly in areas of steeper slopes close to the reservoir and tributaries. In the long term it reduces the water quality risk.	• Reduce fuel loads by appropriate prescribed burning. • Emergency firebreaks should be immediately rehabilitated in accordance with Policy Statement No. 10 *Rehabilitation of Disturbed Land* (CALM, 1986).
Wildfires	• Erosion and turbidity; • Carbon and nutrient contamination; • An increase in pathogens due to the death of animals and the loss of filtering vegetation.	High Low Medium	Intense wildfire can cause turbidity from airborne ash or through runoff when the burn is extinguished or followed by rain. Water Corporation staff attend fires. The prescribed burning program run by Department of Environment and Conservation should reduce the incidence of wildfire.	• Where location, extent or intensity of a fire suggests the need, inspect sites following fire to assess the need for turbidity mitigation works and conduct any necessary works. • Ensure sites that need permanent protection from wildfire have adequate firebreaks and are considered during the Department of Conservation and Environment's Master Burn planning process. • To ensure water quality considerations are addressed, Water Corporation staff should continue to attend all fires in catchment areas. • Water Corporation staff should continue to undertake catchment inspections and post fire water quality monitoring.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Firewood collection	• Pathogen contamination through the presence of people and domestic animals near the reservoir or tributaries; • Rubbish dumping; • Turbidity due to the use of unsealed roads and damage to vegetation during off-road driving.	Medium Low Medium	The collection of firewood is only permitted in designated public firewood areas in State forest and timber reserves. There are no designated firewood collection points within the catchment. Most firewood collection in the catchment is illegal. The primary concern is the potential for people to be close to the reservoir or tributaries during public firewood collection. Rubbish dumping is often associated with public firewood collection points. Domestic animals often accompany people during firewood collection. Dogs are prohibited in the catchment, unless on private property.	*Acceptable activity with conditions.* • Ensure regional plans for public firewood collection areas give consideration to water quality protection objectives. • If designated firewood collection points are established within the catchment, keep outside the RPZ, away from the reservoir and tributaries, and restrict activity to the edge of the catchment. • Ensure any designated firewood collection points are regularly patrolled and any dumped rubbish is removed. • Use signs and brochures to promote water catchment awareness and protection. • Catchment rangers facilitate water quality protection awareness during liaison with visitors to the catchment. • Ensure the public are aware that dogs are not permitted in the catchment, unless on private property. Apply by-law enforcement.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Research projects	• Pathogen contamination; • Increased turbidity due to the use of unsealed roads, particularly close to the reservoir.	Low Low	The risk associated with this activity is minimal, due to the low numbers of people involved and the ease of education prior to the activity occurring. Proponents undertaking research projects must get approval from Water Corporation before they commence. Approval must also be granted from the Department of Environment and Conservation if the research is on land they manage, ie State forest.	*Acceptable activity with conditions.* • Ensure education on water quality protection requirements is undertaken prior to the activity. • Apply a condition of approval that requires adherence to water quality objectives.
Gravel pits	• Increased turbidity from gravel extraction, localised clearing and illegal recreational use; • Fuel and chemical spills from vehicles and machinery; • Rubbish dumping often in the form of car bodies;	Medium Low Medium	Gravel pits are focal points for illegal and sometimes destructive recreational activities usually involving vehicles. Illegal recreational activities may also be responsible for a failure of rehabilitation in gravel pits. Gravel pits used for road maintenance require effective site management to reduce the risks to water quality.	*Acceptable activity with best management practices.* • Approval of gravel extraction proposals should include the conditions stated in Water Quality Protection Note *Extractive industries near sensitive water resources* (Department of Water, 2006). • Ensure contract specifications recognise water quality protection objectives.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Gravel pits *(contin…)*	• Pathogens from human presence.	Medium	Pits are rehabilitated after use in accordance with Policy Statement No. 10 *Rehabilitation of Disturbed Land* (CALM, 1986) and the *Code of Practice for Timber Plantations in Western Australia* (Forest Industries Federation (WA) Inc, 2006).	• Ensure any new gravel pits are constructed outside the RPZ. • Ensure gravel extraction occurs in accordance with the *Code of Practice for Timber Plantations in Western Australia* (Forest Industries Federation (WA) Inc, 2006) and Policy Statement No.2 *Local Government Authority Access to Basic Raw Materials from State Forest and Timber Reserves* (CALM, 1993). • Pits should be rehabilitated immediately after decommissioning, in accordance with Policy Statement No. 10 *Rehabilitation of Disturbed Land* (CALM, 1986). • Inspect water quality protection measures on site. • Restrict vehicular access to gravel pits.
Vehicle roads and tracks	• Turbidity from erosion of unsealed roads and tracks; • Pathogen contamination from public access to the reservoir or tributaries.	Medium Medium	Roads and tracks are necessary for forest management. It is essential they are well maintained to minimise the risk of erosion. Albany Highway passes along the southern border of the catchment.	*Accepted as necessary for forest management, requires best management practices.* • Adherence to Water Quality Protection Note *Roads near sensitive water resources* (Department of Water, 2006).

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	Management priority		
Vehicle roads and tracks *(contin…)*	• Fuel and chemical spills from vehicles and machinery;	Medium	Albany Highway is a major haulage route Shire roads in the catchment are Canning Dam Road and Churchman Brook Road, which are sealed. Control of access is an issue in the catchment due to easy access off Albany Highway. There is a major problem with erosion of tracks within the catchment, much of this is due to illegal recreational use and runoff.	• Set a definition of 'Public Road' under the *MWSSD* by-laws. • Review the road network to identify roads not essential for forest operations and management or transport thoroughfare. Close and rehabilitate tracks that are no longer required. • Educate the public on the definition and implication of by-law enforcement. • Ensure road upgrades follow alignments and incorporate measures to avoid or minimise water source contamination risks. • Ensure an operative emergency response procedure exists and that the LEMAC is aware of catchment boundaries. • Use signs along roads to inform people of their presence in a catchment. Display the emergency contact number in the event of a spill. • Avoid the construction of new roads in the RPZ and throughout the catchment.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Feral animal control • Pigs • Foxes	• Turbidity from pigs wallowing; • Pathogens from wallowing and animal carcasses.	Medium High	Under *MWSSD* by-laws, shooting, trapping or hunting game is prohibited in catchment areas without approval from the Department of Water. Pig wallowing may result in the transfer of faecal material containing pathogens into the reservoir or tributaries. Feral pig control is undertaken by the trap and shoot method only, by Water Corporation Rangers and Department of Environment and Conservation personnel. Shooting to control problem animals is only undertaken by authorised personnel (Department of Environment and Conservation officers) under strict, controlled conditions as part of an integrated management program. The bait used for fox control contains 1080 (sodium monofluoroacetate).	*Acceptable activity by authorised personnel under strict controls*. • Ensure feral pig control is only performed by the 'trap and shoot' method. • Ensure pig carcasses are removed. • Develop inter-agency guidelines for the managed eradication of feral pigs, addressing *MWSSD* by-laws and water quality protection requirements • Continue using 1080 for the control of foxes within the catchment. • Ensure compliance with Administrative Instruction No. 58 *Fox Baiting on CALM managed land and in other CALM programs* (CALM, 1994) and *Fox Control Manual* (CALM, 1996). • Ensure compliance with *Draft Feral Pig Management Strategy for Departmental Management Land Western Australia 2005-2009* (CALM, 2005).

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Feral animal control *(contin…)*			1080 is a naturally occurring chemical that does not pose a risk to water quality. Department of Environment and Conservation policy is to ensure baits are not placed within 100m of drinking water reservoirs.	
Crown land – Recreation *All recreational activities within the catchment are to comply with Statewide Policy No. 13 Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land (Water and Rivers Commission, 2003)*				
Swimming	• Pathogen contamination associated with direct body contact with the reservoir or tributaries.	High	Swimming, bathing, bodily contact with water and washing clothes in the reservoir or its tributaries is prohibited under *MWSSD* by-laws because of the immediate risk to drinking water quality.	*Swimming is prohibited in the reservoir and tributaries in the catchment.* • Use signs and promotional material to ensure the public are aware that swimming is prohibited in the reservoir and tributaries. • Undertake after-hours surveillance with by-law enforcement.
Fishing and marroning	• Pathogen contamination from people close to or in the reservoir and tributaries, and the use of bait;	High	Fishing and marroning in the catchment are prohibited under *MWSSD* by-laws. *MWSSD* by-laws are enforced by Water Corporation after-hours surveillance.	*Fishing and marroning in the reservoir or tributaries is prohibited in the catchment*. • Use signs and advertising material to ensure the public are aware that fishing and marroning are not permitted.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	Management priority		
Fishing and marroning *(contin…)*	• Turbidity from vehicle use close to the reservoir or tributaries.	Medium	Human or animal contact with water poses an immediate threat to water quality. There are additional risks associated with fishing and marroning through on-site camping, the presence of dogs close to or in the reservoir and tributaries, and the use of bait. By-law penalties are small and the activities continue. Preventing these activities in drinking water catchments is essential to protect water quality.	• Liaise with and advertise through the Department of Fisheries and Recfishwest. • Continue to undertake after-hours surveillance of the catchment with by-law enforcement, to deter offenders. • Increase the penalties associated with offences under Part 4 of the *MWSSD* by-laws. • Ensure the public are aware that dogs are not permitted in the catchment, unless on private property. Apply by-law enforcement.
Bushwalking and cycling	• Pathogen contamination from people in close proximity to the reservoir or its tributaries; • Turbidity, primarily from cyclists.	Medium Low	There are no official walk tracks or bike trails within the catchment however its proximity to private property and the number of access roads make it popular for recreational walking and cycling. Although cycling is considered a low risk, it has more of an impact than walking due to the erosion of trails and subsequent turbidity.	*Uncontrolled walking and cycling in the catchment should be discouraged*. • No trails should be developed in the catchment without consultation with the relevant agencies (Department of Water, Department of Environment and Conservation and Water Corporation). • Ensure that any formal trails are established outside the RPZ.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	Management priority		
Bushwalking and cycling *(contin…)*			Erosion results from skids, sudden braking, high speeds, and damage to trails during wet weather use.	• Use signs and brochures to educate people on the *MWSSD* by-laws and the importance of protecting drinking water quality. • Ensure compliance with the recommendations in Water Quality Protection Note *Tracks and trails in sensitive environments* (Department of Water, 2006).
Horseriding	• Pathogen contamination from people, animals, and manure particularly in areas close to the reservoir or tributaries; • Turbidity from horse riding on unsealed roads and tracks.	High Medium	It is prohibited to ride horses in the catchment under *MWSSD* by-laws, except on public roads, in designated areas or with permission from Department of Water and Water Corporation (and also Department of Environment and Conservation if on land they manage). Horses compact ground, contributing to increased overland runoff and turbidity. Currently, there are no designated horse riding areas on land managed by the Department of Environment and Conservation in the catchment.	*Horse riding is prohibited in the catchment, unless on public roads, on designated bridle trails or with relevant approvals.* • Ensure horse riding is restricted to public roads, outside the RPZ. • Use signs and advertising material to ensure the public are aware that horse riding is restricted to public roads, outside the RPZ. Signs may also be used to direct horse riders to local, designated horse riding areas outside the catchment. • Set a definition of 'Public Road' under the *MWSSD* by-laws. • Undertake surveillance with by-law enforcement.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Horseriding *(contin…)*			Proximity to several stables and private property results in high numbers of illegal horse riders within the catchment.	• Ensure compliance with the recommendations of Statewide Policy 13 *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land* (WRC, 2003).
Picnicking	• Pathogen contamination from people and their dogs, particularly in areas close to the reservoir; • Rubbish dumping.	Medium Low	The risk of contamination is increased by proximity to the reservoir. The risk is greater for undesignated sites than picnicking in designated areas due to the lack of management controls. The only designated picnic site in the area is down stream of the dam wall, and poses a risk in so far as the site provides access to the catchment.	*Picnicking is not permitted in the RPZ. It is only acceptable at designated picnic sites.* • Ensure designated picnic areas are outside the RPZ and include appropriate facilities, with no access provided to the reservoir or tributaries. • Use signs and brochures to raise awareness of the catchment and the importance of protecting drinking water quality.
Animal (dog) exercising on Crown land	• Pathogen contamination from people and animals in the catchment, particularly close to the reservoir or tributaries.	Medium	It is prohibited to bring a dog into a catchment area under *MWSSD* by-laws, unless on private property.	*Dogs are prohibited in the catchment, unless on private property*. • Use signs and brochures to ensure the public are aware that dogs are prohibited in the catchment. Signs may also be used to direct dog owners to local areas (outside the catchment) where pets are permitted.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Animal (dog) exercising on Crown land *(contin…)*				• Increase the penalties associated with offences under Part 4 of the *MWSSD* by-laws. • Undertake surveillance with by-law enforcement.
Rubbish dumping	• Pathogen contamination; • Nutrient, chemical, heavy metal and hydrocarbon contamination from domestic, building or industrial waste, fuel, tyres and car bodies.	Medium Medium	Rubbish dumping is often associated with informal or unauthorised recreation or access to the catchment. Rubbish dumping in the catchment is prevalent. It is mostly localised in areas around tracks off Albany Highway and in cleared or poorly vegetated areas of the catchment.	*Rubbish dumping is prohibited in the catchment.* • Continue to work with the City of Armadale, Department of Environment and Conservation and other relevant agencies to reduce rubbish dumping in the catchment. • Undertake surveillance with by-law enforcement, with a focus on the RPZ. • Use signage and brochures to ensure the public are aware that rubbish dumping is not acceptable and that penalties apply under the *Litter Act 1979*.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Recreational hunting	• Pathogen contamination from feral animal carcasses; • Pathogen contamination from people and dogs in the catchment.	High Medium	Under *MWSDD Act by-law 4.3.4*: No person shall shoot, trap or hunt any game or catch, or attempt to catch, any fish or marron within a catchment area, without specific permission in writing from the Department of Water. The Department may attach any conditions that it deems necessary. Illegal recreational hunting poses a serious risk to visitor safety and to water quality ie pathogen contamination from feral animal carcasses and from people and dogs in the catchment. Dogs are prohibited in the catchment. Surveillance by Water Corporation Catchment Rangers currently reduces the occurrence of illegal hunting and the associated risks, but greater surveillance would further minimise the activity.	*Recreational hunting is prohibited in the catchment.* • Use signs and advertising material to advise that recreational hunting is prohibited brochures and to ensure the public are aware that dogs are prohibited in the catchment. • Continue surveillance of the catchment with by-law enforcement. • Increase by-law penalties.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	**Management priority**		
Off-road driving (away from designated roads) • 4WDs • Motorcycles • Unlicensed cars	• Turbidity from erosion of unsealed roads and tracks, particularly steep slopes close to the reservoir, and from damage to the vegetation; • Hydrocarbon contamination from vehicle fuel spills; • Contamination from vehicle dumping.	Medium Low Medium	Under *MWSSD by-law 4.7.2*: No person shall drive a vehicle on any part of a catchment area other than a road or track which has a graded, gravelled, sealed, primed or other prepared surface without written approval from Department of Water. Off-road driving is not permitted on land managed by the Department of Environment and Conservation without a permit. Off-road driving occurs extensively in the catchment, particularly by motorcyclists and drivers of unlicensed cars. The risks associated with this activity are significant, particularly with regard to turbidity caused by the erosion of unsealed roads and tracks. This activity is also associated with the additional risks of vehicle dumping (particularly of stolen vehicles) and subsequent fires.	*Off-road driving (away from designated roads) is prohibited in the catchment.* • Use signs to advertise that off-road driving away from designated roads is prohibited in the catchment. • Undertake surveillance with by-law enforcement. • Increase by-law penalties. • Rehabilitate and revegetate gravel pits in the catchment in accordance with best practice guidelines.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	Management priority		
Water and Rivers Commission and Water Corporation freehold land				
Unauthorised recreation • Off-road vehicle use • Hunting • Bushwalking • Camping • Horse riding	The potential risks associated with these activities have been discussed in detail in previous sections.		WRC and Water Corporation own several properties in the catchment, including land previously utilised for agricultural activities. The properties are used extensively for unauthorised recreation.	*Unauthorised access is prohibited on WRC and Water Corporation land* • Investigate the need for rehabilitation of WRC and Water Corporation land (including stream zones) with local, native vegetation. • Increase by-law penalties. • Prohibit unauthorised access to WRC and Water Corporation properties under trespass laws. • Erect and maintain signs to ensure the public are aware of the private ownership of the properties. • Undertake surveillance of WRC and Water Corporation properties with enforcement of trespass laws.
Fire management	The potential risks have been described above.		Land owned by WRC and Water Corporation is managed for fire by Department of Environment and Conservation and Water Corporation.	Protection strategies have been described above.

Land use / activity	Potential water quality risks		Consideration for management	Recommended protection strategies
	Hazard	Management priority		
Feral animal control	The potential risks have been described above.		Water Corporation currently undertake feral pig control on WRC and Water Corporation owned land in the catchment using the 'trap and shoot' method. This method reduces the risks to water quality as animal carcasses are removed from the catchment.	Protection strategies have been described above.

6 Recommendations

The following recommendations are proposed to help protect water quality in the Churchman Brook Catchment Area. Key stakeholders for each recommendation have been identified in parenthesis :

1 The boundary of the Churchman Brook Catchment Area should be amended under the *Metropolitan Water Supply, Sewerage and Drainage Act 1909,* in accordance with the proposed boundary in Figure 2 *(Department of Water).*

2 Prepare an implementation strategy for this plan describing responsible stakeholders, timeframes and funding sources for the recommended protection strategies *(Department of Water).*

3 Implement the recommended protection strategies as detailed in *Table 1: Land use, potential water quality risks and recommended strategies* of this plan *(Department of Water and applicable stakeholders).*

4 The City of Armadale Town Planning Scheme and the Metropolitan Regional Scheme should incorporate the management principles outlined in this plan and the identified Churchman Brook Catchment Area boundary, Reservoir Protection Zone and priority (P1 and P2) classifications *(City of Armadale, Western Australian Planning Commission).*

5 All development proposals within the Churchman Brook Catchment Area that are likely to impact on water quality and/or quantity, or are inconsistent with Water Quality Protection Note *Land use compatibility in Public Drinking Water Source Areas* (Department of Water, 2004) or Statement of Planning Policy No. 2.7 *Public Drinking Water Source Policy* (WAPC, 2003) should be referred to the Department of Water for advice and recommendations (*Department for Planning and Infrastructure, City of Armadale).*

6 Incidents covered by WESTPLAN – HAZMAT in the Churchman Brook Catchment Area should be addressed through the following:

- The locality plan for the Churchman Brook Catchment Area is provided to the Fire and Rescue headquarters for the HAZMAT Emergency Advisory Team.
- Personnel dealing with WESTPLAN – HAZMAT incidents in the area have ready access to a locality map of the Churchman Brook Catchment Area and training to understand the potential impacts of spills on drinking water quality.
- The City of Armadale Local Emergency Management Advisory Committee is informed of the location and purpose of the Churchman Brook Catchment Area.
- The Water Corporation provides an advisory role during incidents in the Churchman Brook Catchment Area (*Department of Water, Water Corporation).*

7 The surveillance program, and associated by-law enforcement, should continue to identify any incompatible land uses or potential threats within the Churchman Brook Catchment Area. Pursuant to Section 13(1) of the *Water and Rivers Commission Act 1995*, the Department of Water should continue to delegate responsibility for surveillance and enforcement to the Water Corporation (*Department of Water, Water Corporation*).

8 Signs should be erected along the boundary of the Churchman Brook Catchment Area and Reservoir Protection Zone 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*).

9 New recreational events or activities in the catchment should only be approved if in accordance with the requirements of the relevant agencies and Statewide Policy 13 *Recreation within Public Drinking Water Source Areas on Crown Land* (WRC, 2003). New activities within the Reservoir Protection Zone will not be supported by the Department of Water (*Department of Environment and Conservation, City of Armadale, Department of Water, Water Corporation*).

10 Stream zones on property owned by Water Corporation or Water and Rivers Commission should be assessed for the need for rehabilitation. Any rubbish on the properties should also be removed (*Department of Water, Water Corporation*).

11 The Department of Water is to continue working with the Department of Environment and Conservation and the Forest Products Commission to update the forestry manuals, codes and guidelines (*Department of Water, Department of Environment and Conservation, Forest Products Commission).*

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

Glossary

ADWG	The Australian Drinking Water Guidelines, outlines criteria for the quality of drinking water in Australia.
Aesthetic guideline	NHMRC guideline level ascribed to acceptable aesthetic qualities of drinking water such as taste, smell, colour and temperature.
AHD	Australian Height Datum is the height of land in metres above mean sea level. For example this is +0.026 m at Fremantle.
Allocation	The quantity of water permitted to be abstracted by a licence, usually specified in kilolitres per year (kL/a).
ANZECC	Australian and New Zealand Environment Conservation Council.
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand.
CALM	Department of Conservation and Land Management (now operating as Department of Environment and Conservation).
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
CFU	Coliform forming units is a measure of pathogen contamination in water.
DWSPA	Drinking Water Source Protection Assessment.
DWSPP	Drinking Water Source Protection Plan.
FPC	Forest Products Commission.
GL	Gigalitres (1 000 000 000 litres).
HAZMAT	Hazardous Material Advisory Team.
Health guideline	NHMRC guideline level ascribed based on acceptable drinking water quality for human health.
IWSS	Integrated Water Supply System – provides drinking water to 1.5 million customers throughout Perth, Mandurah, Pinjarra, Harvey and the Goldfields and Agricultural regions.
kL	Kilolitres (1000 litres).

km	Kilometres (1000 metres).
km^2	Square kilometres (a measure of area).
m	Metres.
mg/L	Milligrams per litre (0.001 grams per litre).
ML	Megalitres (1 000 000 litres).
mm	Millimetres.
MWSSD Act	*Metropolitan Water Supply, Sewerage and Drainage Act 1909.*
NHRMC	National Health and Medical Research Council.
NTU	Nephelometric turbidity units are a measure of turbidity in water.
P1, P2	Priority 1 (P1), Priority 2 (P2). Priority classification for land use management.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algaecides, fumigants and rodenticides used to kill organisms.
PDWSA	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* and the *Country Areas Water Supply Act 1947*.
Reservoir	A reservoir, dam, tank, pond or lake that forms part of any public water supply works.
RIWI Act	*Rights in Water and Irrigation Act 1914*
RPZ	Reservoir Protection Zone – a 2km buffer measured from the high water mark of a drinking water reservoir, and inclusive of the reservoir. Referred to as a 'Prohibited Zone' under the *Metropolitan Water Supply, Sewerage and Drainage By-laws 1981.*
Runoff	Water that flows over the surface of a catchment area, including streams.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment.
Tributary	A stream, river or lake which flows into a larger stream, river or lake.

WAPC	Western Australian Planning Commission.
Water quality	The physical, chemical and biological measures of water.
WESTPLAN – HAZMAT	Western Australian Plan for Hazardous Materials
WRC	Water and Rivers Commission (now operating as Department of Water).

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World Health Organisation 1996, *Guidelines for Drinking-Water Quality – Volume 2 – Health Criteria and Other Supporting Information*, 2nd edn, World Health Organisation, Geneva, (available from: <www.who.int/water_sanitation_health/dwq/en/2edvol2p1.pdf>).

Appendices

Appendix A Water quality

Explanatory Note

Following storage on site to gain the benefits of natural microbiological improvement, water from Churchman Brook Dam is disinfected by chlorination before being supplied to the public. The Water Corporation is required to comply with the health related guidelines of the Australian Drinking Water Guidelines (ADWG) but not aesthetic guidelines (ie. smell, colour). The health related guidelines were not exceeded during the monitoring period. The aesthetic water quality guidelines were occasionally exceeded.

Health Parameters

Raw water from Churchman Brook Dam is analysed for health related chemicals. Health related chemicals include inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that have been measured at detectable levels in the source between July 1999 and July 2004 are summarised in the following table.

Parameter	Units	Health Guideline Value*	Churchman Brook Dam	
			Range	Median
Metals				
Barium	mg/L	0.7	0.012 – 0.013	0.012
Boron	mg/L	4	0.02 – 0.03	0.02
Inorganics				
Nitrate + Nitrite (as N)	mg/L	11.3	0.017 – 0.098	0.028

* 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 & ARMCANZ, 2004).

Aesthetic Water Quality Data

Aesthetic water quality analyses for raw water from Churchman Brook Dam are summarised in the following table. The values are taken from ongoing monitoring for the period July 1999 to July 2004. All values are in milligrams per litre (mg/L) unless stated otherwise. The water quality parameters that have on occasion exceeded the ADWG are shaded.

Parameter	Units	Aesthetic Guideline Value	Churchman Brook Dam	
			Range	Median
pH		6.5 – 8.5	6.66 – 8.26	7.06
Turbidity	NTU	5	0 – 9.3	2
Colour	TCU	15	1 – 8	2
Conductivity	mS/m	-	20 – 32	25
Total Dissolved Solids	mg/L	500	112 – 170	133
Iron (unfiltered)	mg/L	0.3	0.02 – 0.40	0.15
Manganese (unfiltered)	mg/L	0.1	0.00 – 0.04	0.01
Aluminium (unfiltered)	mg/L	0.2	0.03 – 0.40	0.16
Sodium	mg/L	180	30 – 47	36
Potassium	mg/L	-	0.6 – 1.4	0.9
Calcium	mg/L	-	1.6 – 4.0	2
Magnesium	mg/L	-	3.6 – 5.5	4.4
Hardness (as $CaCO_3$)	mg/L	200	19 – 31	23
Alkalinity (as HCO_3)	mg/L	-	6.3 – 26	9.8
Chloride	mg/L	250	51 – 78	64
Sulphate	mg/L	250	6.5 – 12	7
Silica (as SiO_2)	mg/L		4.9 – 5.8	5.4
Filterable organic carbon	mg/L		0.8 - 4.3	1.4

Microbiological Analysis

Microbiological testing of raw water samples is conducted on a weekly to monthly basis, particularly during summer and autumn. Thermotolerant coliform counts are used as an indicator of the degree of faecal contamination of the raw water from warm-blooded animals. A count of less than 20 colony forming units (cfu) per 100 mL is typically associated with low levels of contamination and is used as a microbiological contamination benchmark (World Health Organisation, 1996).

During the reviewed period of July 1999 to July 2004, positive thermotolerant coliform counts were recorded in 70% of samples, with 14% of the positive samples exceeding 20 cfu/100 mL.

Appendix B Best management guidelines for activities in Public Drinking Water Source Areas

Buffers

Vegetated buffers should be maintained along all streamlines whether ephemeral or permanent.

- Department of Water, 2006, Water Quality Protection Note *Vegetation buffers to sensitive water resources,* Department of Water. Available from <www.water.wa.gov.au>.
- NHMRC and ARMCANZ, 2004, *Australian Drinking Water Guidelines*, National Health & Medical Research Council and Agriculture & Resource Management Council of Australia and New Zealand. Available from <www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.
- Department of Environment, 2002, *River restoration manual – Guides to the nature protection, rehabilitation and long-term management of waterways in Western Australia.* Available from <http://waterways.water.wa.gov.au>.
- Water and Rivers Commission, 2001, *A review of stream and river logging buffers in Western Australia, to ensure their adequacy in protecting waterways from salinity, degradation and turbidity.* Water and Rivers Commission report to the Conservation Commission of Western Australia.
- Water and Rivers Commission, 2000, *Draft Policy: Waterways WA – A policy for Statewide Management of waterways in WA.* Available from <http://waterways.water.wa.gov.au>.

Recreation

- Water and Rivers Commission, 2003, Statewide Policy No. 13 *Policy and Guidelines for recreation within Public Drinking Water Source Areas on Crown Land*. Water and Rivers Commission. Available from <www.water.wa.gov.au>).
- Department of Water, 2006, Water Quality Protection Note *Tracks and trails in sensitive environments,* Department of Water. Available from <www.water.wa.gov.au>.

Pesticide application

Pesticide application should be minimised in all Public Drinking Water Source Areas. For specific needs of crops and best practice contact the Department of Agriculture.

- Department of Health, 2006, Public Service Circular 88 *Use of Herbicides in Water Catchment Areas.* Government of Western Australia. Available from <www.population.health.wa.gov.au/environmental/resources/use%20of%20herbicides%20in%20water%20catchment%20areas.pdf>.

- Water and Rivers Commission, 2000, Statewide Policy No. 2 *Pesticide Use in Public Drinking Water Source Areas,* Water and Rivers Commission. Available from <www.water.wa.gov.au>.

Research projects

Personnel should be educated on personal hygiene in a drinking water catchment, erosion prevention and the importance of protecting public drinking water catchments prior to any activity occurring.

Roads and tracks

Drainage must be controlled to prevent soil erosion and minimise sediment transport, which creates turbidity in the reservoir. Overland runoff should not be channelled into streams. Infiltration into soil should be aided at every opportunity.

- Department of Water, 2006, Water Quality Protection Note *Roads near sensitive water resources.* Available from <www.water.wa.gov.au>.

- Lloyd, B. and Van Delft R., 2001, *Erosion and sediment control manual for the Darling Range, Perth Western Australia*. Upper Canning/Southern Wungong Catchment Team, AgWA.