



Government of Western Australia  
Department of Water

# Quickup River Dam Catchment Area

Drinking water source protection plan

*Denmark town water supply*



*Looking after all our water needs*

Water resource protection series  
Report WRP 111  
December 2011



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# Preface

## ***How do we protect public drinking water source areas?***

The *Australian drinking water guidelines* (ADWG) (NHMRC & NRMCC 2004a) 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 achieve the delivery of a reliable and safe drinking water to your home.

A preventive risk-based approach means that we look at all the different risks to water quality in order 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 affect that can result in a lower cost, safer drinking water supply. Other barriers against contamination include storage and treatment of water to help reduce contaminant levels, disinfecting the water (e.g. chlorination to remove pathogens), maintenance of pipes and testing of water quality. Another community benefit of catchment protection is its complimentary nature to 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 putting the ADWG into practice, writing plans, policies and guidelines, and providing input into land-use planning.

The *Metropolitan Water Supply Sewerage and Drainage Act 1909* (WA) and the *Country Areas Water Supply Act 1947* (WA) 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 source 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 includes recommendations to deal

with water quality contamination risks. The Department of Water will 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 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 are defined and managed to ensure there is no degradation of the quality of the drinking water source using the objective of risk avoidance. Priority 2 (P2) areas are defined and managed to maintain or improve the quality of the drinking water source using the objective of risk minimisation. Priority 3 (P3) areas are defined and managed to maintain the quality of the drinking water source for as long as possible using the objective of risk management. Protection zones surround drinking water extraction points, 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 plan		Comment
1	Prepare drinking water source protection assessment document. (2004)	Prepared by Water Corporation after initial catchment survey and preliminary information gathering. The Department of Water reviewed and endorsed this assessment before it was finalised.
2	Conduct stakeholder consultation. (2009 - 2011)	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 2011)	Draft protection plan released for a public consultation period.
4	<b>Publish approved drinking water source protection plan. (December 2011)</b>	<b>Final protection plan published after considering submissions. Includes recommendations on how to protect water quality. Proclamation of this public drinking water source area can be progressed once the plan is published.</b>



# Summary

This drinking water source protection plan (DWSPP) aims to protect the quality of water in the Quickup River Dam Catchment Area for public drinking water supply, and where practical, achieve water quality improvement. This is achieved through the identification of potential contamination risks associated with land uses in the catchment and the recommendation of protection strategies to ensure these risks are effectively managed.

The Quickup River Dam Catchment Area is the main surface water source operated by the Water Corporation for supply of public drinking water to Denmark. This catchment area is located about 6 km north of Denmark and was proclaimed under the *Country Areas Water Supply Act 1947 (WA)* in May 1990 to ensure protection of the water source.

The Denmark pipehead dam was historically used to supply water to the town of Denmark, but rising salinity levels led to the establishment of Quickup dam as an alternative water source for Denmark. Salinity reduction measures implemented in the Denmark River catchment have resulted in a measurable reduction in stream salinity. Critically low water levels in Quickup dam in recent years has resulted in the Denmark pipehead dam being brought back online as an emergency backup for the Quickup dam.

The Quickup River Catchment Area contains 97 per cent crown land. The majority of this crown land is part of the Mount Lindesay National Park (reserve A47891), with smaller parts of state forest (State Forest 64) and unallocated crown land in close proximity to the Quickup dam. Only about 3 per cent is privately-owned land along the western edge of the dam. The Water Corporation also owns some land adjacent to the Quickup dam, and there are three other lots in private ownership located near the dam. Those lots will continue to be operated for agricultural use consistent with their zoning. The major water quality risk within the catchment is considered to be pathogen contamination from livestock.

Following the availability of improved information from a recent hydrogeological assessment for this catchment, it is proposed that the boundary of the Quickup River Dam Catchment Area be amended to reflect the new data.

The following strategies are recommended to protect water quality within the Quickup River Dam Catchment Area:

- An amended catchment area boundary should be proclaimed under the *Country Areas Water Supply Act 1947 (WA)*. This updates and replaces the existing boundary.
- All crown land and land owned by the Water Corporation in the Quickup River Dam Catchment Area should be managed for Priority 1 (P1) source protection and the remaining private land holdings managed for Priority 2 (P2) source protection (rural lots in P2 areas are compatible land uses).

- A 2 km reservoir protection zone (RPZ) (upstream of the reservoir) is proposed.
- The catchment area boundary, priority areas and RPZ should be incorporated into the Shire of Denmark's town planning scheme and other applicable schemes and strategies.
- All development proposals inconsistent with the Department of Water's Water quality protection note no. 25: *Land use compatibility in public drinking water source areas*, or this DWSPP, should be referred to the Department of Water for advice and recommendations.
- An implementation strategy should be prepared for this DWSPP, assigning time frames and stakeholders responsible for each protection strategy.
- The Water Corporation should maintain its surveillance program to identify any incompatible land uses or potential water quality contamination risks within the catchment area.
- Signage should be maintained along the boundary of the catchment and RPZ to define the location and promote awareness of the need to protect drinking-water quality.

This plan is consistent with the *Australian drinking water guidelines (ADWG)* (NHMRC & NRMCC 2004a) and State planning policy no. 2.7: *Public drinking water source policy*. It has been developed in consultation with the Water Corporation, private landowners, and relevant state and local government departments.

The following table shows useful information about the *Quickup River Dam Catchment Area*:

Local government authority	Shire of Denmark
Location	Denmark
Volume of water held/pumped	1189 ML storage capacity of dam
Date of dam completion	1989
Date of drinking water source protection assessment	December 2004
Final drinking water source protection plan	December 2011
Proclamation status	Proclaimed on 25 May 1990 under the <i>Country Areas Water Supply Act 1947 (WA)</i> . An updated proclamation will be required if the recommendations in this DWSPP are supported.

# 1 Overview of Denmark's drinking water source

## 1.1 The drinking water supply system

The Quickup dam is located along the Quickup River, approximately 410 km south of Perth, 55 km west of the regional centre of Albany, and 6 km north of the town of Denmark. It is the main surface water source operated by the Water Corporation for supply of drinking water to Denmark (Figure A1).

In 1989, the Quickup dam was constructed in response to high salinity levels in the Denmark dam. The Quickup catchment area is mostly forested, with only minimal clearing. The proclaimed catchment comprises an area of 29.7 km<sup>2</sup> and is located entirely within the Shire of Denmark. The Quickup River is an eastern tributary of the Denmark River, and has provided the majority of the drinking water to Denmark since 2000.

Quickup dam is a 10 m high homogenous earth-fill wall. The reservoir covers an area of 50.7 ha and has a storage volume of 1189 ML. Mean annual inflow to the reservoir (1986 – 2007) was estimated to be 1413 ML and the annual yield is 560 ML (Water Corporation, 2008). Based on regional rainfall data from 2001 to 2007, the estimated annual inflow may be reduced to 958 ML and the annual yield to 540 ML. The current dry climate will cause these inflows and yields to be reduced.

Water from the Quickup dam is pumped to Settlers Road tank from where it gravitates to the water treatment plant at Denmark dam. The treatment process for the raw water includes: chemical dosing, sedimentation, clarification, filtration, and disinfection by chlorination and ultra violet light. The treated water is then pumped to the Horsley Road service reservoir. Denmark dam has been used sparingly over recent years, and now operates as an emergency back-up source following the recent upgrade of the treatment plant.

The Denmark water treatment plant now allows improved water treatment prior to distribution to the consumers. This can include:

- dosing to remove manganese
- sand filtration
- ultra filtration
- reverse osmosis (optional)
- UV disinfection
- chlorination.

It should be recognised that although water treatments 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, 2004* (ADWG) (NHMRC & NRMCC 2004a) and

reflects a risk-based, multiple-barrier approach for providing safe drinking water to consumers. This combination of catchment protection and water treatment will deliver a more reliable, safer and lower-cost drinking water to consumers than either approach could achieve individually.

For more information on why it is so important to protect our catchments, please 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* (WA). 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 abstracting water (pumping water from a river or creek) within proclaimed surface water areas throughout the state. Some exemptions may apply such as abstracting water for domestic purposes only.

The Quickup River Dam Catchment Area is not located within a proclaimed surface water area under the *Rights in Water and Irrigation Act 1914* (WA) and therefore a licence is not required for abstraction.

The current number of water services in Denmark is 1947 and annual production from all sources in 2007/08 was close to 447 ML, with 284 ML taken from Quickup dam.

### 1.2.2 Water planning

During 2010, the Department of Water and the Water Corporation provided advice on future water sources for the Lower Great Southern (see the Department of Water's *Lower Great Southern water resource development strategy, June 2010* and Water Corporation's *Water Forever: Lower Great Southern, 2010*). Albany, Mt Barker and Denmark are projected to require an additional 50 to 60 per cent increase in public water supply. Denmark needs a new water source to meet future water demand.

The Department of Water will continue to support the integration of land and water planning and guide the Water Corporation on developing short-, medium- and long-term water sources for the town of Denmark.

### 1.2.3 Future water needs

The Water Corporation is predicting an increased demand in water as a result of Denmark's projected growth. Based on the current trends, total annual consumption is expected to be around 600 ML in 2012 and about 1 000 ML by 2030.

The Water Corporation is looking into raising Quickup's dam wall in the future to provide additional capacity to meet Denmark's predicted water demand.

The use of the Mitchell River as a pump-back (weir) or another location on the Denmark River are two of the short- to medium-term options being investigated by Water Corporation as part of their planning for future water sources in the south coast. The water is planned to be pumped to Quickup dam for storage. These options will need to be assessed by the Department of Environment and Conservation and the Department of Water before a final decision can be made.

The Demark dam is currently used as an emergency source of water for supplementing the water requirements for the town of Denmark.

## 1.3 Characteristics of the catchment

### 1.3.1 Physical environment

The Quickup River Dam Catchment Area is part of a laterite plateau consisting of sands and ironstone gravels over mottled clays, which is dissected by incised valleys that have moderate to steep slopes of yellow podsollic soils and red earths. Drainage is influenced by granite outcrops that form rounded hills about 200 m high. The river systems drain onto low-lying coastal plains, which contain a series of groundwater-dependant swamps and lakes.

The natural vegetation of the catchment is dominated by forests of jarrah and marri. Only a very small stand of karri occurs on privately-owned land.

### 1.3.2 Climate

The area has a Mediterranean-type climate, characterised by warm, dry summers and cool, wet winters. The annual average temperature is around 15 °C.

The long-term average annual rainfall between 1951 and 1984 over the catchment was about 995 mm (Bureau of Meteorology, 2011). Most of the rain falls between May and September. Annual average evaporation is 1 325 mm.

### 1.3.3 Hydrology

The catchment for Quickup dam has an area of 29.7 km<sup>2</sup> and varies in elevation from 50 m Australian Height Datum (AHD) at the dam to about 200 m AHD at the head (top) of the catchment. The highest point in the catchment is the eastern flank of Mt Lindesay at just over 280 m AHD.

Surface run-off over the winter months contributes 65 per cent of water inflow to the dam and subsurface flow all year round contributes about 35 per cent (Water Corporation, 2004).

## 1.4 How is the drinking water protected?

The Quickup River Dam Catchment Area was proclaimed in 1990 under the *Country Areas Water Supply Act 1947 (WA)* for the purpose of public drinking water source protection (Figure A2). By-laws created under this Act enable the Department of

Water to control potentially polluting activities, regulate land use, inspect premises and take the necessary steps to prevent or clean up pollution.

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 for the protection of water quality.

The Water Corporation regularly patrols and surveys the catchment area to identify risks to water quality and enforce the by-laws where required. To find out more about by-laws, please see section 4.6: *Enforcing by-laws and surveying the area*.

In 2004 the Water Corporation prepared the *Quickup River Catchment Area drinking water source protection assessment*. It has information about the catchment, identifies risks to water quality and recommends strategies to manage the risks. This document replaces it, as it provides more up-to-date information.

The Shire of Denmark's local planning scheme does not recognise the Quickup River Dam Catchment Area as a special control area. However, the Department of Water recommends that the Shire of Denmark include this public drinking water source area (PDWSA) a special control area in their local planning scheme. The types of development supported in a PDWSA are described in the Department of Water's Water quality protection note (WQPN) no.25: *Land use compatibility in public drinking water source areas*.

## 1.5 Other useful information

The Denmark River Catchment Area is a recovery catchment under the State's Salinity Action Plan (Department of Conservation and Land Management, 1996), and a recovery plan is presently being prepared by the Department of Water. The establishment of plantations in the upper Denmark River catchment area has seen a considerable reduction in salinity levels, and salinity is expected to reach the target levels of 500 mg/l TDS before the planned date of 2020. The retention of native vegetation and maintenance of plantation coverage are expected to be key themes to the recovery plan.

Wilson Inlet is a significant south coast estuary and is showing signs of eutrophication. The excess nutrient levels lead to considerable algae and seagrass growth in the inlet. The Wilson Inlet Nutrient Reduction Plan (WINRP) (Water and Rivers Commission et al, 2003) is a cross-agency and community plan with an objective of reducing nutrient levels in the inlet. Reducing nutrient levels from the Denmark River catchment area is a key aspect of the WINRP, and is consistent with the objectives of this DWSPP.

The Department of Water and the Water Corporation have jointly investigated future water sources for the Albany-Walpole area, with the outline of water source proposals being contained in the Water Corporation's *Water Forever: Lower Great Southern*, 2010. The Quickup catchment area will continue to provide water to Denmark as part of this future water source planning process.

## 2 Common contamination risks

Land- and water-based uses and 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 on 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 2004b). Contaminants can also interfere with water treatment processes, and destroy water supply infrastructure (such as pipes).

The ADWG outline criteria for acceptable drinking water quality to protect human health, aesthetics and 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

Pathogens are types of microorganisms that are capable of causing disease. These include bacteria, protozoa and viruses. In drinking-water supplies, pathogens that can cause illness 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 (while fishing, marroning, swimming or the like) or domestic animals come into contact with a body of water, pathogens may enter that water source. This 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 runoff 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 are often used as indicator bacteria for identifying faecal contamination in a water source.

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 2004a).

When people consume drinking water contaminated with pathogens the effects vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes even death. During 2000, seven people died in Walkerton, Canada, because the town's water supply was contaminated by a pathogenic strain of *E. coli* and campylobacter (NHMRC & NRMCC 2004b). 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 very 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 2004a). A number of these chemicals (organic and inorganic) are potentially toxic to humans.

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills, incorrect use or leakage from storage areas. In 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 & NRMMC 2004a).

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 Quickup River Dam Catchment Area for microbiological, health-related and aesthetic (non-health-related) characteristics. This data shows the quality of water in the catchment. An assessment of the drinking water quality 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 Quickup River Dam Catchment Area from March 2006 to February 2011 is presented in Appendix B. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at <[www.watercorporation.com.au](http://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 Quickup River Dam Catchment Area contains around 97 per cent of crown land. The majority of this crown land is part of the Mount Lindesay National Park (reserve A47891), with smaller parts of state forest (State Forest 64) and unallocated crown land in close proximity to the Quickup dam. Only about 3 per cent of privately-owned land is situated along the western edge of the dam. The Water Corporation recently acquired a significant parcel of land adjacent to the dam for the purpose of protecting the drinking water source. Current land uses and activities and their risks to the drinking water source are described below. Table 1, at the end of this section, summarises this information in an easy-to-read format. Appendix C displays a more detailed risk assessment. The land use, activities and land tenure in the Quickup River Dam Catchment Area are depicted in Figure A3.

The Shire of Denmark's *Local planning scheme no.3* map denotes the crown land situated in the Quickup catchment area as public use, and the privately-owned land in the catchment area is zoned rural. However, the local planning scheme does not recognise the Quickup River Dam Catchment Area as a special control area for the purpose of water resource protection consistent with State planning policy no. 2.7: *Public drinking water source policy*.

Land uses and activities within the Quickup River Dam Catchment Area have the potential to impact on water quality. These include:

- crown land (e.g. state forest, national parks, forest conservation areas)
- roads and tracks (unsealed)
- general agriculture (pasture and cattle grazing) on rural land
- small nursery
- infrastructure (e.g. power lines, pipelines, and associated roads and tracks)

These land uses and activities are illustrated in Figure A4 and some photographs are provided in Appendix D.

### 3.2.1 Crown land

Most of the Quickup River Dam Catchment Area is located in national park and state forest, which are vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation (DEC) under the *Conservation and Land Management Act 1984* (WA). This area of national park and state forest is managed under the *Walpole wilderness area and adjacent parks and reserves management plan no. 61*, which was gazetted on 7 July 2009, and the *Forest management plan 2004–2013*.

#### *National park*

There is one large national park within the catchment area that is unofficially known as the Mt Lindesay National Park (Crown Reserve 47891). This national park was established in 2004 as part of the Walpole wilderness initiative. The reserve is vested in the Conservation Commission of Western Australia and managed by the DEC.

National parks are used for restoring the natural environment, protecting indigenous flora and fauna and preserving any features of archaeological, historic or scientific interests. Recreational uses are also commonly found in national parks.

There is no evidence of organised recreational use in the national park within the Quickup River Dam Catchment Area, although there is likely to be some use of tracks and trails for individual pursuits such as firewood collection, horse riding and off-road vehicles.

Unauthorised swimming and marroning have been reported to occur in the dam and measures need to be taken to prevent this access and to educate the community of the health risks posed by direct human contact with this water body.

There are no designated horse-riding trails, cycling trails or camping sites within the Quickup catchment area. The *Walpole wilderness area and adjacent parks and reserves management plan no. 61* (see page 157) identifies potential for a developed recreation site at the junction of Nutcracker Road and Denmark-Mt Barker Road (the site is located outside the reservoir protection zone). The proposed site is intended to be a key entry and interpretation site with universal access to the area. However, detailed plans have not yet been drawn up for this conceptual proposal.

Consultation should occur with Department of Water and Water Corporation prior to development of any potential sites and should be in accordance with Department of Water's Statewide policy no. 13: *Policy and guidelines for recreation within public drinking water source areas on crown land* (Policy 13). Please note that the issue of recreation within drinking water catchments has been reviewed by the Standing Committee on Public Administration. The findings of the inquiry were reported in September 2010 and are currently being considered by government. The outcome of this review will be reflected in a review of Policy 13, and should be considered when assessing any proposed recreation activities within the proposed Quickup River Dam Catchment Area.

DEC often applies the chemical *phophite* as stem injections and broad-scale foliar spraying at particular sites to control the introduction and spread of dieback (*Phytophthora cinnamomi*).

Feral animal (e.g. feral pigs and foxes) and weed control is undertaken by DEC in national park and state forest covered by the Quickup River Dam Catchment Area. DEC is a member of the community-based Lake Muir-Denbarker Feral Pig Control Group, which has an active feral pig control program in place extending between Lake Muir and Denbarker. Shooting and trapping for controlling pigs, and the use of 1080 baits for controlling foxes have been successfully used for over 10 years.

Rare plants and the Mount Lindesay threatened ecological community occur mainly in the upper catchment and are managed by DEC on a site basis through feral animal and weed control, dieback management and other activities.

### *Forest conservation areas*

Most of the remaining crown land in this catchment is part of State Forest 64, which is proposed to be reclassified under section 62(1) of the *Conservation and Land Management Act 1984* as 'forest conservation area' in the *Walpole wilderness and adjacent parks and reserves management plan* (DEC and Conservation Commission of WA 2008). No potential future recreational opportunities have been identified for State Forest 64 in DEC's management plan.

There are two designated firewood collection areas (Hay location) located in the proposed reservoir protection zone (in close proximity to the Quickup dam). Advice was received from the DEC's Frankland District that these areas are not viable firewood collection areas anymore, and the current areas will be reviewed and relocated. The Department of Water's Policy 13 identifies firewood gathering in a reservoir protection zone (RPZ) as an incompatible activity.

DEC manages state forest and timber reserves according to the *Forest management plan 2004–2013* (FMP). The purpose of state forest and timber reserves as outlined in the FMP includes conservation, recreation, timber production on a sustainable yield basis, water catchment protection and other purposes prescribed by the Conservation and Land Management Regulations 2002 (e.g. beekeeping), and the *Walpole wilderness area and adjacent parks and reserves management plan no. 61*, 2009.

### *Unallocated crown land*

Unallocated crown land is located to the east (west of Kernutts Road) of the Quickup dam and is partly contained in the RPZ. This portion of land is not vested with any government agency. However, the *Forest management plan 2004-2013* and *Walpole wilderness area and adjacent parks and reserves management plan no. 61* both propose that this area (excluding location 7648) be added to state forest with the classification of forest conservation area.

The portion of land that is located within the proposed RPZ should be managed for the purpose of water source protection. The land situated within the RPZ is considered to be most vulnerable to contamination, and any risk of contamination should be prevented.

#### 3.2.2 Unauthorised recreation

There have been reports of people swimming, fishing and marroning in the dam, particularly during the summer season. Body contact with the water can result in pathogen contamination (see section 2.2). This has been assigned a high level of risk to the drinking water source (see Table 1 in Appendix C). Measures need to be taken to prevent access (e.g. on foot or vehicle) to the reservoir, and to educate the community of the health risks posed by direct human contact with the reservoir water body.

#### 3.2.3 Roads and tracks

There are several fire management tracks in the national park and state forest. DEC maintains these tracks on a regular basis to ensure adequate access for undertaking prescribed burns, and in the event of the need to manage any bushfires. A number of tracks are gated, but other tracks provide open access for people to enter the Quickup River Dam Catchment Area. Vehicle access (away from designated tracks and public roads) is a prohibited activity in a proclaimed public drinking water source area. The erosion caused by vehicles may contribute to turbidity in the reservoir. Hydrocarbon contamination can also come from vehicle accidents, leaks and spills. Therefore, the road network (unsealed roads in catchments) within the Quickup River Dam Catchment Area should be reviewed, and those tracks that are not essential to the management of the catchment should be closed to the public or rehabilitated. Gates and signage can assist in controlling access to the catchment area.

The Denmark-Mount Barker Road is a major regional transportation route between two growing communities. The road traverses the RPZ in a proposed Priority 1 area.

The road has potential to have a high impact on water quality if fuel or chemical spills occur as a result of a road accident. An emergency response plan should be put in place under the responsibility of the regional emergency management district to address this issue.

In general new major roads and associated infrastructure are not supported in a P1 area and RPZ, unless it can be demonstrated alternative siting is impractical or important to the state's interest.

The Department of Water recognises Main Road's statutory obligation to provide a safe and efficient road network for the public in Western Australia. Main Roads indicated in their submission that they may undertake works to upgrade Denmark-Mount Barker Road in the future, including realignment, widening, building a dual use path, resurfacing, constructing additional infrastructure including detention basins, and perform general maintenance. The Department of Water recommends that best management practices are employed in PDWSAs to protect the quality of the drinking water source.

Any further extension or upgrade of the Denmark-Mount Barker Road (for the portion located within the Quickup River Dam Catchment Area) should consider the Department of Water's WQPN no. 44 *Roads near sensitive water resources*.

### 3.2.4 Fire management

Fire management is an essential land management practice in forested surface water catchments, which potentially can reduce the impacts of bushfires. DEC is the lead agency for fire management (e.g. prescribed burning, fire suppression and fire control) in the state's conservation reserves and state forests. Fire management is regulated by legislation such as the *Bushfires Act 1954 (WA)* and *Conservation and Land Management Act 1984 (WA)*, and is guided by DEC's Policy statement no. 19: *Fire management policy*.

The Quickup River Dam Catchment Area is contained in the Walpole Wilderness, where a range of fire management options (including mosaic burning) are being implemented, to not only reduce the social and economic impacts that may arise from bushfires, but also the impacts on biodiversity values. Improved fire management practices may be developed by DEC based on the findings of the fire mosaic project research trial run in the Walpole-Nornalup National Park, once completed.

Current burning advice, maps of the autumn 2011 burn program and maps for all six seasons (autumn 2011 to spring 2013) are available on the Department of Environment and Conservation's website.

There is a large area in the upper Quickup River Dam Catchment Area that DEC manages as a Fire Exclusion Reference Area (FERA). This area is bounded by Nutcracker Road, Stan Road, Sandy Track and the Denmark-Mt Barker Road.

DEC's definition of a FERA is an area from which fire has been deliberately excluded to provide a reference site for scientific studies of the effect of fire on the environment. Areas selected should be broadly representative of the landscape within which they are located. Areas less than approximately 500 hectares are valuable for scientific study if they have not been burnt for a long period of time. DEC's records indicate that this area has not been burnt for at least 13 years.

### 3.2.5 General agriculture (rural land)

The private land on the western edge of the dam is used for broadacre farming. Cattle grazing occurs on this land within the proposed reservoir protection zone.

Some broadacre cropping and the operation of a small, private nursery also occur within the catchment. Contamination risks associated with cropping and nurseries include nutrient and chemical contamination from the use of fertilisers and pesticides.

Wastewater from farm residences is disposed of via on-site septic tank systems, which present a risk of pathogen and nutrient contamination, albeit a low risk given the distance to the reservoir.

The privately-owned properties are well fenced, restricting stock movement to considerable distances from the water body.

It is noted that rural land uses are well-managed. The Department of Water recognises that the rural land uses are consistent with the zoning of the land and that they will continue. The Department of Water also acknowledges that diversification or rural land uses may occur in the future, as it has in the past.

During the public consultation process the owners of this rural land advised that the land has been held in private-ownership since it was first surveyed and released for agriculture land use over 100 years ago. Depending on market opportunities the owners may grow crop (use fertilizer, pesticides and other chemicals) or increase the stocking rates on the land in the future. A new shed and extra dwelling are also planned for the farm; both buildings are supported by the Department of Water.

All of the existing land uses and activities in the Quickup River Dam Catchment Areas can continue. New potential land uses consistent with the rural zoning of the farm are also able to occur. We recommend that best management practices are considered in all PDWSAs to protect the quality of drinking water. Any new developments and land uses or expansion of existing land uses or activities should consider the recommendations in this plan. The approval of any such change is managed by the Local Government Agency through state and local government planning processes. The Department of Water will advise the Shire of Denmark on any such proposals consistent with the advice of this plan. The Department of Water can also provide advice on any such proposals directly to land owners.

### 3.2.6 Water Corporation land

In 2009/2010 the Water Corporation finalised the strategic purchase of a significant area of farm land adjacent to Quickup dam for the purpose of water source protection and future infrastructure development needs.

Run-off from rural zoned land adjacent to an area to the west of the catchment may contribute to *Escherichia coli* detections in the raw water. This run-off may be transported via the stormwater system along the western side of the road to the Quickup dam. This should be investigated and protective measures (e.g. divert stormwater run-off around the dam and outside the catchment area) be taken to ensure the quality of the drinking water source is not affected.

Water from the Denmark dam (emergency supply) is occasionally used to augment the Quickup dam via a diversion pipe. This pipe enters the Quickup dam near the off-take area, from where raw water is transported to the Denmark water treatment plant. The location of this pipe should be investigated, and if required, extended to ensure the longest possible retention time of raw water can be achieved in the Quickup dam.

### 3.2.7 Mining

There are no known mineral resources within the catchment area, but the area is largely underlain by metamorphic rock that has the potential to host a variety of minerals. Surficial laterite, which covers much of the area, has the potential to host bauxite. The southern portion of the catchment area is covered by mining tenement applications. Any conditions on proposed mining tenements and mining activities within the Quickup River Dam Catchment Areas are placed via the Department of Mines and Petroleum in consultation with the Department of Water.

### 3.2.8 Native title claims

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 that cover the Quickup River Dam Catchment Area. These are Southern Noongar (WAD 6134/98) and Wagyl Kaip (WAD 6286/98).

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



Table 1 Land use and potential water quality risks

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance
Swimming, fishing and marroning in the dam	Pathogens from body contact and bait used for fishing and marroning	High	Swimming, fishing and marroning are incompatible in a PDWSA.	Statewide policy no. 13: <i>Policy and guidelines for recreation within PDWSA on crown land</i>
Recreational hunting	Pathogens from human and animal waste and carcasses	High	Hunting is an incompatible recreational activity in a PDWSA	
Agriculture – extensive (cattle grazing)	Pathogens from animals	High	These activities are compatible with conditions in a P2 area.	WQPN no. 25: <i>Land use compatibilities in PDWSA</i>
Rural living in RPZ (including small nursery)	Pathogens, and fertiliser and pesticide use	High	All existing and approved land uses and activities in a proclaimed area can continue. Special constraints apply for chemical storage and use.	WQPN no. 32: <i>Nurseries and garden centres, PSC88, Statewide policy no. 2: Pesticide use in PDWSA</i>
Fire management (bushfires)	Turbidity and ash from burning large areas of bushland.	Medium	Accepted with best management practices (see Appendix C).	Fire management strategies implemented by DEC
Public roads (e.g. Denmark- Mt Barker Road)	Hydrocarbons, pesticides and turbidity	Medium	New roads in P1 areas and RPZs are normally opposed by this department. Existing sealed roads are acceptable with conditions in P1 and P2 areas, and RPZs.	WQPN no. 44: <i>Roads near sensitive water resources, PSC88, Statewide policy no. 2: Pesticide use in PDWSA</i>
Firewood collection (Hay Block firewood areas), wildflower picking, and seed collection	Pathogens from human and domestic animals	Low	Firewood collection areas are not supported in RPZs.	WQPN no 25: <i>Land use compatibilities in PDWSA</i>

## 4 Protecting your drinking water source

The objective of this drinking water source protection plan is to preserve water quality at its current level and where practical achieve an improvement, so as to provide a safe, good quality drinking water supply to Denmark.

This plan recognises the right of existing approved land uses to continue to operate. The minimisation of risks to water quality is imperative for the protection of public health and the Department of Water will work with land owners, managers or operators to implement best management practices.

### 4.1 Proclaiming the public drinking water source area

The proclamation process begins with public consultation undertaken as part of the development of this drinking water source protection plan. This plan recommends proclamation of an amended Quickup River Dam Catchment Area under the *Country Areas Water Supply Act 1947 (WA)*.

The Quickup River Dam Catchment Area was originally proclaimed under the *Country Areas Water Supply Act 1947 (WA)* in 1990. Due to improved information from a recent hydrological assessment of the catchment, we propose to change the boundary of this catchment area as shown in Figure A2, to reflect this new data.

Once the changed catchment area is proclaimed, the Shire of Denmark should incorporate the 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. There is no requirement to obtain a licence or permit for the existing land uses to operate within this catchment.

All existing and 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.

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 resource 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. For further detail, please refer to our WQPN no. 25: *Land use compatibility in public drinking water source areas*.

The proposed priority areas for the Quickup River Dam Catchment Area have been determined in accordance with current Department of Water policy. These areas are described below and displayed in Figure A5. 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*.

We propose to assign the Water Corporation land and all crown land in the Quickup River Dam Catchment Area as P1 for the reasons stated below. DEC is generally supportive of the proposed P1 area and RPZ over DEC-managed land in the catchment area.

- The source currently acts as the main source of water for the town of Denmark and is considered a long-term water source with a high strategic value.
- Water from this source will constitute a strategic supply to the Denmark town water supply scheme, so it should be afforded the highest feasible level of protection.
- The land held by Water Corporation is directly located along the western portion of the dam and is considered of strategic importance because it provides a buffer zone between private rural land and the dam.
- Existing land uses on the crown land are considered compatible with P1 source-protection objectives.
- The existing native vegetation on crown and Water Corporation's land currently provides limited input of contaminants and significant water quality protection and should be retained and protected.

We propose to assign the private rural zoned land as P2 for the following reasons:

- The land is privately owned and zoned rural.
- Rural land uses are considered compatible within a P2 area.
- Existing land uses in these areas can be managed for P2 source protection objectives by implementing best management practices.

### 4.3 Defining protection zones

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

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 the dam wall. The RPZ that occur in the *Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)* are legislatively set at a distance of 2 km from the high water level of a dam. For consistency, and where reasonable, we also apply RPZs to country sources. In proposed 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. This legislation is not yet in force.

A 2 km RPZ around Quickup dam is proposed for protecting the Denmark drinking water source. Most of the area contained in the RPZ is crown land. A small number of private lots are located in the RPZ. Public access is generally not supported on crown land within RPZs, however, RPZs do not restrict access to privately owned property or public roads. The proposed RPZ for the Quickup River Dam Catchment Area is shown in Figure A5.

### 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 Statement of planning policy no.2.7: *Public drinking water source policy* (2003) it is appropriate that the Quickup River Dam Catchment Area, its priority areas and protection zone be recognised in the Shire of Denmark's local planning scheme. Any development proposals within the Quickup River Dam 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 Parliamentary Committee reviews instrumental in the integration of water quality protection and land use planning in WA.

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 improve

their facilities and reduce water quality contamination risks (see section 4.6: *Using best management practices*).

In strategically significant areas the department has developed a policy that allows it to approach landowners and consider buying land or negotiating measures to reduce contamination risks.

## 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. 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. Examples include Statewide policy no.13: *Policy and guidelines for recreation within public drinking water source areas on crown land* (Water and Rivers Commission 2003); Policy statement no. 18: *Recreation, Tourism and Visitor Services* (DEC, 2007); Statewide policy no. 2: *Pesticide use in public drinking water source areas* (Water and Rivers Commission 2000); the Department of Health circular PSC 88: *Use of herbicides in water catchment areas* (2007); and the Department of Water's WQPN no.44: *Roads near sensitive water resources* (2006), which are listed in this plan's *References* section.

Education and awareness-raising (such as through providing information on signs and publications) are key mechanisms for protecting water quality, especially for people visiting the area. We will produce a brochure once this plan is finalised, describing the Quickup River Dam Catchment Area, its location and the main threats to its water quality. The brochure will inform people in simple terms about the drinking water source and why it is important to protect it. We will make it available to the community and other stakeholders.

## 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* (WA). 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 are 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 existing delegation of surveillance and by-law enforcement to the Water Corporation be continued, and signage is maintained.

## 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 Shire of Denmark's local emergency management committee (LEMC), through the Great Southern emergency management district, should be familiar with the location and purpose of the Quickup River Dam Catchment Area. A locality plan will be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. DEC is the lead agency for bushfire control management for most of the catchment area outside of the gazetted fire emergency response zone. The Water Corporation should have an advisory role to the HAZMAT team for incidents in the Quickup River Dam 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 Quickup River Dam 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

Table 1 (found at the end of Section 3) identifies the potential water quality risks associated with existing land uses in the Quickup River Dam Catchment Area. Further information and the recommended protection strategies to deal with those risks are outlined in Appendix C.

When the final *Quickup River Dam Catchment Area drinking water source protection plan* is complete, an implementation strategy will be drawn up based on the recommendations in section 5 and Appendix C.

## 5 Recommendations

The following recommendations apply to the entire Quickup River Dam Catchment Area. The bracketed stakeholders are those expected to have a key responsibility for, or a primary interest in the relevant recommendation being implemented.

1. Amend the boundary of the Quickup River Dam Catchment Area under the *Country Areas Water Supply Act 1947* (WA). (Department of Water)
2. Develop an implementation strategy for this plan's recommendations (including the recommended protection strategies as detailed in Appendix C) showing responsible stakeholders and planned timeframes. (Department of Water, applicable stakeholders)
3. Incorporate this plan and reflect the identified Quickup River Dam Catchment Area boundary, its P1 and P2 areas and RPZ in the Shire of Denmark's local planning scheme in accordance with the WAPC's Statement of planning policy no.2.7: *Public drinking water source policy*. (Shire of Denmark)
4. All development proposals within the Quickup River Dam Catchment Area that are inconsistent with the Department of Water's Water quality protection note no.25: *Land use compatibility in public drinking water source areas* or recommendations in this plan should be referred to the Department of Water for advice and recommendations. (Department of Planning, Shire of Denmark, proponents of proposals)
5. Incidents covered by WESTPLAN–HAZMAT in the Quickup River Dam Catchment Area should be addressed by ensuring that:
  - the Shire of Denmark's LEMC is aware of the location and purpose of the Quickup River Dam Catchment Area
  - the locality plan for the Quickup River Dam Catchment Area is provided to the Fire Emergency Services Authority (FESA) headquarters for the HAZMAT emergency advisory team
  - the Water Corporation acts in an advisory role during incidents in the Quickup River Dam Catchment Area
  - personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Quickup River Dam Catchment Area and information to help them recognise the potential impacts of spills on drinking water quality. (Department of Water and Water Corporation)
6. Signs located along the boundary of the Quickup River Dam Catchment Area should be maintained to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number and be purpose-designed for their intended audience (e.g. vehicles travelling along Denmark-Mt Barker Road). (Water Corporation)
7. The location (proximity to off-take area in Quickup dam) of the diversion pipe that runs from the Denmark dam to Quickup dam should be reviewed for the purpose

of increasing the retention time in the reservoir. (Water Corporation and Department of Health).

8. The elevated microbiological counts in the water samples taken from the Quickup dam should be further investigated to determine the source(s) of contamination and manage the risk to drinking water quality. (Water Corporation)
9. The feasibility of providing a stormwater system along the western side of the road leading to the Quickup dam should be investigated. This could divert stormwater run-off around the dam outside the catchment area. (Water Corporation)
10. The two firewood collection areas within the RPZ should be reviewed and possibly relocated to the outside of the Quickup River Dam Catchment Area. (Department of Environment and Conservation, Department of Water)
11. Review the road network (unsealed roads in catchment), and close restrict access to, or rehabilitate roads that are not essential. (Department of Environment and Conservation and Department of Water)
12. Vesting should be sought for the unallocated crown land along the eastern side of the dam (within the RPZ) for a purpose compatible with water source protection. (Department of Water or Department of Environment and Conservation)
13. Review this plan after five years. (Department of Water)



# Appendices

## Appendix A – Figures

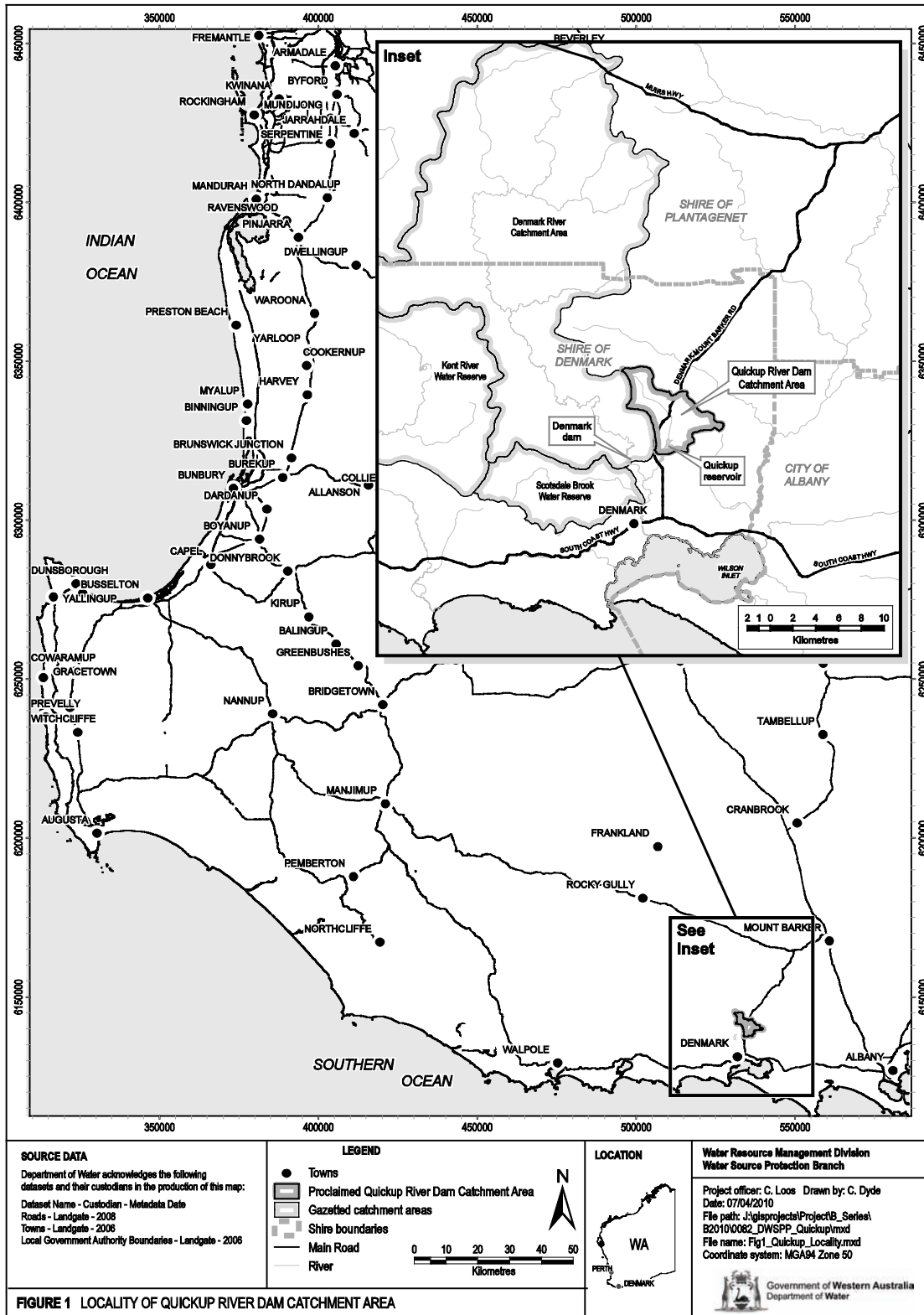


Figure A1 Quickup River Dam Catchment Area locality map

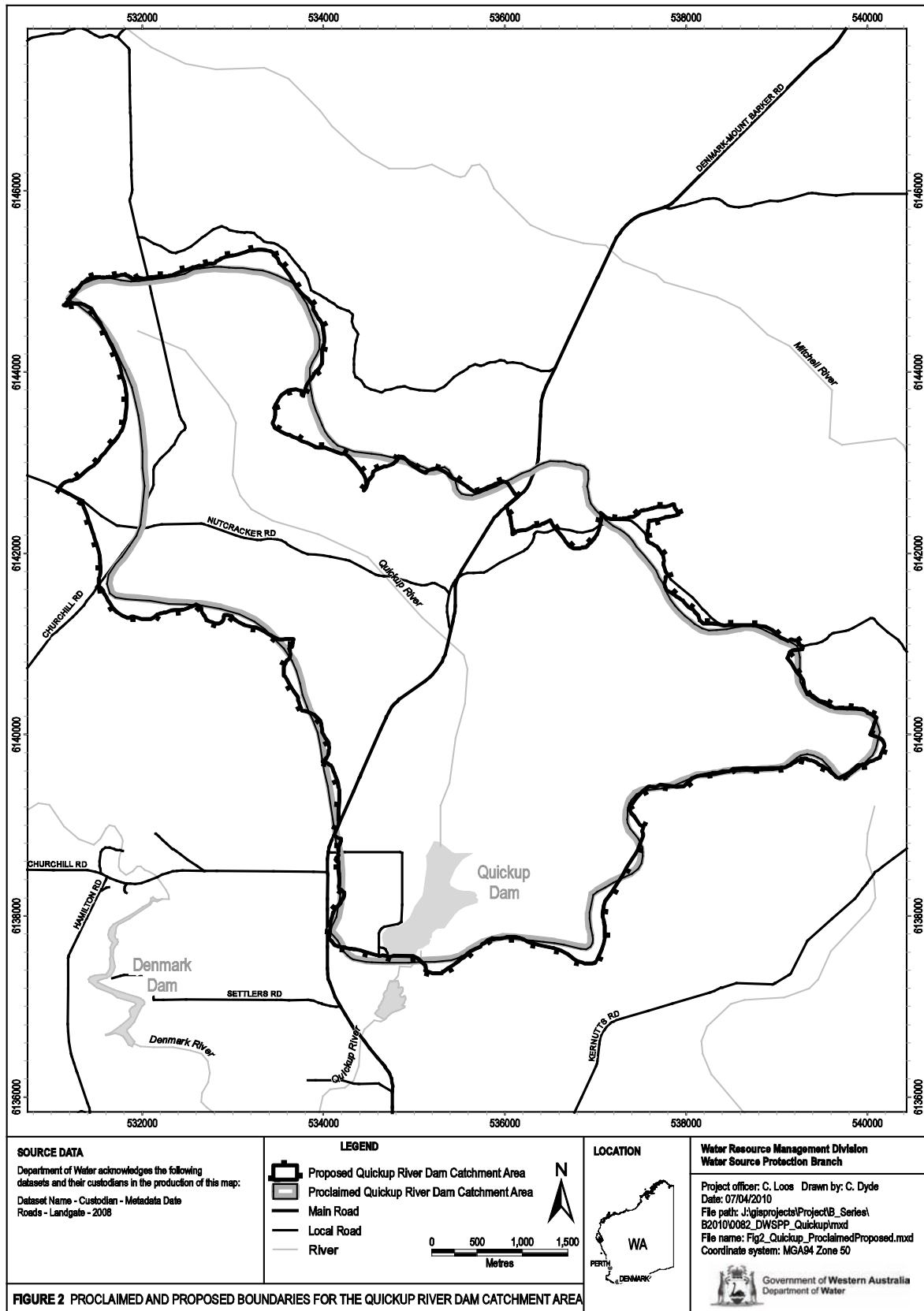


Figure A2 Proclamed and proposed boundaries for the Quickup River Dam Catchment Area

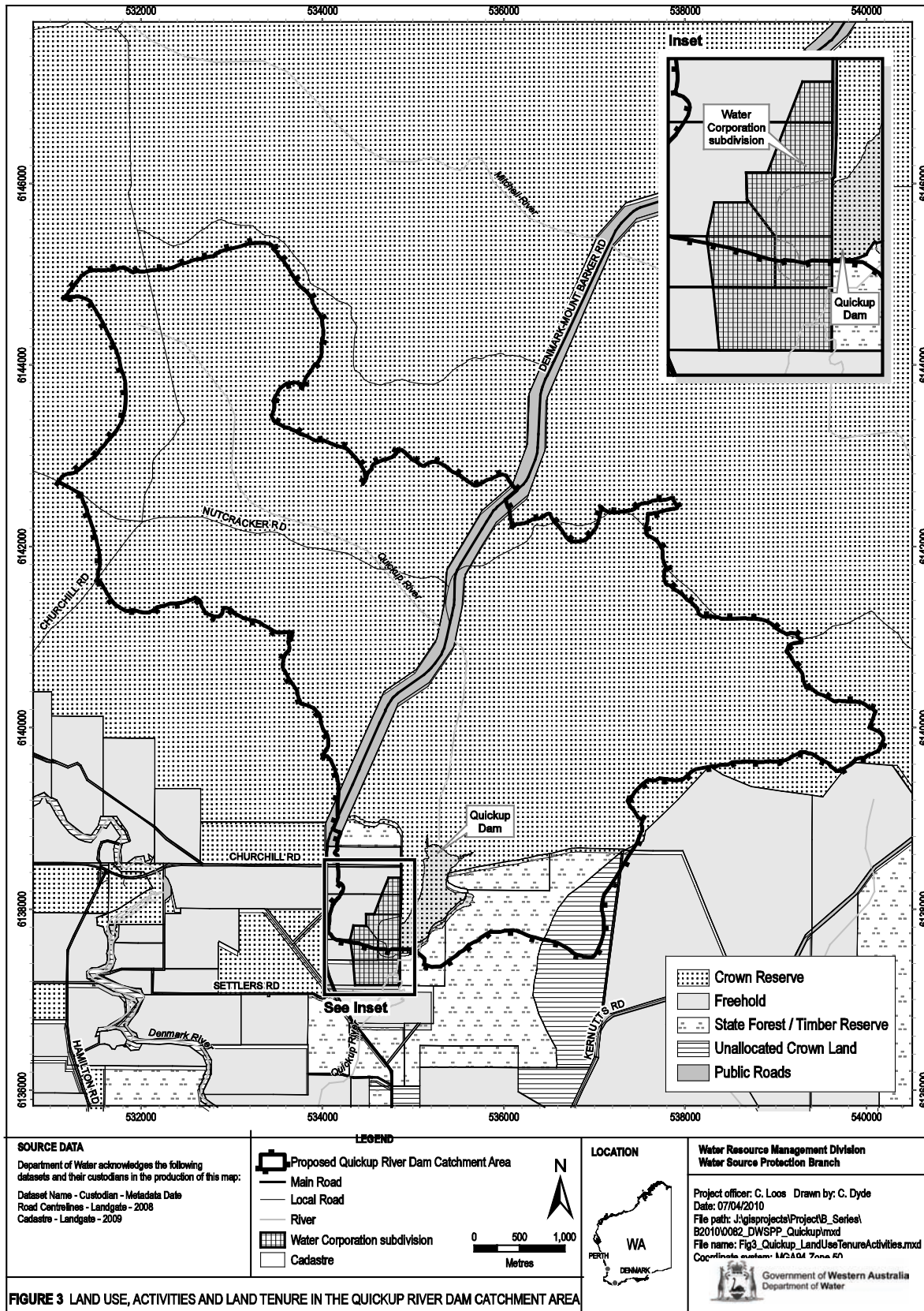


Figure A3 Land use, activities and tenure in the proposed Quickup River Dam Catchment Area

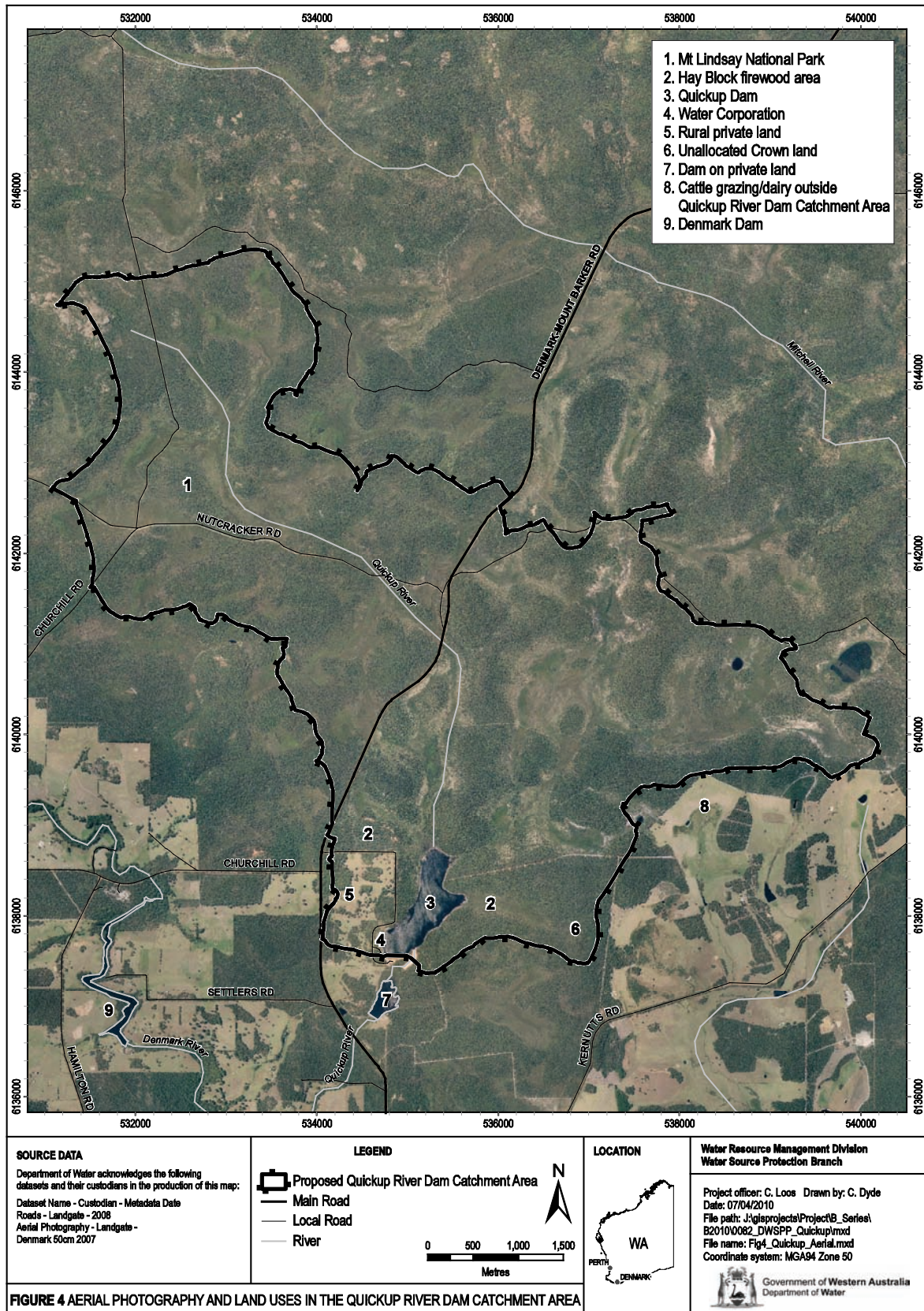


Figure A4 Quickup River Dam Catchment Area – aerial and other land use information

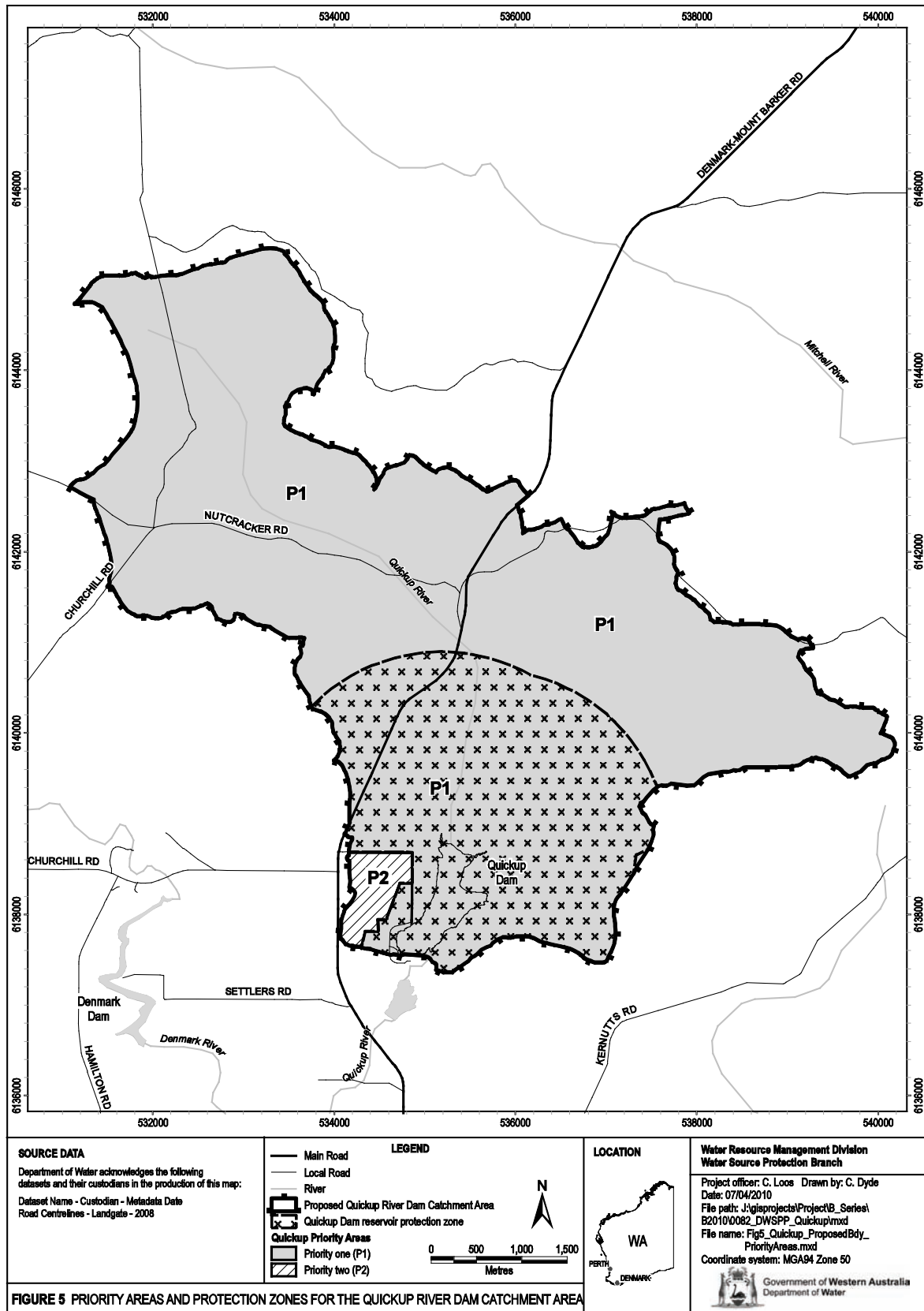


Figure A5 Proposed boundary, priority areas and protection zone for Quickup River Dam Catchment Area

## 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 Quickup Dam in accordance with the *Australian drinking water guidelines* (ADWG) and interpretations agreed to with the Department of Health. The raw water is regularly monitored for:

- a. Aesthetic-related characteristics**– (non-health related)
- b. Health-related characteristics**
  - health related chemicals
  - microbiological contaminants

Following is data representative of the quality of raw water in Quickup Dam. In the absence of specific guidelines for raw water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customers tap. Results that exceed the ADWG have been shaded to give an indication of potential raw water quality issues associated with this source.

It is important to appreciate that the raw water data presented does not represent the quality of drinking water distributed to the public. Barriers such as storage and extensive water treatment, to name a few, exist downstream of the raw water to ensure it meets the requirements of the ADWG. For more information on the quality of drinking water supplied to Denmark refer to the most recent Water Corporation Drinking Water Quality Annual Report at [http://www.watercorporation.com.au/W/waterquality\\_annualreport.cfm?uid=2377-9937-9579-7091](http://www.watercorporation.com.au/W/waterquality_annualreport.cfm?uid=2377-9937-9579-7091).

### **Aesthetic-related characteristics**

Aesthetic water quality analyses for raw water from Quickup Dam are summarised in Table 1.

The values are taken from ongoing monitoring for the period March 2006 to February 2011. All values are in milligrams per litre (mg/L) unless stated otherwise. Any water quality parameters that have been detected are reported, those that have on occasion exceeded the ADWG are shaded.

Table 2 Aesthetic-related detections for Quickup Dam

Parameter	Units	ADWG aesthetic guideline value*	Denmark Quickup Dam SP	
			Range	Median
Chloride	mg/L	250	165 - 195	180
Colour – True	TCU	15	100 - >200	>200
Hardness as CaCO <sub>3</sub>	mg/L	200	60 - 70	65
Iron unfiltered	mg/L	0.3	1.2 – 5.5	2.6
Sodium	mg/L	180	89 - 235	120
Total filterable solids by summation	mg/L	500	364 - 421	392.5
Turbidity	NTU	5	2.9 - 16	8.2
pH measured in laboratory	No unit	6.5 – 8.5	4.7 – 6.65	5.805

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

\* Results that exceed the ADWG have been shaded to give an indication of potential raw water quality issues associated with this source.

### Health-related characteristics

#### Health parameters

Raw water from Quickup Dam is analysed for health related chemicals including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that have been measured at detectable levels in the source between March 2006 and February 2011 are summarised in Table 2. No health parameter exceeded the ADWG.

Table 3 Health related detections for Quickup Dam

Parameter	Units	ADWG health guideline value*	Denmark Quickup Dam SP	
			Range	Median
Barium <sup>^</sup>	mg/L	0.7	0.001 – 0.001	0.001
Boron <sup>^</sup>	mg/L	4	0.05 – 0.05	0.05
Chromium	mg/L	0.05	0.0006 – 0.001	0.0008
Copper	mg/L	2	0.018 – 0.03	0.02
Iodide <sup>^</sup>	mg/L	0.1	0.03 – 0.03	0.03
Nitrate as nitrogen <sup>^</sup>	mg/L	11.29	0.094 – 0.064	0.094
Nitrite as nitrogen <sup>^</sup>	mg/L	0.91	0.026 – 0.026	0.026

Parameter	Units	ADWG health guideline value*	Denmark Quickup Dam SP	
			Range	Median
Nitrite plus nitrate as nitrogen	mg/L	11.29	0.014 – 0.14	0.12
Manganese unfiltered	mg/L	0.5	0.004 – 0.035	0.018
Sulphate	mg/L	500	29 - 32	30.5

\* 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 2004).

† The guideline value of 11.29 mg/L nitrite plus nitrate (as nitrogen) and nitrate (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.

^ Based on one sample.

### Microbiological contaminants

Microbiological testing of raw water samples from Quickup Dam 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.

A count less than 20 most probable number (MPN) per 100 mL is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark of the raw water (WHO 1996). As such, counts less than 20 MPN are seen as being an indication of raw water that has not been recently contaminated with faecal material.

During the reviewed period of March 2006 to February 2011, 45 per cent of samples had *Escherichia coli* counts greater than 20 MPN/100mL.

Run-off from farmland adjacent to an area to the west of the catchment and possibly illegal recreation contribute to *Escherichia coli* detections in the raw water. In 2009/10, the Water Corporation finalised the strategic purchase of a significant area of farm land adjacent to Quickup dam for the purpose of restricting incompatible land uses and protecting the dam from contaminated run-off. Regular surveillance of the outer catchment is conducted by catchment rangers.

Disinfection by UV and chlorination form part of the water treatment process of raw water from Quickup dam. These multiple barriers are effective in eliminating the current level of microbial risk in the raw water.



Appendix C – Table 1 Land use, potential water quality risks and recommended protection strategies

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas)</b>					
Swimming in the dam	Pathogens from people and pet dogs in the water	High	Human or animal contact with water involves an immediate threat to water quality with the potential for pathogenic contamination.	<ul style="list-style-type: none"> <li>• water quality monitoring</li> <li>• limited signage and fencing</li> <li>• Water Corporation surveillance, in cooperation with officers from DEC and the Department of Fisheries</li> <li>• water quality monitoring</li> </ul>	<p><b><i>Incompatible activity in P1 areas and RPZ</i></b></p> <p>Adhere to Statewide policy no. 13: <i>Policy and guidelines for recreation within public drinking water source areas on crown land.</i></p> <p>Consider advice in Standing Committee Public Administration Report 11: Recreation activities within PDWSA.</p> <p>Increase public awareness that swimming is prohibited under the CAWS Act By-laws.</p> <p>The road network (unsealed roads in catchments) within the Quickup River Dam Catchment Area should be reviewed, and those tracks that are not essential to the management of the catchment should be closed to the public or rehabilitated.</p>
	Turbidity due to erosion of reservoir banks	Low	Swimming in dams and feeder streams is prohibited under the <i>Country Areas Water Supply (CAWS) Act By-laws 1957 (WA)</i> .		
	Nutrients from human and animal waste	Low	The dam is easily accessible with limited signage and fencing near the dam wall.		
	Litter from human activity in the catchment	Low	The Department of Health recommends that swimming in water used for public supply does not occur.		
	Hydrocarbons from vehicles accessing catchment area	Low			

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Swimming in the dam (continued)					<p>Use signage to indicate that swimming is not permitted.</p> <p>Undertake surveillance and by-law enforcement.</p>
Fishing and marroning	Pathogens from human activity, bait and carcasses	High	<p>This human activity in contact with water involves an immediate threat to water quality with the potential for pathogenic contamination.</p> <p>Fishing for perch and marroning occurs in the dam regularly, particularly at the back of the dam. The dam is easily accessible with limited signage and fencing only near the dam wall.</p> <p>The Department of Fisheries is responsible for management of fishing and marroning.</p>	<ul style="list-style-type: none"> <li>• limited signage and fencing</li> <li>• Water Corporation surveillance</li> <li>• water quality monitoring</li> <li>• Statewide Policy no 13: <i>Policy and guidelines for recreation within public drinking water source areas on crown land</i></li> </ul>	<p><b><i>Incompatible activity in P1 areas and RPZ</i></b></p> <p>Adhere to Statewide policy no. 13: <i>Policy and guidelines for recreation within public drinking water source areas on crown land.</i></p> <p>Increase public awareness that fishing and marroning is prohibited under the CAWS Act By-laws.</p> <p>Use signage to indicate that fishing and marroning is not permitted.</p> <p>Continue to undertake surveillance and by-law enforcement in cooperation with officers from DEC and the Department of Fisheries.</p>
	Turbidity from erosion and runoff	Low			
	Hydrocarbons from vehicles accessing catchment area	Low			

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Fishing and marroning (continued)			Fishing and marroning is not permitted under CAWS Act and <i>Fish Resources Management Act, 1994</i>		The road network (unsealed roads in catchments) within the Quickup River Dam Catchment Area should be reviewed, and those tracks that are not essential to the management of the catchment should be closed to the public or rehabilitated.
Off-road driving in the catchment area (away from public roads) <ul style="list-style-type: none"> <li>• 4WDs</li> <li>• motorcycles</li> <li>• unlicensed cars</li> </ul>	Pathogens from human activity	High	Easy access to tracks from main traffic routes, but little activity evident.	<ul style="list-style-type: none"> <li>• HAZMAT emergency response</li> <li>• Water Corporation and DEC surveillance</li> <li>• signage and gates</li> <li>• water quality monitoring</li> <li>• a permit is required for off-road driving on land managed by DEC</li> </ul>	<p><b><i>Incompatible activity in P1 areas and RPZ</i></b></p> <p>Use signage to promote awareness that off-road driving is not permitted.</p> <p>Continue to undertake surveillance to control off-road driving in the catchment.</p> <p>Track maintenance and management in state forest, national park, and forest conservation areas to be undertaken by DEC.</p> <p>The road network (unsealed roads in catchments) within the Quickup River Dam Catchment Area should be reviewed, and those tracks that are not essential to the</p>
	Turbidity from erosion of unsealed roads and tracks	Medium	Off-road driving in the catchment is common with vehicles frequently and easily accessing the reservoir banks from the south and east. The reservoir banks are muddy and susceptible to erosion.		
	Hydrocarbon contamination from fuel spills from refuelling and vehicle accidents	Medium	The majority of off-road driving is related to fishing and marroning.		

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Off-road driving in the catchment area (away from public roads) (continued)			There is some fencing along the southern boundary of the land managed by Water Corporation and a gate at the western end, restricting vehicle access near the dam wall.  Access is unrestricted with limited signage.		management of the catchment should be closed to the public or rehabilitated  Monitor and, where necessary or appropriate, enforce the restriction of vehicle access on DEC-managed land in the Quickup River Dam Catchment Area.
Horse riding	Pathogen contamination from people and animals in the catchment	Medium	Little horse riding activity is evident  No designated trails for horse riding exist in the catchment area.	<ul style="list-style-type: none"> <li>• limited signage and fencing</li> <li>• Water Corporation surveillance</li> <li>• water quality monitoring</li> <li>• Statewide Policy no 13: <i>Policy and guidelines for recreation within</i></li> </ul>	<b>Incompatible in P1 areas (except on designated trails and public roads) and the RPZ</b>  <i>Adhere to Statewide policy no 13: Policy and guidelines for recreation within public drinking water source areas on crown land.</i>  Consider advice in Standing Committee Public Administration Report 11: Recreation activities within PDWSA.
	Turbidity from the use of horses and vehicles on unsealed roads and tracks	Low	Consider advice in Standing Committee Public Administration Report 11: Recreation activities within PDWSA.		

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Horse riding (continued)	Nutrients from excreta originating from horses	Low		public drinking water source areas on crown land.	<p>In general, horse riding is permitted in DEC-managed lands in accordance with DEC's policy no. 18 <i>Recreation, tourism and visitor services</i>. However, the Department of Water does not support horseriding in a PDWSA, apart from designated trials and public roads.</p> <p>Use signage to indicate where horse riding is or is not permitted.</p> <p>The road network (unsealed roads in catchments) within the Quickup River Dam Catchment Area should be reviewed, and those tracks that are not essential to the management of the catchment should be closed to the public or rehabilitated.</p>
Resource harvesting: (e.g. wildflower picking, seed collection, and firewood collection)	Pathogens from human and domestic animal activity	Medium	<p>There are two designated firewood collection points within proposed RPZ.</p> <p>The Forest Management Regulations 1993</p>	<ul style="list-style-type: none"> <li>• DEC and Water Corporation surveillance</li> <li>• signage (limited)</li> <li>• water quality monitoring</li> </ul>	<p><b><i>Compatible with conditions in P1 areas and incompatible within the RPZ</i></b></p> <p>Firewood collection should be prohibited in the RPZ.</p>

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Resource harvesting (continued)	Hydrocarbons from vehicles	Low	apply.	<ul style="list-style-type: none"> <li>DEC operates a managed permit system for firewood collection</li> </ul>	<p>Designated firewood collection areas should be provided outside the RPZ. The existing designated areas should be discontinued for use.</p> <p>DEC should continue to manage a permit system for non-commercial firewood collection by the public in areas outside the RPZ.</p> <p>DEC should provide signage to indicate fire collection area.</p> <p>Water Corporation and DEC to undertake ongoing surveillance.</p> <p>Other resource-harvesting activities to be restricted to outside proposed RPZ and away from feeder streams</p> <p>DEC to continue to apply conditions for wildflower picking and seed collection licences that requires adherence to water quality.</p>
	Litter from human activities	Low	Some illegal collection of firewood (outside designated firewood collection areas) is however likely to occur in the Quickup catchment area with the potential for people to be close to tributaries and dam.		
	Turbidity from the removal of vegetation leading to soil erosion	Low	<p>There are currently no permitted apiary sites located within the Quickup River Dam Catchment Area.</p> <p>Hydrocarbon waste from machinery is associated with public firewood collection.</p> <p>Activities and numbers are managed by DEC through the issuing of licences under the Forest Management</p>		

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Resource harvesting (continued)			<p>Regulations 1993 and the Wildlife Conservation Regulations 1970.</p> <p>There are currently 10 - 15 commercial licences issued on an annual basis for people to take protected (native) flora from crown land.</p>		
Feral animal control (e.g. feral pigs, rabbits and foxes)	Pathogens from feral pigs and decaying animal carcasses	High	<p>Feral pigs have been observed in the catchment area.</p> <p>DEC undertakes a pig trapping and shooting program in the catchment.</p> <p>DEC also undertakes 1080 baiting for foxes under the Western Shield fox baiting program.</p>	<ul style="list-style-type: none"> <li>• water quality monitoring</li> <li>• feral animal control program</li> <li>• baiting is undertaken in accordance with the Code of practice for the safe use and management of 1080 in Western Australia</li> </ul>	<p><b>Acceptable activity with conditions in P1 and RPZ</b></p> <p>Continuation and potential enhancement of feral animal control program.</p> <p>Feral animal control should be undertaken in accordance with recommendations of the Department of Water's WQPN no. 96: <i>Pest animal management in public drinking water source areas.</i></p> <p>Baiting is undertaken in accordance with the Department of Health's</p>
	Feral pigs can increase turbidity levels through wallowing, disturbance of vegetation and digging up soil	Low			
	Chemicals from use of baits	Low			

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Feral animal control (continued)			Monitoring of feral pig activities in the catchment area is undertaken by DEC in association with the community-based Lake Muir-Denbarker Feral Pig Control Group.		<p><i>Code of practice for the safe use and management of 1080 in WA and A guide to the use of pesticides in WA.</i></p> <p>A bait-free buffer to be maintained around the full supply level of the reservoir water body extending for a minimum distance of 100 m. All other baits in the catchment area to be placed at least 20 m away from any flowing stream.</p> <p>Monitoring of feral pig activities to be continued in the catchment area by DEC (in association with the community-based Lake Muir-Denbarker Feral Pig Control Group).</p>
Recreational hunting	Pathogens from human and domestic animals, and decaying animal carcasses	High	Little activity is evident.	<ul style="list-style-type: none"> <li>• water quality monitoring</li> <li>• DEC undertakes animal control programs on land managed by them</li> </ul>	<p><b><i>Unacceptable activity in a P1 area and RPZ</i></b></p> <p>Hunting in PDWSAs is prohibited under the CAWS Act by-laws</p> <p>Signage should include that hunting is not permitted in a PDWSA.</p>



Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Recreational hunting (continued)	Turbidity from erosion of unsealed roads and tracks	Medium		<ul style="list-style-type: none"> <li>Statewide policy no 13: <i>Policy and guidelines for recreation within public drinking water source areas on crown land</i></li> <li>hunting in PDWSAs is prohibited under the CAWS Act by-laws</li> <li>Water Corporation and DEC surveillance</li> </ul>	<p>Water Corporation and DEC to continue to undertake surveillance and by-law enforcement.</p> <p>DEC to control feral animals through their management program.</p> <p>Adhere to Statewide policy no 13: <i>Policy and guidelines for recreation within public drinking water source areas on crown land.</i></p> <p>WQPN no. 96: <i>Pest animal management in public drinking water source areas.</i></p>
	Hydrocarbon contamination from vehicles accessing the catchment area	Medium			
Weed control (including dieback management)	Chemicals from use of herbicides	Low	DEC is responsible for undertaking weed control on crown land managed by them.	<ul style="list-style-type: none"> <li>Water Corporation and DEC surveillance</li> </ul>	<p>Adhere to Statewide policy no 13: <i>Policy and guidelines for recreation within public drinking water source areas on crown land</i>, and the Department of Health's Circular no PSC88: <i>Use of herbicides in water catchment areas and A guide to the use of pesticides in Western Australia.</i></p>
	Turbidity from the removal of vegetation leading to soil erosion	Low			

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Fire management (prescribed burns and bushfires)	Turbidity through fuel reduction burning and the construction and maintenance of fire breaks and water points, and the use of unsealed roads and tracks	Medium	DEC is responsible for undertaking fire management on crown land managed by them.  Prescribed burning is conducted in the catchment, with fire regimes determined through consideration of a number of factors, including: biodiversity requirements, maintenance of ecosystem health and productive capacity, conservation of soil, water and catchment values, regeneration and protection of native forests and plantations, and protection of human life and community assets.	<ul style="list-style-type: none"> <li>• DEC undertakes fire management for crown land managed by them</li> <li>• Water Corporation and DEC surveillance</li> <li>• water quality monitoring</li> <li>• fire management options may be reviewed by DEC after finalising the fire mosaic project research trial undertaken in the Walpole-Nornalup National Park</li> </ul>	<p><b><i>Accepted with best management practices as this is considered a necessary activity in forest management</i></b></p> <p>DEC is the responsible state agency for implementing fire management strategies on crown land.</p> <p>Develop specific objectives and guidelines related to water quality objectives and liaise with DEC to recommend inclusion of those best management practices into their fire management protocols.</p> <p>Identify appropriate water sources for fire management, which may include specific points for accessing watercourses and the streams.</p> <p>Water Corporation participation during major fires and post fire management and monitoring.</p>
	Pathogens from decaying carcasses, human presence, and loss of filtering vegetation	Medium			
	Carbon and nutrient contamination from airborne or waterborne (surface run-off) ash	Medium	Possible chemical contamination from the use of fire		

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Crown land (state forest, national parks, and forest conservation areas) (continued)</b>					
Fire management (continued)	Chemical and hydrocarbon contamination from fuel spills	Medium	<p>suppressants (foams) and fire retardants in the control of bushfires.</p> <p>There are no known water points used for fire management purpose within the catchment area.</p> <p>Prescribed burning within the catchment is undertaken in accordance with the <i>Forest Management Plan 2004-2013</i> and the <i>Walpole wilderness area and adjacent parks and reserves management plan</i>.</p> <p>All transient public access in the catchment increases risk of bushfires e.g. camping, bushwalking, picnicking, fishing, marroning.</p>		<p>Water Corporation to be advised of any prescribed burns by DEC, where the prescribed burns are undertaken within RPZ or in proximity to Water Corporation's infrastructure.</p> <p>Ensure that any planned firebreaks required on an ongoing basis minimise risks to soil disturbance.</p> <p>Guidance for fire suppressants (foams) and fire retardants used in the control of bushfires along waterways are provided in DEC's <i>Fire operations guideline 76</i>.</p>

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
<b>Public roads and tracks</b>					
Public roads and tracks (e.g. Denmark- Mt Barker Road and unsealed tracks)	Hydrocarbons and chemicals from fuel and chemical spills from vehicles	Medium	Denmark – Mt Barker Road transects the Quickup River Dam Catchment Area, with sections crossing the proposed RPZ.	<ul style="list-style-type: none"> <li>• WESTPLAN-HAZMAT emergency response</li> <li>• signage (not always in place)</li> <li>• water quality monitoring</li> <li>• Water Corporation surveillance</li> </ul>	<p><b><i>In general, new major roads are incompatible in a P1 area and RPZ, and compatible with conditions in a P2 area</i></b></p> <p>Denmark-Mt Barker Road is an existing road and will be recognised as a non-compatible land use in this catchment area (proposed P1 area and in RPZ).</p> <p>The best management practices recommended in the Department of Water's WQPN no 44: <i>Roads in sensitive water resources</i> and WQPN 10: <i>Contaminant spills emergency response</i> should be considered when planning and undertaking any future road upgrade. Best management practices may also be offered in other WQPNs that are available on the Department of Water's website.</p> <p>WESTPLAN-HAZMAT emergency response to be maintained.</p> <p>Restrict development of new roads through the catchment.</p>
	Pesticides from weed spraying along edges of roads	Low	The catchment contains minor roads which are managed by the Shire of Denmark.		
	Turbidity from erosion of unsealed roads and tracks	Medium	Most of the roads in the catchment (mostly unsealed roads) are managed by DEC and are currently publicly accessible.		
	Litter deposited along roads	Low	Roads and tracks also provide public access to the waterbody and catchment, which increases associated risks such as: <ul style="list-style-type: none"> <li>• rubbish dumping</li> <li>• bushfires and</li> <li>• pathogen contamination.</li> </ul>		

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Public roads and tracks (continued)					<p>The road network (unsealed roads in catchments) within the Quickup River Dam Catchment Area should be reviewed, and those tracks that are not essential to the management of the catchment should be closed to the public or rehabilitated.</p> <p>Ensure an emergency response process is in place for fuel spillage and accident management.</p> <p>Continue to use signage to promote awareness that people are in a PDWSA. Display the emergency contact number in the event of a spill.</p> <p>Undertake surveillance.</p>
<b>Infrastructure</b>					
<p>Infrastructure maintenance</p> <ul style="list-style-type: none"> <li>• power lines</li> <li>• pipelines</li> <li>• associated roads/tracks</li> <li>• reservoir, dam and associated structure</li> </ul>	Hydrocarbons and chemicals from fuel and chemical spills from vehicles and machinery	Low	Maintenance is necessary for the operation of the infrastructure. But, the risks to water quality associated with maintenance need to be managed.	<ul style="list-style-type: none"> <li>• water quality monitoring</li> <li>• HAZMAT emergency response</li> </ul>	<b><i>Infrastructure corridors are compatible with conditions in P2 and P3 areas, and occasionally approved with conditions in P1 areas where it can be demonstrated alternative siting is impractical or vital to the state's interest</i></b>

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Infrastructure maintenance (continued)			particularly close to the dam	<ul style="list-style-type: none"> <li>pesticide use should be in accordance with the Department of Water's Statewide policy no. 2: <i>Pesticide use in public drinking water source areas</i> and Department of Health's Circular no. PSC88: <i>Use of herbicides in water catchment areas</i>.</li> </ul>	<p>Ensure access roads and tracks for infrastructure maintenance are maintained with appropriate culverts and installed where tracks cross streams. A permit for bed and banks interference from the Department of Water may be required if the activities involve the disturbance of bed and banks of a waterway.</p> <p>Ensure an emergency response process is in place for fuel spillage.</p> <p>Ensure maintenance workers are aware of water quality protection objectives and adopt best management practices.</p> <p>Encourage adherence to Department of Water's water quality protection note no 83: <i>Infrastructure corridors near sensitive water resources</i>.</p> <p>Pesticide use should be in accordance with the Department of Water's Statewide policy no. 2: <i>Pesticide use in public drinking water source areas</i> and the Department of Health's Circular no PSC88: <i>Use of herbicides in water</i></p>

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Infrastructure maintenance (continued)					<i>catchment areas and A guide to the use of pesticide in Western Australia.</i>
<b>Rural land (private land)</b>					
Agriculture – extensive (stock grazing)	Pathogen contamination from domestic animal waste products	High	Cattle are grazed on rural land adjacent to the dam, but stock does not have direct access to the dam.	<ul style="list-style-type: none"> <li>• water quality monitoring</li> <li>• secure fencing and control stock movement.</li> </ul>	<p><b><i>Agriculture – extensive (stock grazing) activities are compatible with conditions in a P2 PDWSA.</i></b></p> <p>Water Corporation to maintain water quality monitoring program.</p> <p>Land owner to ensure stock is securely fenced and kept at least 100 m away from the dam.</p> <p>Landowners to inform the relevant agency of any spills or accidents with the potential to contaminate water resources.</p> <p>Regular maintenance of on-site wastewater management systems should be undertaken by the landowner.</p> <p>Encourage landholders to consider best management practices for protecting the quality of drinking water (e.g. the Department of</p>
	Nutrients from excreta originating from domestic animals	Moderate	The current water source protection process recognises the right of landowners to continue a current land use.		
	Pesticides from pest control	Low	The Department of Water recommends that best management practice is considered in all PDWSAs.		
	Fuel and chemical spills from vehicles and machinery	Low			

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Agriculture – extensive (stock grazing) (continued)					Water's WQPN Agriculture – dryland crops near sensitive water resources and Stockyards).
Rural residential land (including small nursery)	Potential pathogen contamination	High	The current water source protection process recognises the right of landowners to continue a current land use. However best management practices should be considered.	<ul style="list-style-type: none"> <li>• water quality monitoring</li> <li>• land planning controls</li> </ul>	<p><b><i>Rural living and plant nurseries are compatible with conditions in P2 PDWSA</i></b></p> <p>Pesticide use should be in accordance with Statewide policy no. 2: <i>Pesticide use in public drinking water source areas</i> and Circular no. PSC88: <i>Use of herbicides in water catchment areas</i>.</p> <p>Landowners to inform the relevant agency of any spills or accidents with the potential to contaminate water resources.</p> <p>Regular maintenance of septic tank systems should be undertaken by the landowners.</p>
	Hydrocarbons and chemicals (Fuel and chemical spills)	Low	Wastewater from farm residences is disposed via septic tank systems. A couple of residences are located close to the dam.		
	Pesticide and fertiliser use from small scale nursery	Low	The effluent disposal systems are located more than 100 m away from dam.		
	Pesticides from weed spraying along edges of roads, pipelines and other	Low			



Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Rural residential land (including small nursery) (continued)	structures		<p>A small scale nursery is operated by one of the rural landholders.</p> <p>Depending on market opportunities the owners may grow crop (use fertilizer, pesticides and other chemicals) or increase the stocking rates on the land in the future. An additional shed and dwelling may also be constructed on the farm.</p>		<p>Best management practices should be considered in all PDWSAs. Relevant best management practices are provided in WQPN no. 65: <i>Toxic and hazardous substances – storage and use</i> and WQPN 70: <i>Wastewater treatment – onsite domestic systems</i>.</p> <p>Advice on sustainable stocking rates for cattle farming can be provided by the Department of Agriculture and Food WA (DAFWA). Information can also be obtained from the DAFWA's website at <a href="http://www.agric.wa.gov.au">www.agric.wa.gov.au</a>.</p>
<b>Mining activities</b>					
Mineral extraction	Hydrocarbons and chemicals from fuel and chemical spills from vehicles and machinery	Low	The southern part of the Quickup River catchment area is covered by mining tenement applications.		<p><b>Mining is compatible with conditions in P1 areas</b></p> <p>Any proposed mining tenements and mining activities within this catchment area needs to be assessed by Department of Mines and Petroleum in consultation with the Department of Water.</p>

Land use/activity	Potential water quality risks		Consideration for management	Current preventive measures	Recommended protection strategies
	Hazard	Management priority			
Mineral extraction (continued)					Best management practices should be in accordance with our Water quality protection guideline series: Mining and mineral processing.
<b>Water Corporation land (private land)</b>					
Water Corporation land (including consideration for future water infrastructure)	Pathogens from stormwater run-off (road located west of dam)	High	Run-off from farmland adjacent to an area to the west of the catchment appears to contribute to pathogen detections (indicators) in the raw water.	<ul style="list-style-type: none"> <li>Water Corporation's operators are aware of the water source protection requirements</li> <li>water quality monitoring</li> </ul>	<p><b><i>Water infrastructure for supplying drinking water is compatible with conditions in P1 PDWSA</i></b></p> <p>Effectiveness of stormwater system along the access way (west of dam) to the dam wall to be investigated and improved by Water Corporation (e.g. divert stormwater run-off around the dam outside the catchment area, if possible).</p> <p>Continue with appropriate best-management practices for the handling of any machinery and chemicals in accordance with the Department of Water's requirements.</p> <p>Ensure an emergency response process is in place for fuel spillage.</p>
	Nutrients from stormwater run-off (road located west of dam)	Moderate	The Water Corporation plans to increase the Quickup dam wall in the near future.		
	Turbidity from erosion of unsealed roads and tracks, and hardstand areas	Moderate	Access to dam via the existing service road.		
	Hydrocarbons and chemicals from fuel and chemical spills from vehicles and machinery	Low	A stormwater system exists along the first portion of the access way (near Denmark-Mt Barker Road) leading to the bushland, in proximity to the reservoir.		

## Appendix D – Photographs



*Figure D1 Cattle grazing on rural zoned farm land*



*Figure D2 Culvert*



*Figure D3 Access way to Quickup dam (public access prevented by locked gate).*



*Figure D4 Rural zoned land close to Quickup dam*

## List of shortened forms

<b>ADWG</b>	<i>Australian drinking water guidelines</i>
<b>AHD</b>	Australian height datum
<b>ANZECC</b>	Australian and New Zealand Environment Conservation Council
<b>ARMCANZ</b>	Agriculture and Resource Management Council of Australia and New Zealand
<b>CAWS</b>	<i>Country Areas Water Supply Act 1947 (WA)</i>
<b>DAFWA</b>	Department of Agriculture and Food (WA)
<b>DEC</b>	Department of Environment and Conservation
<b>DWSP</b>	Drinking water source protection plan
<b>FMP</b>	<i>Forest management plan 2004–2013</i>
<b>FERA</b>	Fire exclusion reference area
<b>GL</b>	gigalitre
<b>HAZMAT</b>	hazardous materials
<b>km</b>	kilometre
<b>km<sup>2</sup></b>	square kilometre
<b>LEMC</b>	local emergency management committee
<b>m</b>	metres
<b>mg/L</b>	milligram per litre
<b>mL</b>	millilitre
<b>ML</b>	megalitre
<b>mm</b>	millimetre
<b>MPN</b>	most probable number
<b>NHMRC</b>	National Health and Medical Research Council
<b>NTU</b>	nephelometric turbidity units
<b>NRMMC</b>	Natural Resource Management Ministerial Council
<b>PSC 88</b>	public sector circular number 88

<b>PDWSA</b>	public drinking water source area
<b>RPZ</b>	reservoir protection zone
<b>TCU</b>	true colour units
<b>TDS</b>	total dissolved solids
<b>WESTPLAN- HAZMAT</b>	Western Australian plan for hazardous materials
<b>WINRP</b>	Wilson Inlet Nutrient Reduction Plan

# Glossary

<b>Abstraction</b>	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
<b>Adsorb</b>	Adsorb means to accumulate on the surface of something.
<b>Aesthetic guideline value</b>	The concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMMC 2004a).
<b>Allocation</b>	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
<b>Australian drinking water guidelines</b>	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2004</i> (NHMRC & NRMMC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's Bibliography).
<b>Augment</b>	Augment means to increase the available water supply. For example, pumping back water from a secondary storage/reservoir dam.
<b>Australian height datum</b>	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
<b>Catchment</b>	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
<b>Department of Environment and Conservation</b>	The Department of Environment and Conservation was established on 1 July 2006, bringing together the Department of Environment and the Department of Conservation and Land Management.
<b>Effluent</b>	Effluent is treated or untreated liquid, solid or gaseous waste discharged by a process such as through a septic tank and leach drain system.
<b>Eutrophication</b>	Deterioration of a waterway resulting from nutrient enrichment.
<b>Gigalitre</b>	A gigalitre is equivalent to 1 000 000 000 litres or one million kilolitres.
<b>Health guideline value</b>	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2004a).
<b>Hydrocarbons</b>	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil,

petroleum and natural gas all contain hydrocarbons.

<b>Hydrology</b>	The science dealing with water on the land, its properties, laws, geographical distribution, etc.
<b>Leaching/leachate</b>	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater. The material washed out is known as leachate. Leachate can pollute groundwater and waterways.
<b>mg/L</b>	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
<b>Most probable number</b>	Most probable number is a measure of microbiological contamination.
<b>Nutrient load</b>	The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area.
<b>Nutrients</b>	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
<b>Pathogen</b>	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, including bacteria (such as <i>Escherichia coli</i> ), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i> ) and viruses.
<b>Pesticides</b>	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
<b>pH</b>	A logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below seven indicates an acidic solution and above seven indicates an alkaline solution.
<b>Pollution</b>	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.
<b>Public drinking water source area</b>	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> and the <i>Country Areas Water Supply Act 1947 (WA)</i> .
<b>Public sector circular number 88</b>	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.



<b>Reservoir</b>	A reservoir, dam, tank, pond or lake that forms part of any public water-supply works.
<b>Reservoir protection zone</b>	A buffer measured from the high water mark of a drinking water reservoir, and inclusive of the reservoir (usually 2 km). This is referred to as a prohibited zone under the Metropolitan Water Supply Sewerage and Drainage Act By-laws 1981 (WA).
<b>Runoff</b>	Water that flows over the surface from a catchment area, including streams.
<b>Scheme supply</b>	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
<b>Storage reservoir</b>	A major reservoir of water created in a river valley by building a dam.
<b>Stormwater</b>	Rainwater that has run off the ground surface, roads, paved areas etc., and is usually carried away by drains.
<b>Total dissolved solids</b>	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMCC 2004a).
<b>Treatment</b>	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
<b>Turbidity</b>	The cloudiness or haziness of water caused by the presence of fine suspended matter.
<b>Wastewater</b>	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant.
<b>Water quality</b>	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
<b>WQPN</b>	Water quality protection note
<b>WINRP</b>	The Wilson Inlet Nutrient Reduction Plan

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