Department of Water
Government of Western Australia

Dookanooka Water Reserve
Drinking Water Source Protection Plan

REPORT NO. 72
June 2007

Water Resource Protection Series

Department of Water
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Dookanooka Drinking Water Source Protection Plan

Three Springs Town Water Supply

Department of Water

Water Resource Protection Series

Report WRP 72

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Subject of cover photograph
Dookanooka production bore 1/02, taken by Alana Thorpe

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Preface

The Department of Water has prepared this Drinking Water Source Protection Plan to report on the activities and risks to water quality within the Dookanooka Water Reserve and to recommend management strategies to address these.

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

The Australian Drinking Water Guidelines recommend a multiple barrier risk based approach to protect public drinking water source. Protection of drinking water catchments is the 'first barrier', with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection includes understanding the catchment, the hazards and hazardous events that can compromise drinking water quality, and developing and implementing preventive strategies and operational controls to ensure the safest possible water supply from our surface water dams and groundwater aquifers.

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

This plan should be used to guide State and Local Government land use planning decisions. It should be recognised in the Shire of Three Springs Town Planning Scheme, consistent with the Western Australian Planning Commission's *Statement of Planning Policy No. 2.7 - Public Drinking Water Source Policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the Dookanooka Water Reserve

The stages involved in preparing a Drinking Water Source Protection Plan are:

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

Summary

Three Springs is located in the Mid West Region of Western Australia, 313km north of Perth and is a service centre for the local mining and agricultural industries. Water for the town, surrounding farms and the nearby talc mine is supplied from two Water Corporation bores, located within the Dookanooka Water Reserve. The Dookanooka Water Reserve is located approximately 17 kilometres west of Three Springs and was proclaimed under the *Country Areas Water Supply Act* in 1992 to protect the public drinking water source.

The bores draw water from the Parmelia Formation, which was deposited in the Late Jurassic and consists of interbedded sandstone, claystone, siltstone and shale. This formation forms a semi-confined aquifer.

The water table in the area of the Dookanooka Water Reserve is greater than 60 metres deep and the bores are screened at a depth of over 200 metres. Combined with the semi-confined nature of the aquifer this results in a low risk of contamination to the drinking water source from the surrounding extensive agricultural land uses.

There is, however, a degree of risk to the drinking water source as the aquifer is not completely confined. Therefore, it is proposed that the boundary of the Dookanooka Water Reserve be amended to include the additional area formed by a 300 metre Wellhead Protection Zone (WHPZ), in order to protect the area around the production bores where the water source is most vulnerable to contamination. The current gazetted Water Reserve will be managed for Priority 1 source protection while the remainder of the proposed Dookanooka Water Reserve will be managed for Priority 2 source protection. The boundary and priority classifications have been determined to provide the appropriate level of protection for the drinking water source, while recognising the rights of landowners to continue established approved land use activities.

The following strategies are recommended to protect the Dookanooka Water Reserve:

- extend the boundary of the Water Reserve to include the proposed WHPZ, in order to ensure the appropriate level of protection;
- the Water Reserve boundary, priority classifications and management principles outlined in this plan should be incorporated into the Shire of Three Springs's Town Planning Scheme and other applicable schemes and strategies;
- any development proposals that are inconsistent with the Water Quality Protection Note *Land use compatibility in Public Drinking Water Source Areas* should be referred to the Department of Water for comment; and

- best management practices for current or approved land uses in the Dookanooka Water Reserve should be implemented.

1 Drinking water source overview

1.1 Existing water supply system

Three Springs is located in the Mid West Region of Western Australian approximately 313 kilometres north of Perth. The town has a population of around 470 (Australian Bureau of Statistics, 2001) and functions as a service centre for the local talc mine and agricultural industry, which includes cereal cropping, animal grazing and wildflower farming.

The Dookanooka Water Reserve is located within the Shire of Three Springs, approximately 17 kilometres west of the Three Springs townsite (Figure 1). The wellfield consists of two production bores (1/00 and 1/02), which are approximately 18 metres apart and drilled into the Parmelia Formation (see Figure 2 for bore locations). Bore 1/00 is screened between 264 and 288 metres with a static water level of 64 metres. Bore 1/02 is screened between 205 and 229 metres with a static water level of 63 metres.

Water from the production bores is treated and pumped into the Dookanooka collector tank, where it is chlorinated and then pumped to Sweetman's summit tank. From here it gravitates to the Three Springs No. 6 service tank, which supplies the town reticulation system. There are also a number of off-takes from the mainline, which provide water to nearby farms, several farms in Womarden and the talc mine, approximately 10 kilometres east of Three Springs. The current number of services supplied by the Dookanooka Wellfield is approximately 216.

1.2 Water treatment

Groundwater extracted from the Dookanooka bores is first aerated to raise the pH and reduce iron levels of the raw water. All water is then disinfected by chlorination prior to supply as drinking water.

It should be recognised that although treatment and disinfection are essential barriers used to ensure a safe, good quality, aesthetically acceptable drinking water supply, catchment management and water source protection are fundamental 'first barriers' for the protection of water quality. This approach is endorsed by the Australian Drinking Water Guidelines (ADWG) (NHMRC & NRMMC, 2004) and reflects a multiple barrier 'catchment to consumer' risk based approach for the provision of safe drinking water to consumers.

1.3 Catchment details

1.3.1 Physiography

Dookanooka Water Reserve is located on the Dandaragan Plateau, a sand and laterite capped plateau overlying Cretaceous sediments. The Plateau is flat to gently undulating with an elevation ranging from 140 to 260 metres above sea level. The most significant topographical feature in the area is the Dandaragan Scarp, which is located on the western boundary of the Plateau and rises up to 50 metres above land further to the west.

Deep yellow sands are common to the uplands while the valleys are dominated by deep red and yellow brown sands.

1.3.2 Climate

Three Springs experiences a mild Mediterranean-type climate with hot, dry summers and cool, wet winters. Average annual rainfall is approximately 390 millimetres.

1.3.3 Hydrogeology

Dookanooka wellfield is located to the west of the Urella Fault in the Dandaragan Trough, a major structural unit of the Perth Basin. The trough is bounded on the east by the Urella and Darling Faults and on the west by the Beagle Fault System.

The Parmelia Formation occurs between the Dandaragan Scarp and the Urella Fault and is separated from the underlying Yarragadee Formation by the Otorowiri Member, a siltstone aquiclude. The Parmelia Formation is of Late Jurassic age and consists of interbedded sandstone, claystone, siltstone and shale. The total thickness of the sandstone in the Parmelia Formation is variable but is generally in the order of 100 to 200 metres thick. The Yarragadee Formation is of Middle to Late Jurassic age and consists of sandstone, siltstone, shale and claystone up to 2500 metres thick (Water Authority, 1995).

The Dookanooka bores draw water from the Parmelia Formation. The Parmelia Formation forms an aquifer of regional extent, which has a complex flow system and contains large resources of fresh to brackish water. At its surface the aquifer is recharged by direct infiltration of rainfall and associated runoff, however, the presence of interbedded shale produces semi-confining layers beneath the Dookanooka borefield. The depth to the watertable in the area of the Dookanooka bores is more than 60 metres, and flow is in a general northerly direction.

Carbon 14 dating techniques have been used to determine the average age of water in the Dookanooka bores. The average corrected age of the water in Bore 1/79 (which has been redrilled to form bore 1/00) was found to be 2300 years. This provides a good indication of the considerable length of time it takes for water infiltrating at the recharge area to be withdrawn by the bores

1.4 Future water supply requirements

The existing wellfield adequately meets the current requirements of Three Springs. At this stage the Water Corporation considers that the present source should also be sufficient to meet future demand.

1.5 Protection and allocation

1.5.1 Existing water source protection

The Dookanooka Water Reserve was proclaimed in 1992 under the *CAWS Act 1947.* By-laws are applied under this Act to ensure protection of the water source against contamination. The current gazetted Water Reserve covers Lot 3 on Diagram 68095 (see Figure 2).

1.5.2 Current allocation licence

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

The Dookanooka wellfield is located within the Arrowsmith Groundwater Area. The resource is managed in accordance with this Department's Interim Sub-regional Allocation Strategy titled, *Managing the Water Resources of the Arrowsmith Groundwater Area, WA* (see References section)*.* The Water Corporation hold a Groundwater Well Licence (no. 65324) to draw 240 000 kilolitres per annum from the existing two production bores for public water supply purposes. Current abstraction is lower than this, with a volume of 166 389 kilolitres abstracted during the 2005/06 licence period.

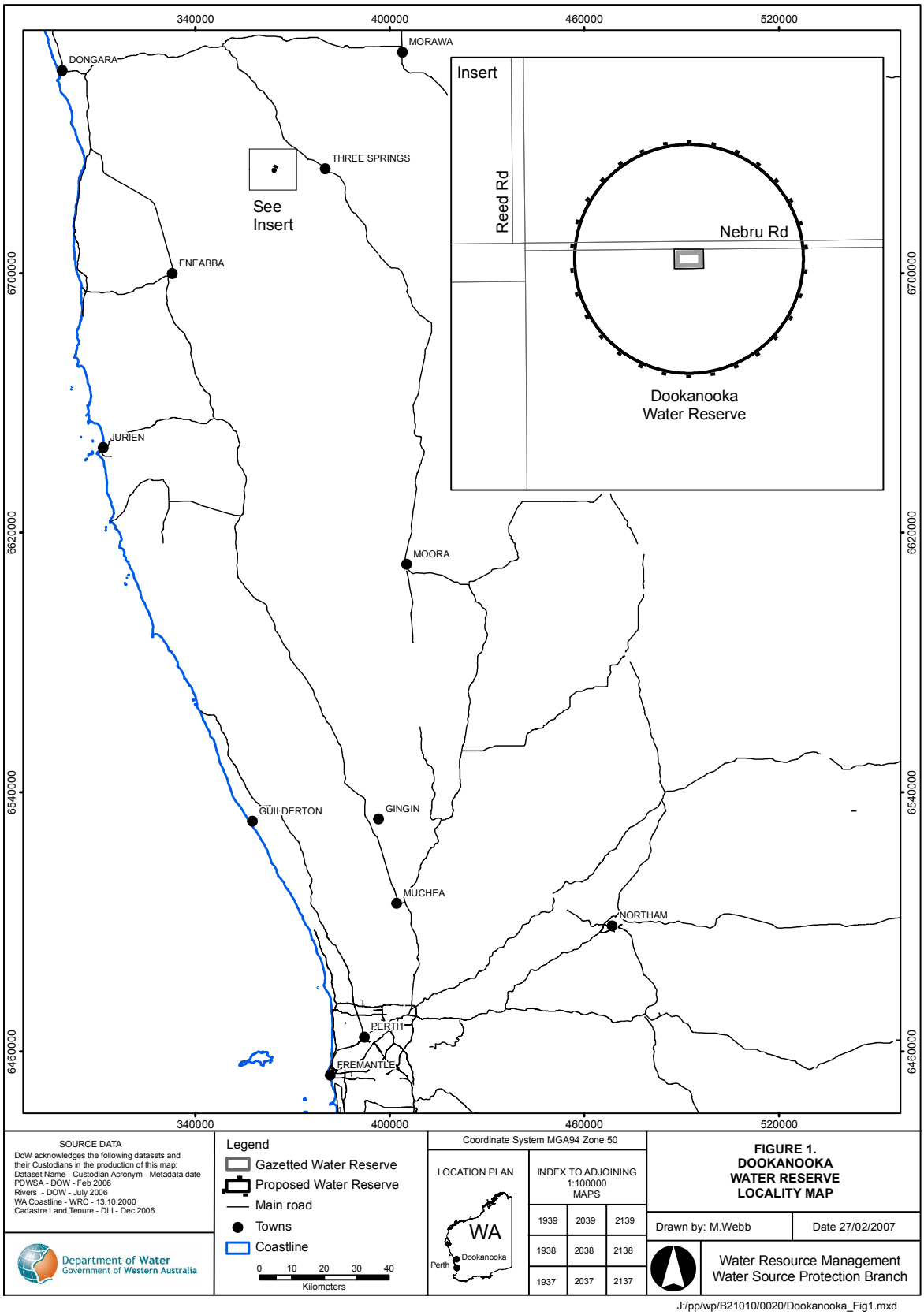

Figure 1 Dookanooka Water Reserve locality map

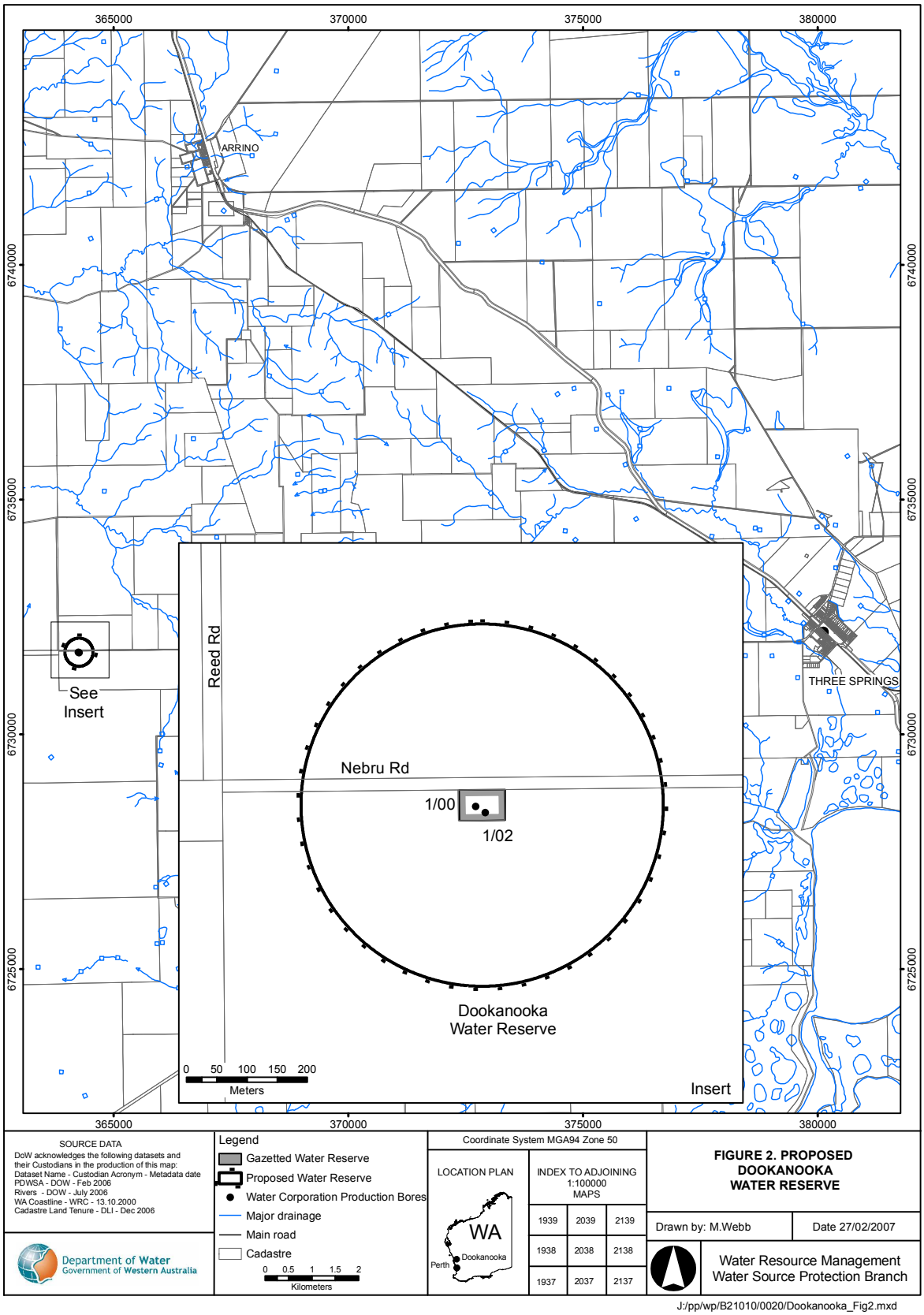

Figure 2 Dookanooka Water Reserve

2 Water quality monitoring and contamination risks

The Water Corporation regularly monitors the raw water quality from the Dookanooka wellfield for microbiological contamination, health related and aesthetic (non-health related) characteristics in accordance with the ADWG. The results of this monitoring are then reviewed by an intergovernmental committee, chaired by the Department of Health, called the Advisory Committee for the Purity of Water.

A water quality summary for the Dookanooka wellfield is presented in Appendix A. For more information on water quality, see the Water Corporation's most recent Drinking Water Quality Annual Report at <www.watercorporation.com.au> > Water > Water Quality > Downloads > access the most recent Annual Report.

Contamination risks relevant to the Dookanooka Water Reserve are described below.

2.1 Microbiological contaminants

Pathogens are types of micro-organisms that are capable of causing diseases. These include bacteria (such as *Escherichia coli*), protozoa (such as *Cryptosporidium* and *Giardia*) and viruses. In water supplies the pathogens of concern that can cause illness are mostly found in the faeces of humans and domestic animals. *Escherichia coli* counts are a way of measuring these pathogens and are an indicator of faecal contamination.

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

The effects on people from consuming drinking water that is contaminated with pathogens is considerably varied, ranging from mild illness (such as stomach upset or diarrhoea) to death. This was the case in Walkerton, Canada in 2000, where seven people died due to the contamination of a pathogenic strain of *Escherichia coli* in the town water source and supply (NHMRC & NRMMC, 2004b). Preventing the introduction of pathogens into the water source is the most effective barrier in avoiding this public health risk.

2.2 Health related characteristics

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

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides, rodenticides and miticides. Contamination of a drinking water source by pesticides may occur as a result of accidental spills, incorrect or over use and leakage from storage areas. In such cases, prompt action is required to notify relevant authorities and clean up the spill.

Nutrients (such as nitrogen) can enter drinking water supplies from leaching of fertiliser, septic tanks, and from faeces of domestic animals (such as cattle grazing on the land). Nitrate and Nitrite (ions of Nitrogen) can be toxic to humans at high levels, with infants less than 3 months old being most susceptible (NHMRC & NRMMC, 2004).

Hydrocarbons (fuels, oils, solvents) are potentially toxic to humans, and harmful by-products may be formed when they are combined with chlorine in water treatment processes. Hydrocarbons can occur in water supplies from pollution events from vehicle accidents, refuelling and leakage from storage areas.

2.3 Aesthetic characteristics

Impurities in drinking water can affect the aesthetic qualities of water such as appearance, taste, smell and 'feel'. Such impurities are not necessarily hazardous to human health, for example water that is cloudy and has a distinctive colour may not be harmful (NHMRC & NRMMC, 2004b).

Iron and dissolved organic matter can affect the colour and appearance of water, and salinity can affect the taste. The ADWG have set limits on water quality characteristics to meet aesthetic requirements of consumers.

Some properties such as pH can contribute to the corrosion and encrustation of pipes. The ADWG also sets out aesthetic guidelines for these types of water quality characteristics.

2.4 Groundwater bores

Under the provisions of sections 26D and 5C of the *RIWI Act,* a licence is required to construct a bore or extract water (unless exempt under the *RIWI* Exemption and Repeal (Section 26C) Order 2001) within a proclaimed groundwater area. The Dookanooka Water Reserve is located within the Arrowsmith Groundwater Area.

Any bores drilled near to a public drinking water supply bore have the potential to contaminate the drinking water source. For example, a poorly constructed bore may introduce contaminants through surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer. If a public drinking water source bore is nearby, it may abstract the contaminated water.

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

source. This will be assessed through the Department of Water's water licensing process where applicable under the *RIWI Act.*

All bores should be constructed in accordance with *Minimum Construction Requirements for Water Bores in Australia* (National Minimum Bore Specifications Committee, 2003).

2.5 Mineral exploration bores

Any drilling undertaken in close proximity to a drinking water source area has the potential to contaminate the source by providing a pathway for contaminants to travel from the ground surface down into the aquifer from which the production bores draw from. Where possible, exploration drilling should be kept outside of the Water Reserve and downstream of the production bores. All drilling undertaken in close proximity to the production bores must be must be appropriately backfilled and sealed in order to prevent contamination of the water source.

3 Land use assessment

3.1 Existing land uses

The current gazetted Dookanooka Water Reserve is owned by the Water Corporation and zoned rural in the Shire of Three Springs Town Planning Scheme No. 1. Land surrounding the gazetted Water Reserve, which is included in the proposed Dookanooka Water Reserve, is privately owned and also zoned rural (see Figure 3). The primary agricultural land use on the privately owned land is broad acre cereal cropping including wheat, barley, lupins and canola. Some low intensity stock grazing (sheep and cattle) also occurs.

3.2 Proposed land uses

Under the current rural zoning there is the potential for intensification of agricultural land uses in the area. Nutrient outputs are likely to be greater from more intensive agriculture, which could potentially result in a higher risk of contamination to the water source than the current extensive agriculture. Any proposals to intensify or change the agricultural land use that are inconsistent with the Water Quality Protection Note *Land use compatibility in Public Drinking Water Source Areas* should be referred to the Department of Water for comment. The Department will make recommendations where appropriate.

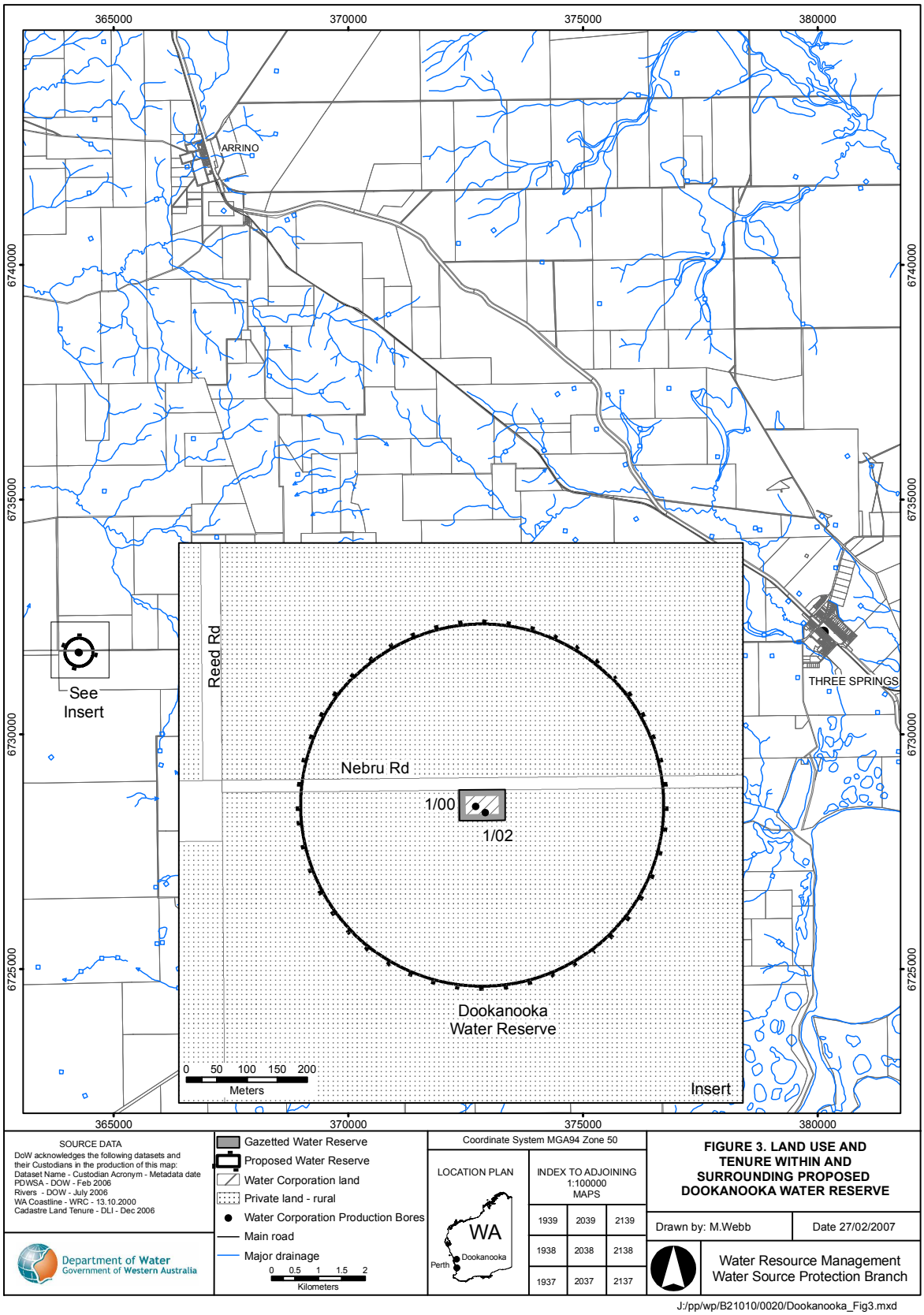

Figure 3 Land use and tenure within and surrounding the Dookanooka Water Reserve

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to protect the drinking water source in the interest of providing safe drinking water to the town of Three Springs, while recognising the rights of existing approved land uses to continue within the Dookanooka Water Reserve.

The priority classifications for the Dookanooka Water Reserve have been assigned to ensure consistency with this Department's current framework for public drinking water source protection. The priority classifications reflect the form of land tenure, the strategic importance of the water source, hydrogeology, land use and zoning.

4.2 Proclaimed area

The boundary of the current gazetted Dookanooka Water Reserve (see section 1.5.1) is proposed to be amended under the *CAWS Act 1947* to include the additional area that is formed by a 300 metre Wellhead Protection Zone (WHPZ) around the production bores. This will include a portion of Lot 1 on Diagram 68095 and will allow protection of the area where contamination of the drinking water source is most likely to occur. The proposed new boundary for Dookanooka Water Reserve is shown in Figure 2.

4.3 Priority classifications

An explanation of the priority classification system and the detail of land use compatibility within each priority classification is provided in the Water Quality Protection Note *Land use compatibility in Public Drinking Water Source Areas* (see References section).

The area covered by the current gazetted Water Reserve (Lot 3 on Diagram 68095) will be classified as Priority 1 (P1). The remainder of the proposed Dookanooka Water Reserve will be classified as Priority 2 (P2). Extensive agriculture is a compatible land use within the proposed P2 classification (see the Department's Water Quality Protection Note *Land use compatibility in Public Drinking Water Source Areas*). The priority classifications for Dookanooka Water Reserve are shown in Figure 4.

4.4 Protection zones

The Department of Water defines Wellhead Protection Zones (WHPZ) around each production bore (500 metre radius in P1 areas and 300 metre radius in P2 and P3 areas) in which activities are to be managed to maximise protection against contamination. A 300 metre WHPZ around the production bores is proposed for Dookanooka Water Reserve (see Figure 4).

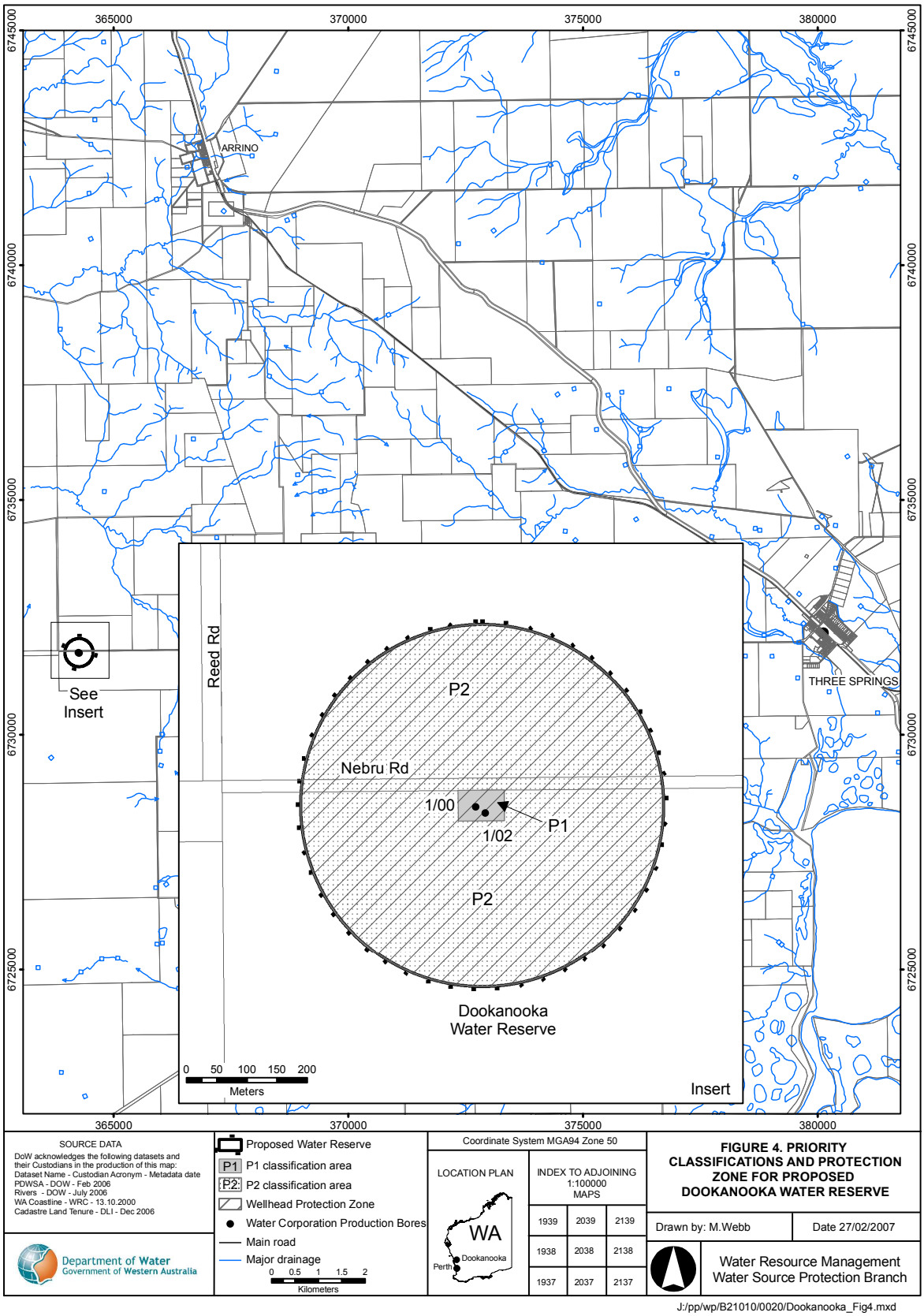

Figure 4 Priority classifications and protection zone for Dookanooka Water Reserve

4.5 Land use planning

It is recognised under the *State Planning Strategy* (Western Australian Planning Commission, 1997) that the establishment of appropriate protection mechanisms in statutory land use planning processes is necessary to secure the long-term protection of drinking water sources. As outlined in Statement of Planning Policy No.2.7 *Public Drinking Water Source Policy* (Western Australian Planning Commission, 2003) it is appropriate that the Dookanooka Water Reserve, protection zones and priority classifications be recognised in the Shire of Three Spring's Town Planning Scheme. Land use and activities in this water reserve should be guided by this Plan and the Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas.* Any development proposals located within the Dookanooka Water Reserve that are inconsistent with the Department of Water's Water Quality Protection Note *Land use compatibility in Public Drinking Water Source Areas* should be referred to the Department of Water for advice and recommendations.

4.6 Best management practices

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

There are guidelines available for many land uses in the form of industry codes of practice, environmental guidelines or Water Quality Protection Notes. These have been developed in consultation with stakeholders such as industry groups, producers, state government agencies and technical advisers. Examples include *Agriculture – dryland crops near sensitive water resources* and *Stockyards* (see References section). The guidelines help managers reduce the risk of their operations causing unacceptable environmental impacts. They are recommended as best practice for water quality protection.

Education and awareness (eg signage and information material) is a key mechanism for water quality protection, especially for those people visiting the area who are unfamiliar with the Dookanooka Water Reserve. A brochure will be produced once this Plan is endorsed, describing the Dookanooka Water Reserve, its location and the main threats to water quality protection. This brochure will be made available to the community and will serve to inform people in simple terms about the drinking water source and its protection.

4.7 Surveillance and By-law enforcement

The quality of public drinking water sources within country areas of the State is protected under the *CAWS Act 1947*. Declaration of these areas allows existing By-laws to be applied to protect water quality.

The Department of Water considers By-law enforcement, through on-ground surveillance of land use activities in Public Drinking Water Source Areas as an important water quality protection mechanism.

Signs are erected to educate the public and to advise of activities that are prohibited or regulated. This Plan recommends that the delegation of surveillance and By-law enforcement to the Water Corporation.

4.8 Emergency response

Escape of chemicals during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of Three Spring's Local Emergency Management Advisory Committee (LEMAC) through the Mid West-Gascoyne Emergency Management District should be familiar with the location and purpose of the Dookanooka Water Reserve. A locality plan should be provided to the Fire and Rescue Services headquarters for the Hazardous Materials Emergency Advisory Team (HAZMAT). The Water Corporation should have an advisory role to any HAZMAT incident in the Dookanooka Water Reserve.

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

4.9 Recommended protection strategies

Table 1 identifies the potential water quality risks associated with existing land uses in the Dookanooka Water Reserve and recommends protection strategies to minimise these risks.

Following publication of the final Dookanooka Water Reserve Drinking Water Source Protection Plan, an Implementation Strategy will be drawn up based on the recommendations in Table 1. It will describe timeframes and funding sources for the recommended protection strategies and identify responsible stakeholders. This is reflected in the Recommendations section of this plan.

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

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Broad acre cropping: • Wheat • Barley • Lupins • Canola	Nutrients from fertilizer application	Medium	Cereal cropping is the dominant land use in the area. All farms apply nitrogen and phosphorous to the soil with soil and plant testing often used to optimise application rates. No-tillage farming is becoming more common. Depth to the water table is >60m and aquifer is semi-confined	• Water quality monitoring • Sealed bores and fenced compound • Signage - at wellfield and Arrowsmith Groundwater Area	Best practice management as recommended in this Department's note *Agriculture – dryland crops near sensitive water resources* and the Department of Agriculture and Food Farmnote series. New bores in the vicinity of the production bores should be appropriately assessed by the Department of Water.
	Pesticides	Low	Herbicides used in the area include glyphosate, simazine, atrazine and others with application usually occurring at seeding and 4 to 8 weeks later if required. Pesticides used include chlorophyrifos, cypermethtrin, alphamethrin and others with application as required. Depth to the water table is >60m and aquifer is semi-confined	• Water quality monitoring • Sealed bores and fenced compound • Signage - at wellfield Arrowsmith Groundwater Area	Best practice management for the application of pesticides and herbicides as recommended in Statewide Policy No.2 *Pesticide use in Public Drinking Water Source Areas* and Circular No: PSC 88 *Use of Herbicides in Water Catchment Areas* New bores in the vicinity of the production bores should be appropriately assessed by the Department of Water.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
Stock Grazing: • Sheep • Cattle	Nutrients from animal manure	Low	Sheep and cattle grazing are generally secondary land uses to cropping in the area and stocking rates are usually low. Depth to groundwater is >60m and aquifer is semi-confined.	• Water quality monitoring • Sealed bores and fenced compound • Signage - at wellfield and Arrowsmith Groundwater Area	Best practice management as recommended in the Department of Agriculture and Food's Farmnote series New bores in the vicinity of the production bores should be appropriately assessed by the Department of Water.
	Pathogens from animal manure	Low			
Roads	Hydrocarbons from accidents or spills	Low	Bulk haulage on roads in the area is mainly associated with servicing farms ie haulage of grain, fertilizer and chemicals. The bores are located upslope and approximately 50m from Nebru Road, an unsealed rural access road. Accidents and spills are rare. The Local Emergency Management Advisory Committee (LEMAC) responds to incidents.	• Water quality monitoring • Sealed bores and fenced compound • Signage – at wellfield and Arrowsmith Groundwater Area • LEMAC response	Best practice management as recommended in this Department's Note *Roads near sensitive water resources.* Continuation of water quality monitoring and surveillance program.
	Pesticides from accidents or spills	Low			
	Nutrients from accidents or spills involving fertilizer	Low			
Mineral exploration	Hydrocarbons	Low	Exploration bores can potentially provide a pathway for contaminants to travel down into	• DOIR place specific conditions on the mining tenement	Exploration drilling should be located outside the Wellhead Protection Zone.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	**Management priority**			
	Nutrients	Medium	the semi-confined aquifer.	with regards to the presence of a Water Reserve • Water quality monitoring • Sealed bores and fenced compounds	All exploration bores drilled within close proximity of the production bores should be backfilled and sealed in an approved manner.
	Pathogens	Medium			
Intensive Agriculture (potential)	Nutrients Pesticides Hydrocarbons	Medium	Under the current rural land use zoning there is the potential for intensification of agricultural activities on the land within and surrounding the proposed Water Reserve. Depth to groundwater is >60m, bores are >200m deep and aquifer is semi-confined.	• Water quality monitoring • Land use planning approvals process	Relevant local government authorities to refer development proposals that are inconsistent with the Department's Land Use Compatibility Table to the Department of Water for advice and recommendations. New bores in the vicinity of the production bores should be appropriately assessed by this Department.

5 Recommendations

1 Implement the recommended protection strategies as detailed in *Table 1: Land use, potential water quality risks and recommended strategies* of this Plan *(Applicable stakeholders)*.

2 The boundary of the Dookanooka Water Reserve should be amended under the *Country Areas Water Supply Act 1947 (Department of Water).*

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

4 The Shire of Three Springs Town Planning Scheme should incorporate this Plan and reflect the identified Dookanooka Water Reserve boundary, Priority 1 and Priority 2 classifications and the protection zone *(Shire of Three Springs)*.

5 All development proposals within the Dookanooka Water Reserve that are inconsistent with the Water Quality Protection Note *Land use compatibility in Public Drinking Water Source Areas* or Statement of Planning Policy No.2.7 *Public Drinking Water Source Policy* should be referred to the Department of Water for advice and recommendations (*Department for Planning and Infrastructure, Shire of Three Springs)*.

6 Applications to construct a bore and/or extract groundwater in close proximity to the production bores within the Dookanooka Water Reserve should be assessed to ensure that the bores are appropriately located. Best management practices should be recommended for the maintenance and construction of the bores to prevent potential contamination or reduction in water availability to the public drinking water source bores (*Department of Water)*.

7 Exploration bores drilled in close proximity to the production bores must be backfilled and sealed in an approved manner (*Mining tenement holder, Department of Water).*

8 Any new exploration bores should be located outside of the Wellhead Protection Zones. Proposals to undertake exploration drilling within the Wellhead Protection Zones should be forwarded to the Department of Water for advice and recommendations (*Mining tenement holder, Department of Industry and Resources).*

9 Incidents covered by WESTPLAN – HAZMAT in the Dookanooka Water Reserve should be addressed through the following:

- the Mid West-Gascoyne LEMAC should be aware of the location and purpose of the Dookanooka Water Reserve;
- the locality plan for the Dookanooka Water Reserve is provided to the Fire and Rescue headquarters for the HAZMAT Emergency Advisory Team;
- the Water Corporation provides an advisory role during incidents in the Dookanooka Water Reserve; and
- personnel dealing with WESTPLAN – HAZMAT incidents in the area have ready access to a locality map of the Dookanooka Water Reserve and training to understand the potential impacts of spills on drinking water quality

(*Department of Water, Water Corporation)*.

10 Pursuant to Section 13(1) of the *Water and Rivers Commission Act 1995*, the Department of Water should consider delegating responsibility for surveillance and enforcement measures of the Dookanooka Water Reserve to the Water Corporation (*Water Corporation*).

11 Signs located along the boundary of the Dookanooka Water Reserve 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 (*Water Corporation*).

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

Appendices

Appendix A - Water quality

The information provided in this appendix was developed by the Water Corporation's Water Quality Branch.

The Water Corporation has monitored the raw (source) water quality from the Dookanooka borefield 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 including:

- health related chemicals; and
- microbiological contaminants.

Following is data representative of the quality of raw water from the Dookanooka borefield. 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 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 Three Springs refer to the most recent Water Corporation Drinking Water Quality Annual Report at <www.watercorporation.com.au./W/waterquality_annualreport.cfm?uid=2377-9937-9579-7091>.

Aesthetic related characteristics

Aesthetic water quality analyses for raw water from Dookanooka borefield are summarised in the following table.

The values are taken from ongoing monitoring for the period January 2002 to May 2007. 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.

Turbidity, chloride, sodium, pH and iron concentration have been measured at levels exceeding the guidelines. Salinity (TFSS) has consistently been measured at levels

above the ADWG aesthetic level (500mg/L), however it is stated in the ADWG that a level between 500 – 1000mg/L is acceptable based on taste.

Aesthetic related detections for Dookanooka borefield

Parameter	Units	ADWG Aesthetic Guideline Value*	Dookanooka Borefield Raw Water SP	
			Range	Median
Aluminium unfiltered	mg/L	NA	<0.008 - 0.03	<0.008
Chloride†	mg/L	250	305 - 350	327.5
Conductivity at 25ºC	mS/m	NA	105 - 200	115
Hardness as $CaCO_3$†	mg/L	200	70 - 85	77.5
Iron unfiltered	mg/L	0.3	0.004 - 0.65	0.135
Manganese unfiltered	mg/L	0.1	0.004 - 0.028	0.02
pH	-	6.5 - 8.5	5.3 - 5.91	5.8
Sodium†	mg/L	180	200 - 215	207.5
Sulphate†	mg/L	250	39 - 41	40
TFSS†	mg/L	500	645 - 705	675
Turbidity	NTU	5	<0.1 - 6	0.5

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

†Water quality data observed from 2 sampling occasions

Health related characteristics

Health Parameters

Raw water from Dookanooka borefield is analysed for health related chemicals including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that were measured at detectable levels in the source between January 2002 and May 2007 are summarised in the following table. All health related water quality parameters detected in the water source were within the ADWG levels and pose no health concern.

Health related detections for Dookanooka borefield

Parameter	Units	ADWG Health Guideline Value*	Dookanooka Borefield Raw Water SP	
			Range	Median
Barium†	mg/L	0.7	0.1 - 0.16	0.13
Boron†	mg/L	4	0.12 - 0.14	0.14
Manganese unfiltered	mg/L	0.5	0.004 - 0.028	0.02
Mercury†	mg/L	0.001	<0.0005 - 0.0008	<0.0005
Nitrate as nitrogen	mg/L	11.29	0.2 - 0.66	0.25
Nitrite as nitrogen	mg/L	0.91	<0.002 - 0.012	<0.002
Nitrite plus nitrate as N†	mg/L	11.29	0.16 - 0.2	0.18
Sulphate†	mg/L	500	39 - 41	40

* A health guideline value is the concentration or measure of a water quality characteristic that, based on present knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHRMC & ARMCANZ, 1996).

† Water quality data observed from 3 or less sampling occasions

Microbiological contaminants

Microbiological testing of raw water samples from Dookanooka borefield is currently conducted on a monthly basis. *Escherichia coli* counts are used as an indicator of the degree of recent faecal contamination of the raw water from warm-blooded animals. A detection of *Escherichia coli* in raw water abstracted from any bore may indicate possible contamination of faecal material through ingress in the bore, or recharge through to the aquifer (depending on aquifer type).

During the reviewed period of January 2002 to May 2007, no positive *Escherichia coli* counts were recorded in any samples collected from the borefield. This is indicative of minimal contamination of the groundwater from faecal sources.

Appendix B - Photographs

Photo 1 Nebru Road and the surrounding rural land use

Photo 2 Water Corporation Production Bore 1/00

Glossary

Abstraction	The pumping of groundwater from an aquifer.
ADWG	The Australian Drinking Water Guidelines, outlining guideline criteria for the quality of drinking water in Australia.
Aesthetic guideline	NHMRC guideline level ascribed to acceptable aesthetic qualities of drinking water such as taste, smell, colour and temperature.
AHD	Australian Height Datum is the height of land in metres above mean sea level. For example this is +0.026 m at Fremantle.
Allocation	The quantity of water permitted to be abstracted by a licence, usually specified in kilolitres per year (kL/a).
ANZECC	Australian and New Zealand Environment Conservation Council.
Aquifer	A geological formation or group of formations able to receive, store and transmit significant quantities of water.
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand.
Bore	A narrow, lined hole, also known as a well, drilled to monitor or draw groundwater.
Borefield	A group of bores to monitor or withdraw groundwater.
Catchment	The area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
CFU	Colony forming units is a measure of pathogen contamination in water.
Confined aquifer	An aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure.
HAZMAT	Hazardous Materials
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
kL	Kilolitres (1000 litres)
km	Kilometres (1000 metres)
LEMAC	Local Emergency Management Advisory Committee

m	Metres
mg/L	Milligrams per litre (0.001 grams per litre)
mm	Millimetres
MPN	Most probable number, a measure of microbiological contamination.
mSv	Millisieverts, a measure of annual radiological dose
NHRMC	National Health and Medical Research Council.
NTU	Nephelometric turbidity units are a measure of turbidity in water.
Nutrients	Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
Pathogen	Disease producing organisms that can cause disease through the consumption of water which include bacteria (such as Escherichia coli), protozoa (such as Cryptosporidium and Giardia) and viruses.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms.
Public Drinking Water Source Area (PDWSA)	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the *Metropolitan Water Supply Sewerage and Drainage Act 1909* and the *Country Areas Water Supply Act 1947*.
Recharge	Water infiltrating to replenish an aquifer.
Recharge area	An area through which water from a groundwater catchment percolates to replenish (recharge) an aquifer. An unconfined aquifer is recharged by rainfall throughout its distribution. Confined aquifers are recharged in specific areas where water leaks from overlying aquifers, or where the aquifer rises to meet the surface.
Scheme supply	Water diverted from a source or sources by a water authority of private company and supplied via a distribution network to customers for urban, industrial or irrigation use.
Semi-confined aquifer	A semi-confined or leaky aquifer is saturated and bounded above by a semi-permeable layer and below by a layer that is either impermeable or semi-permeable.

TCU	True colour units, a measure of colour in water
TDS	Total dissolved salts, a measurement of ions in solution, such as salts in water.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment.
Unconfined aquifer	An aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the watertable.
Water quality	The physical, chemical and biological measures of water.
Water Reserve	An area proclaimed under the *Country Areas Water Supply Act 1947* or the *Metropolitan Water Supply Sewerage and Drainage Act 1909* for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater.
Wellfield	A group of bores to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater. A wellhead protection zone (WHPZ) is usually declared around wellheads in drinking water areas to protect the water source from contamination.
WESTPLAN HAZMAT	Western Australian Plan for Hazardous Materials.

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