



Department of Water
Government of Western Australia



Bindoon-Chittering Water Reserve Drinking Water Source Protection Plan

Bindoon-Chittering Town Water Supply

Water Resource Protection Series

REPORT NO. 73
July 2007



Department of **Water**
Government of Western Australia

Bindoon-Chittering Water Reserve Drinking Water Source Protection Plan

Bindoon-Chittering Town Water Supply

Department of Water

Water Resource Protection Series

Report WRP 73

July 2007

Department of Water

Level 4, 168 St Georges Terrace
Perth Western Australia 6000

<www.water.wa.gov.au>

Telephone +61-8-6364 7600

Facsimile +61-8-6364 7601

For more information about this report, contact
Program Manager Protection Planning, Water Source Protection Branch, or send an
email to drinkingwater@water.wa.gov.au.

July 2007

ISSN 1326-7442

Subject of cover photograph

Bore CCC2 and surrounding compound, taken by Kellie Ketteringham

Contents

Contents.....	iii
Tables.....	iv
Preface.....	v
Summary.....	vi
1 Drinking water source overview.....	1
1.1 Existing water supply system.....	1
1.2 Water treatment.....	1
1.3 Catchment details.....	1
1.3.1 Physiography.....	1
1.3.2 Climate.....	1
1.3.3 Hydrogeology.....	2
1.4 Future water supply requirements.....	2
1.5 Protection and allocation.....	2
1.5.1 Existing water source protection.....	2
1.5.2 Current allocation licence.....	2
2 Water quality monitoring and contamination risks.....	6
2.1 Microbiological contaminants.....	6
2.2 Health related chemicals.....	6
2.3 Aesthetic characteristics.....	7
2.4 Groundwater bores.....	7
3 Land use assessment.....	9
3.1 Existing land uses.....	9
3.2 Proposed land uses.....	9
4 Catchment protection strategy.....	11
4.1 Protection objectives.....	11
4.2 Proclaimed area.....	11
4.3 Priority classifications.....	11
4.4 Protection zones.....	12
4.5 Land use planning.....	14
4.6 Best management practices.....	14
4.7 Surveillance and By-law enforcement.....	15
4.8 Emergency response.....	15
4.9 Implementation of this plan.....	15
5 Recommendations.....	18
Appendices.....	21
Glossary.....	28
References and further reading.....	31
Contributors.....	34

Appendices

Appendix A — Summary of submissions	21
Appendix B — Water quality	22
Appendix C — Hydrogeology	25
Appendix D — Photographs.....	27

Figures

Figure 1 Bindoon-Chittering Water Reserve locality map.....	4
Figure 2 Bindoon-Chittering Water Reserve	5
Figure 3 Land use and tenure within and surrounding the Bindoon-Chittering Water Reserve	10
Figure 4 Priority classifications and protection zone for Bindoon-Chittering Water Reserve	13

Tables

Table 1 Land use, potential water quality risks and recommended strategies	16
--	----

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 Bindoon-Chittering 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 sources. 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 groundwater aquifers.

This plan details the location and boundary of the drinking water reserve, which provides potable water to the Bindoon-Chittering Scheme. It 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 Chittering 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 proposed Bindoon – Chittering 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 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 Drinking Water Source Protection Plan	Final Plan published after considering advice received in submissions. Includes recommendations on how to protect the catchment.

Summary

Bindoon is a small settlement of approximately 300 people located in the Chittering Valley, 87 kilometres (km) north of Perth, Western Australia. Water Corporation abstracts groundwater from a wellfield approximately 6 km west of Bindoon. The two production bores (CCC1 and CCC2) draw water from the top part of the Leederville aquifer.

The town services surrounding farming land used predominantly for fruit growing, vineyards, cattle and sheep grazing and small rural subdivision, with tourism becoming more prominent.

The plan proposes a major reduction of the original proposed water reserve to a 300 metre (m) radius, circular Wellhead Protection Zone (WHPZ) around the production bores. The original proposed water reserve covered an approximate area of 3260 Hectares (Ha) while the new proposed water reserve will cover an approximate area of 28 Ha. The WHPZ represents about 1% of the original proposed water reserve and only intersects approximately 2% of the four surrounding private lots of land.

The protection of the source will be achieved by establishing a 300 m WHPZ around the bores. The WHPZ is also the proposed Bindoon-Chittering Water Reserve boundary.

The proposed water reserve boundary and priority classifications have been determined to provide the appropriate level of protection for the drinking water source, recognising the rights of landowners to continue established approved land use activities.

The following strategies are recommended to protect the Bindoon-Chittering Water Reserve:

- The boundary of the Reserve at Bindoon-Chittering needs to be proclaimed and best management practices and guidelines need to be available to the public to help the community protect their drinking water;
- The Water Reserve, including the WHPZ and Priority 1 and 2 classifications, should be recognised in the Shire of Chittering's Town Planning Scheme and other applicable schemes and strategies in accordance with the Western Australian Planning Commission's Statement of Planning Policy No. 2.7 - *Public Drinking Water Source Policy*; and
- Best management practices for current or approved land uses in the water reserve should be implemented.

1 Drinking water source overview

1.1 Existing water supply system

Bindoon is a small settlement located in the Chittering Valley, 87 kilometres (km) north of Perth, Western Australia (see Figure 1). The town services surrounding farming land used predominantly for fruit growing, vineyards, cattle and sheep grazing and small rural subdivision, with tourism becoming more prominent.

Chittering wellfield provides water to the Bindoon-Chittering Scheme. It is located approximately 6 km west of Bindoon (see Figure 2).

Chittering wellfield is operated by the Water Corporation and is comprised of two production bores CCC1 and CCC2 (see Figure 2). The bores draw water from the Henley Sandstone Member of the Osborne Formation, which is the top part of the Leederville aquifer. The bores are screened between 138 and 160 metres (m) with a static groundwater level of approximately 66 m below natural surface.

Water abstracted from the bores is treated at the wellfield before gravitating into a 90 kilolitre (kL) clearwater tank. Water from the clearwater tank is then pumped into a 2500 kL ground tank. Water then either gravitates to the low-level reticulation, or is pumped to a 100 kL elevated tank to supply a small high-level zone of residential services.

1.2 Water treatment

Raw (untreated) water from the Chittering bores is pre-chlorinated to precipitate iron before being removed by filtration. The pH is then corrected by caustic soda injection. Chlorination also provides a disinfection barrier against possible microbiological contamination.

1.3 Catchment details

1.3.1 Physiography

The Chittering wellfield occurs on the Dandaragan Plateau, an area bounded by the Gingin Scarp and to the east by the Darling Scarp. The Plateau is flat to gently undulating and ranges from about 140 m to 260 m above sea level. The valleys are dominated by deep red and yellow brown sands and deep yellow sands are common in the uplands (Water Authority 1993).

1.3.2 Climate

The Bindoon-Chittering area experiences a mild temperate climate with hot, dry summers and cool, wet winters. The average annual rainfall at Chittering Heights

(Station 9221) recorded since 1992 is 679.3 millimetres (Bureau of Meteorology 2006).

1.3.3 Hydrogeology

The Chittering bores abstract water from the Henley Sandstone Member, a saturated sequence of porous sand and sandstone which is confined by clay and shale of the overlying Mirrabooka Member. Recharge to the Henley Sandstone Member is primarily from upward leakage from the underlying Leederville Formation.

The Henley Sandstone and Mirrabooka Member comprise the Osborne Formation, which with the underlying Leederville Formation form part of a deep sequence of sedimentary rock within the Northern Perth Basin.

A more detailed statement of the area's hydrogeological characteristics can be found in Appendix C.

1.4 Future water supply requirements

The water source is considered adequate to meet demand for the area in which the Water Corporation is currently licensed to provide water supply, including growth due to subdivision of existing land blocks within this area. However, there is no capacity to meet additional demand from outside the Water Corporation's licensed area. Local and State Governments and the Water Corporation are considering a number of options (including water trading) to try and meet future water demands of the Bindoon and Chittering communities.

1.5 Protection and allocation

1.5.1 Existing water source protection

A Water Reserve for the Bindoon-Chittering water source has not been proclaimed under the *Country Areas Water Supply Act 1947* for the purpose of protecting the public drinking water source from potential contamination. It is proposed to proclaim the Water Reserve following consultation of this Plan.

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 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 Bindoon-Chittering groundwater resource lies within the Gingin Groundwater Area, which was proclaimed in 1975 under the *Rights in Water and Irrigation Act 1914*.

The Water Corporation is licensed to draw 220 000 kL (Groundwater Well License 65011) per annum from the Chittering wellfield for public water supply purposes. The current number of services is approximately 357. Abstraction in 2005/2006 was 194 488 kL.

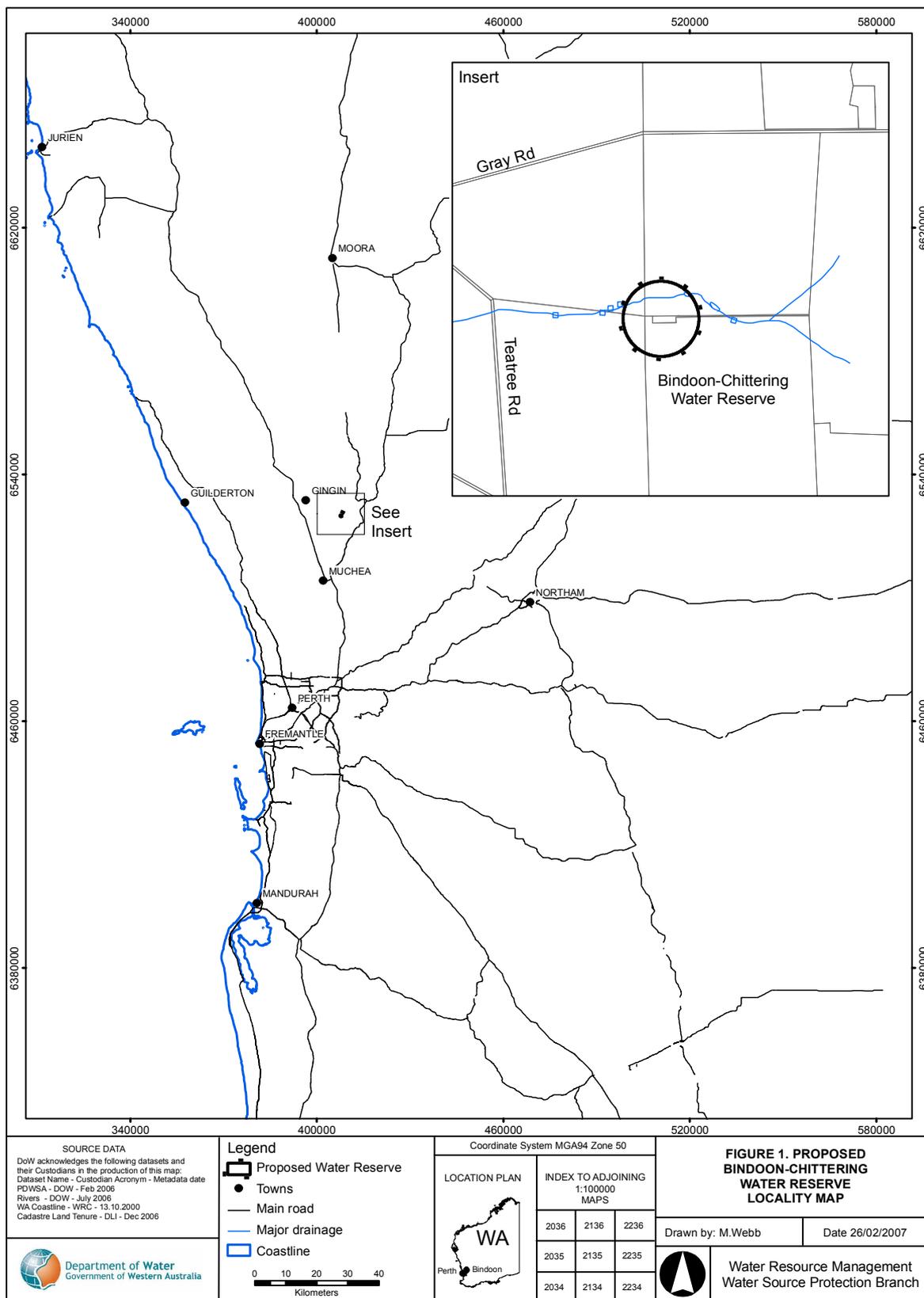


Figure 1 Bindoon-Chittering Water Reserve locality map

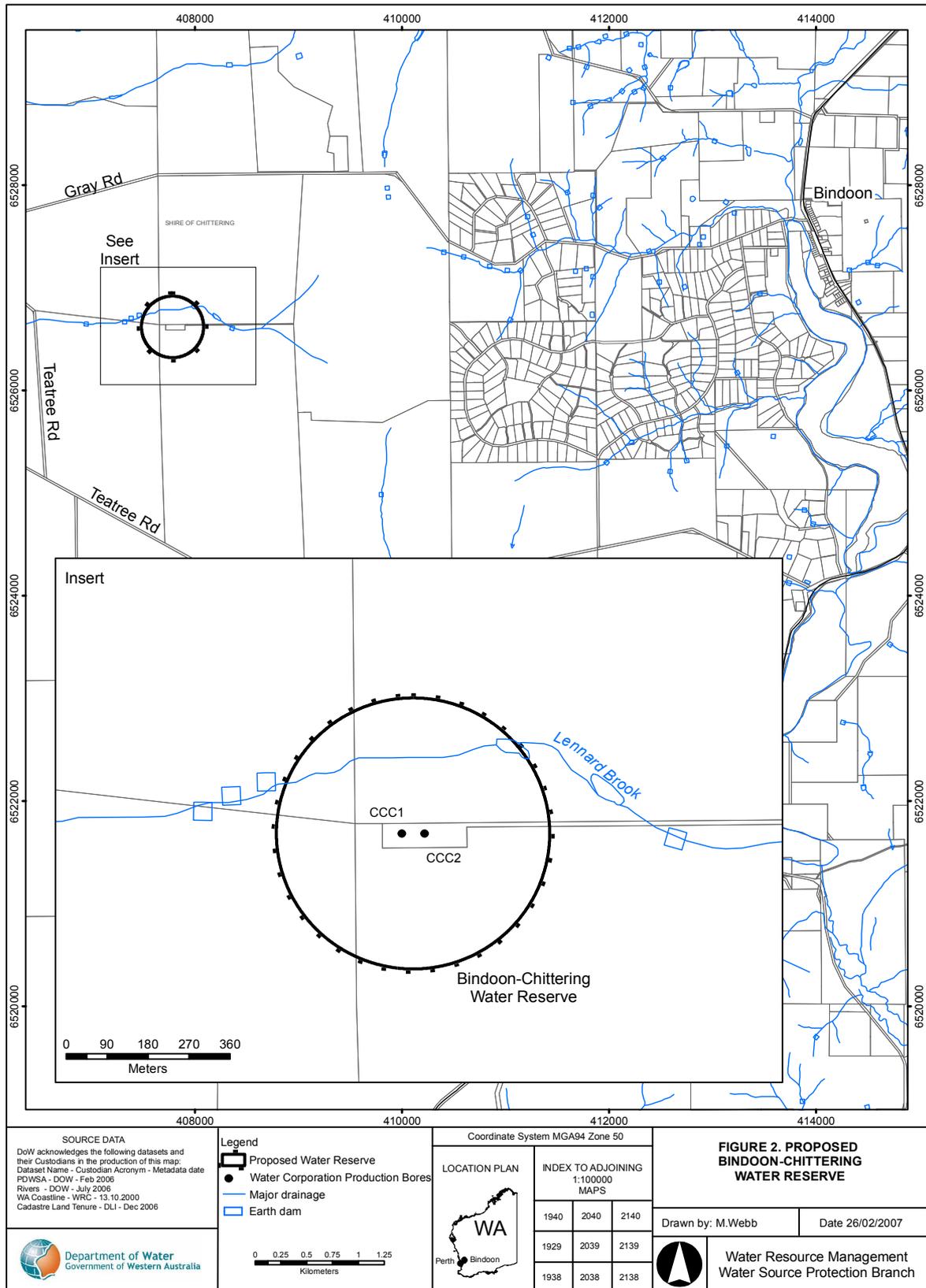


Figure 2 Bindoon-Chittering Water Reserve

2 Water quality monitoring and contamination risks

The Water Corporation regularly monitors the raw water quality from the Chittering borefield for microbiological contamination, health related chemicals 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 Chittering borefield from January 2002 to May 2007 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> > Water > Water Quality > Downloads > access the most recent Annual Report.

Contamination risks relevant to the Bindoon-Chittering 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 & NRMCC, 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 chemicals

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 2D 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 Bindoon-Chittering Water Reserve is located within Gingin 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 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.

As the bores are screened at depths between 138 and 160 m they would ordinarily be considered to have negligible risk of contamination. However, the existing production bores were not constructed strictly in accordance with the guidelines for confined aquifer bores and there is some potential for leakages to the bores groundwater extraction screens from overlying aquifers which do have a higher potential for contamination. Therefore a 300 m WHPZ is proposed to protect the aquifers from contamination in the immediate vicinity of the production bores.

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).

3 Land use assessment

3.1 Existing land uses

Land surrounding and within the proposed Bindoon-Chittering Water Reserve is currently zoned Agriculture Resource under the Shire of Chittering Town Planning Scheme No. 6. Land within the proposed reserve is privately owned and existing land uses include: 1) a vegetation protection area (as designated in the Shire of Chittering's Local Planning Strategy) which is also the Lennard Brook Reserve, 2) broad acre grazing and 3) the Water Corporation's bore compound. A sand quarry is located to the North West of the proposed Water Reserve (see Figure 3).

Broadacre cropping and grazing is the primary agricultural land use occurring in the proposed Public Drinking Water Source Area (PDWSA). Potential contaminants from these land uses include nutrients from fertiliser application and animal manure and pesticides from weed and pest control. However, the confined nature and depth of the aquifer below the proposed PDWSA results in a low risk of the water source becoming contaminated by these land uses. Extensive agriculture is compatible with the proposed Priority 2 classification of the Water Reserve (see the Department's Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas*).

3.2 Proposed land uses

The area around the Chittering wellfield has been classified as Rural Retreat under the Shire of Chittering Local Planning Strategy, with staged development planned. Although it is classified as Rural Retreat, with a minimum of 10 ha subdivision, the Plan recommends that no further subdivision should occur within the proposed PDWSA which has a total area of about 28 ha. Should subdivision occur, land use within the PDWSA must continue to comply with Priority 2 (P2) compatible land uses and existing vegetation should be retained. A definition study is currently being conducted on the future Perth-Darwin National Highway alignment with the general corridor passing between the wellfield and the Chittering townsite. The Department of Water would not support the route passing through the proposed Water Reserve. Best management practices for roads are recommended and can be found in the Department's Water Quality Protection Note – *Roads in sensitive areas*.

Under the current Agricultural Resource zoning there is the potential for intensification of agricultural land uses in the area. Nutrient and pesticide impacts are likely to be greater from more intensive agriculture, which could potentially result in a higher risk of contamination to the drinking water source than the current extensive agriculture. Any proposals to intensify the agricultural land use or to develop the land in the Water Reserve, that is inconsistent with the Water Quality Protection Note – *Land use compatibility in Public Drinking Water Source Areas*, or the Statement of Planning Policy 2.7 – *Public Water Sources*, should be referred to the Department of Water.

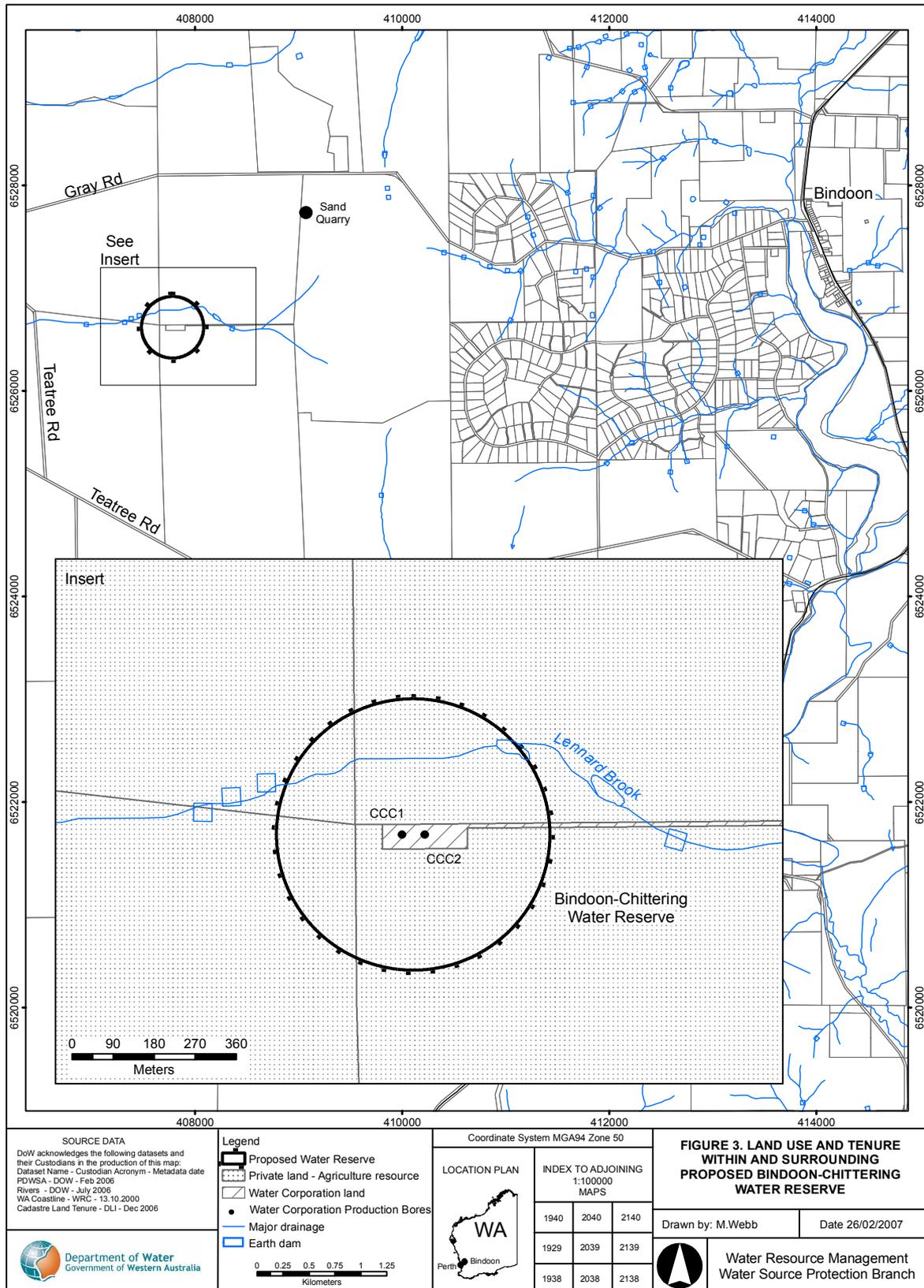


Figure 3 Land use and tenure within and surrounding the Bindoon-Chittering Water Reserve

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to protect the drinking water source to ensure safe drinking water to Bindoon and Chittering. Existing approved land uses within the Water Reserve, can continue.

The priority classifications for the Bindoon-Chittering 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, land use and zoning, and aim to provide the appropriate level of protection for the drinking water source.

4.2 Proclaimed area

The proposed Bindoon-Chittering Water Reserve will be proclaimed under the *County Areas Water Supply Act 1947* (CAWS) to ensure an appropriate level of protection for the drinking water source.

Proclaiming the Water Reserve ensures that the CAWS by-laws apply, and allows the Department to manage potentially polluting land uses. It covers the compound on which the bores are located as well as a 300m Wellhead Protection Zone that is also the boundary for the Water Reserve. This will include a portion of Lots 18 and 21 on Plan 12392 as well as Lots 14 and 15 on Plan 12192. The inclusion of this additional area will allow protection of the area where contamination of the drinking water source is most likely to occur. The proposed boundary Bindoon-Chittering Water Reserve is shown in Figure 2.

4.3 Priority classifications

An explanation of the priority classification and the protection approach and detail of land use compatibility with each priority classification can be obtained from the Departments Water Quality Protection Notes *Land use compatibility in PDWSA* and *Protecting Public Drinking Water Source Areas* (see Reference Section).

The Water Corporation's bore compound will be classified as Priority 1 (P1), in order to provide the highest level of protection. The remainder of the proposed Bindoon-Chittering Water Reserve will be classified as Priority 2 (P2), which is compatible with the current rural land use. The proposed priority classifications for Bindoon-Chittering Water Reserve are shown in Figure 4.

4.4 Protection zones

Wellhead Protection Zones (WHPZ) are defined around each bore (500 metres radius in Priority 1 areas and 300 metres radius in Priority 2 and Priority 3 areas) in which activities are to be managed to maximise protection against contamination in the immediate vicinity of the production bores (see Figure 4).

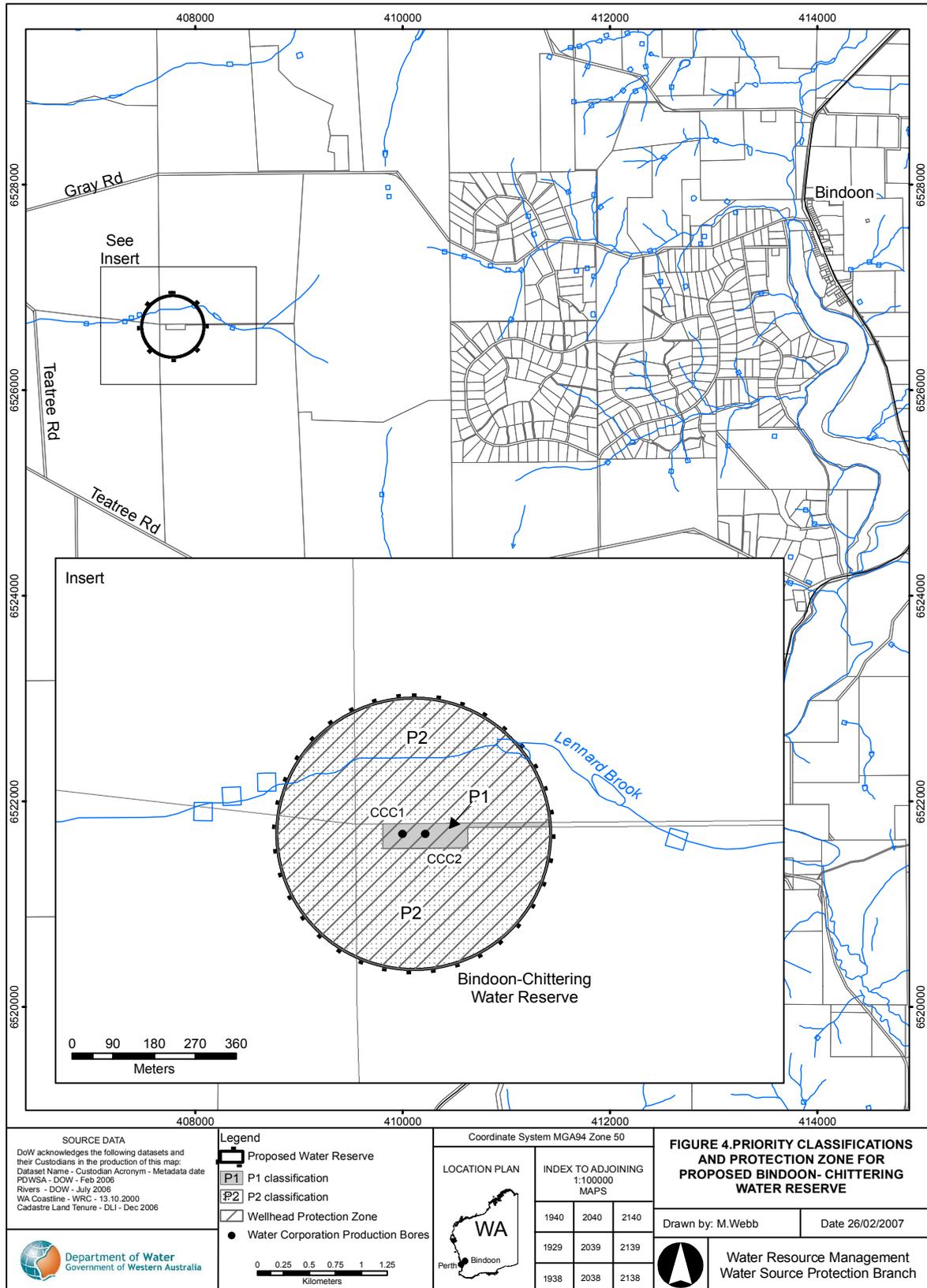


Figure 4 Priority classifications and protection zone for Bindoon-Chittering Water Reserve

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 ensure 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 therefore appropriate that the Bindoon-Chittering Water Reserve, protection zones and priority classifications be recognised in the Shire of Chittering's Town Planning Scheme. Any development proposals within the Bindoon – Chittering Water Reserve that are inconsistent with advice from 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*, *Land use compatibility in Public Drinking Water Source Areas*, *Land use planning in Public Drinking Water Source Areas* and *Protecting Public Drinking Water Source Areas*, which are listed in the References. 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 Bindoon-Chittering Water Reserve. A brochure will be produced once this Plan is endorsed, describing the Bindoon-Chittering 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, its importance and the need to protect it.

4.7 Surveillance and By-law enforcement

The quality of public drinking water sources within country areas of the State is protected under the *Country Areas Water Supply 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 around PDWSAs to educate the public and to advise of activities that are prohibited or regulated. This Plan recommends that delegation of surveillance and By-law enforcement to the Water Corporation is continued.

4.8 Emergency response

Escape of chemicals during unforeseen incidents and use of chemicals during emergency responses can result in water contamination. The Shire of Chittering's Local Emergency Management Advisory Committee (LEMAC) through the Wheatbelt Emergency Management District should be familiar with the location and purpose of the Bindoon-Chittering 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 Bindoon-Chittering 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 Bindoon-Chittering Water Reserve. These personnel should receive training to ensure an adequate understanding of the potential impacts of spills on the water resource.

4.9 Implementation of this plan

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

Following publication of the final Bindoon-Chittering 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	Pesticides	Low	Low intensity	<ul style="list-style-type: none"> Water quality monitoring The bores are sealed at ground level and within fenced compounds Signage at wellfield 	Best practice management (as recommended in Statewide Policy No.2 <i>Pesticide use in Public Drinking Water Source Areas</i> and Circular No: PSC 88 <i>Use of Herbicides in Water Catchment Areas</i>) be adopted for the use and application of pesticides and herbicides within the Water Reserve.
	Nutrients from fertiliser application	Medium	Low intensity	<ul style="list-style-type: none"> Water quality monitoring The bores are sealed at ground level and within fenced compounds Signage at wellfield 	Best practice management as recommended in this Department's note <i>Agriculture – dryland crops near sensitive water resources</i> and the Department of Agriculture and Food Farmnote series.
Grazing	Nutrients from animal manure	Low	Low intensity	<ul style="list-style-type: none"> Water quality monitoring The bores are sealed at ground level and within fenced compounds Signage at wellfield 	Best practice management as recommended in the Department of Agriculture and Food's Farmnote series.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Grazing cont.	Microbiological contaminants from animal manure	Low	Low intensity	<ul style="list-style-type: none"> • Water quality monitoring • The bores are sealed at ground level and within fenced compounds • Signage at wellfield 	Best practice management as recommended in the Department of Agriculture and Food's Farmnote series.
Roads	Hydrocarbons from dangerous goods transport including fuel and tanker spills and accidents	Low	Low intensity	<ul style="list-style-type: none"> • Water quality monitoring • The bores are sealed at ground level and within fenced compounds • Signage at wellfield • LEMAC response 	<p>Best practice management for new and proposed roads as recommended in this Department's Note <i>Roads near sensitive water resources</i>.</p> <p>Continuation of water quality monitoring, surveillance program and LEMAC response.</p>

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 proposed Bindoon-Chittering Water Reserve should be proclaimed 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 Chittering Town Planning Scheme should incorporate this Plan and reflect the Bindoon-Chittering Water Reserve boundary, Priority 1 and Priority 2 classifications and protection zones in accordance with the Statement of Planning Policy No.2.7 – *Public Drinking Water Source Policy (Shire of Chittering)*.
- 5 All development proposals within the Bindoon-Chittering Water Reserve that are inconsistent with 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 Chittering*).
- 6 Assessment of development or subdivision proposals that relate to the proposed PDWSA by the Department of Water should support the retention of native vegetation within the Lennard Brook Landscape Protection Area (as designated in the Shire of Chittering’s Local Planning Strategy) and the WHPZ.
- 7 Applications to construct a bore and/or extract groundwater in close proximity to the production bores within the Bindoon-Chittering Water Reserve should be assessed to ensure that the bores are appropriately located. Bores within the proposed PDWSA would not be supported. Other bores considered to constitute a risk to the PDWSA will require best management practices 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*).
- 8 Incidents covered by WESTPLAN – HAZMAT in the Bindoon-Chittering Water Reserve should be addressed through the following:
 - The *Wheatbelt* LEMAC should be aware of the location and purpose of the Bindoon-Chittering Water Reserve.
 - The locality plan for the Bindoon-Chittering 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 Bindoon-Chittering Water Reserve.
 - Personnel dealing with WESTPLAN – HAZMAT incidents in the area have ready access to a locality map of the Bindoon-Chittering Water Reserve and training to understand the potential impacts of spills on drinking water quality.

(Department of Water, Water Corporation)

- 9 The surveillance program should be maintained to identify any incompatible land uses or potential threats to the Bindoon-Chittering Water Reserve (*Water Corporation*).
- 10 Signs located along the boundary of the Bindoon-Chittering Water Reserve should be maintained to define the location and promote awareness of the need to protect drinking water quality (*Water Corporation*).
- 11 The future water allocation for the wider Bindoon-Chittering area needs to be addressed through options that are best suited to the environment, community, the local and state governments and the Water Corporation (*Department of Water, Shire of Chittering, Water Corporation*).
- 12 Upon replacement of the existing production bores, construction of new bores should be in accordance with appropriate guidelines to ensure no hydraulic connection with overlying aquifers. Any decommissioned bores must be pressure sealed to prevent potential contamination (*Water Corporation*).
- 13 A review of this Plan should be undertaken after five years or following replacement of the existing bores (*Department of Water*).

Appendices

Appendix A – Summary of submissions

The following table is a summary of the submissions received from the 2007 release of the Draft Plan, the current status of that issue and how they have been addressed in this current Plan.

Summary of submissions from the 2007 release of the Draft Plan

Issue raised	Current status	Response in Plan/Comment
Hydrogeology is inaccurate.	Reviewed the documents referenced in the hydrogeology section of the DWSPP. Found to be an adequate representation of the Bindoon-Chittering area.	No change in plan.
The boundary and priority classifications of the Water Reserve need to be changed.	Reviewed the boundary and classifications of the Water Reserve based on the hydrogeology of the report. Found to be an adequate boundary and correctly classified priority areas.	No change in plan.
Timeliness of producing an implementation plan is of concern. Need to involve private stakeholders more.	Assured submitter that we endeavour to produce the implementation plan as soon as it is feasible as well as involving all relevant stakeholders.	No change in plan.
Concerns in cost of maintaining water source protection.	Outside the scope of the DWSPP.	No change in plan.
Concerns with the licensing of private bores.	Outside the scope of the DWSPP.	No change in plan.
Concerns with the legislation of the Department of Water.	Outside the scope of the DWSPP.	No change in plan.
Future water allocation for Bindoon-Chittering needs to be addressed.	Recommendation was formed with consultation with the Water Corporation; this adequately addresses who needs to be consulted for the future water allocation for the wider Bindoon-Chittering area.	Stated as Recommendation 11 in plan.
When will the production bores be replaced?	There was no surety stated due to consultation with the Water Corporation and concluding that the bores are adequately protected through the additional wellhead protection zone until their end of life.	No change in plan.

Appendix B – 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 Chittering 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); and
- b. health related characteristics including:
 - health related chemicals; and
 - microbiological contaminants.

Following is data representative of the quality of raw water in Chittering 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 Bindoon-Chittering Scheme 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 Chittering borefield are summarised in Table 1.

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.

The raw water from Chittering borefield is of fair quality with the exception of high iron and manganese concentrations, pH and turbidity. Colour and turbidity in the raw water are occasionally above the ADWG value due to the precipitation of iron.

The pH levels are occasionally more acidic than the ADWG aesthetic level after treatment. The ADWG level for pH is based on minimising corrosion and encrustation of pipes. The occasionally low pH levels in the Bindoon-Chittering Town Water Supply pose no threat to human health.

Aesthetic related detections for Chittering borefield.

Parameter	Units	ADWG Aesthetic Guideline Value*	Chittering Borefield Raw Source SP	
			Range	Median
Aluminium unfiltered	mg/L	NA	<0.008 – 0.032	<0.008
Chloride [†]	mg/L	250	145 – 160	152.5
Colour – True	TCU	15	<1 – 10	2
Conductivity at 25°C	mS/m	NA	51 – 89	56
Hardness as CaCO ₃ [†]	mg/L	200	45 – 48	46.5
Iron unfiltered	mg/L	0.3	3.2 – 13	7.5
Manganese unfiltered	mg/L	0.1	0.055 – 0.18	0.101
pH	–	6.5 – 8.5	5.73 – 6.16	5.94
Sodium [†]	mg/L	180	82 – 86	84
Sulphate [†]	mg/L	250	18	18
TFSS [†]	mg/L	500	334 – 350	342
Turbidity	NTU	5	<0.1 – 90	0.6

* 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 Chittering borefield 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 sources between January 2002 and May 2007 are summarised in the table below. All health related water quality parameters detected were within ADWG levels and pose no health concern.

Health related detections for Chittering borefield.

Parameter	Units	ADWG Health Guideline Value*	Chittering Borefield Raw Source SP	
			Range	Median
Barium [†]	mg/L	0.7	0.03 – 0.035	0.03
Boron [†]	mg/L	4	<0.02 – 0.034	0.03
Fluoride	mg/L	1.5	0.3 – 0.35	0.325
Manganese unfiltered	mg/L	0.5	0.055 – 0.18	0.101
Nitrate as nitrogen [†]	mg/L	11.29	0.039 – 0.21	0.1245
Nitrite as nitrogen [†]	mg/L	0.91	0.007 – 0.011	0.009
Sulphate [†]	mg/L	500	18	18

* 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 Chittering 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 C – Hydrogeology

The Chittering bores abstract water from the Henley Sandstone Member.

The Chittering borefield is located within the Barberton Terrace, an area of shallow basement situated between the Darling and Muchea Faults (Mory & Iasky 1996). The area is underlain by a sequence of sedimentary rocks predominantly of Cretaceous age. The Cretaceous sediments are obscured by a veneer of Cainozoic sediments.

- Cainozoic sediments

Cainozoic sediments across the Chittering borefield area comprise colluvial and aeolian sand and silt, alluvial silty sand, and lateritic gravel and sand. The thickness of the Cainozoic sediments in Chittering Country Club 2 bore is 18 m.

- The Molecap Greensand

The Molecap Greensand is of Cretaceous age and overlies the Mirrabooka Member of the Osborne Formation. The Molecap Greensand is described as a poorly consolidated, fine to coarse, grey to dark greenish-grey silty sandstone, weathering to a yellow – brown (Moncrieff, 1989). Within the Eclipse Hill Subarea the Molecap Greensand is difficult to distinguish from the underlying Mirrabooka Member without palynological evidence (Kay and Diamond 2001). The Molecap Greensand and underlying Mirrabooka Member have a combined thickness exceeding 120 m within the Eclipse Hill Subarea.

- The Osborne Formation

The Henley Sandstone Member of the Osborne Formation unconformably overlies the Pinjar Member of the Leederville formation. The Kardinya Shale Member of the Osborne Formation is not apparent between the Muchea and the Darling Faults within the Eclipse Hill Sub Area. The sand shale sequence observed in the Chittering Country Club bores (CCC1 and CCC2) may represent the Mirrabooka Member of the Osborne Formation (Kay and Diamond 2001).

The Henley Sandstone Member is about 30 m thick. It comprises fine to coarse sandstone.

In this area it is likely that groundwater will be present as ephemeral perched aquifers and saturated discontinuous sandy horizons situated in unconfined sediments within the Cainozoic veneer, Molecap Greensand and Mirrabooka Member of the Osborne Formation. Groundwater levels of the surficial aquifer within the Eclipse Hill Subarea can range from a few metres below the surface for perched groundwater systems to about 10 m below ground level for more extensive unconfined saturated sediments. Recharge to the surficial aquifers will be from direct infiltration from local rainfall and indirectly from surface run – off.

Groundwater will be present within saturated porous sand and sandstone of the Henley Sandstone Member of the Osborne Formation and the underlying Pinjar Member of the Leederville Formation. Within the Eclipse Hill Groundwater Subarea the Henley Sandstone Member is in hydraulic connection with the underlying Pinjar Member of the Leederville Formation and forms the top part of the Leederville aquifer. (Kay & Diamond 2001)

The Henley Sandstone Member of the Osborne Formation and the underlying Leederville Formation are confined by clay and shale sequences within the overlying Mirrabooka Member. Recharge to the Henley Sandstone Member is primarily by upward leakage from the underlying Leederville Formation. The main recharge area for the Leederville aquifer is about 100 km north in an area referred to as the Agaton area (Commander 1981).

As the bores are screened between 138 and 160 m they would ordinarily be considered to have negligible risk of contamination. However, as the bores were not constructed strictly in accordance with the guidelines for confined bores there is some potential for leakages to the bores groundwater extraction screens from overlying aquifers which have a higher potential for contamination. Therefore a 300 m WHPZ is proposed to protect the aquifer in the immediate vicinity of the bores from contamination.

Appendix D – Photographs

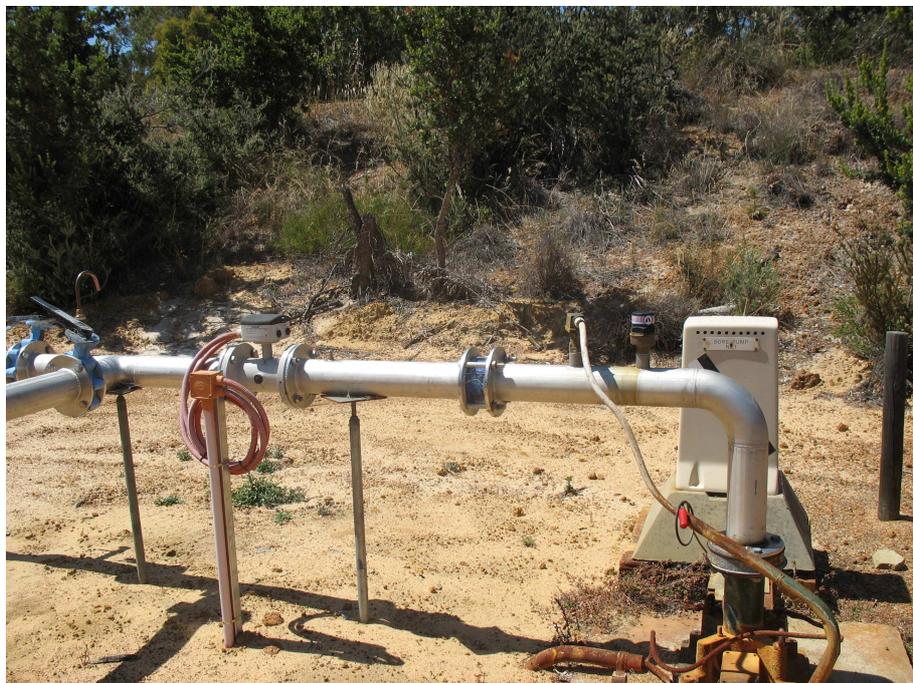


Photo 1 Bore CCC1



Photo 2 Bore CCC2

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.
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.
Ha	Hectare (a measure of area)
HAZMAT	Hazardous Materials.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
km	Kilometres (1000 metres)

LEMAC	Local Emergency Management Advisory Committee
m	Metres
mg/L	Milligrams per litre (0.001 grams per litre)
mm	Millimetres
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.
Perched	An unconfined aquifer, often ephemeral or seasonal, perched on top of an impermeable horizon near the land surface and separated from deeper groundwater by an unsaturated zone.
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 <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> and the <i>Country Areas Water Supply Act 1947</i> .
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.
TCU	True Colour
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.
Water quality	The physical, chemical and biological measures of water.
Water Reserve	An area proclaimed under the <i>Country Areas Water Supply Act 1947</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> for the purposes of protecting a drinking water supply.
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 a 300 m or a 500 m protection zone declared around Wellheads in drinking water areas to protect the water source from contamination.
WESTPLAN HAZMAT	Western Australian Plan for Hazardous Materials.

References and further reading

- Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) & Australian and New Zealand Environment and Conservation Council (ANZECC) 1996, *Draft Rural Land Uses and Water Quality – A Community Resource Document*, ARMCANZ & ANZECC, Canberra.
- BSD Consultants Pty Ltd 1985, *Chittering Country Club Estate Bore Completion Report: Bores CCC1 and CCC2*, (unpublished).
- Commander D.P 1981, *The Hydrogeology of the Eneabba Area, Western Australia*, The University of Western Australia, MSc Thesis (unpublished).
- Davison, WA & Yu, X 2004, *Perth Region Aquifer Modelling System – PRAMS: Hydrogeological and Conceptual Model*, Department of Environmental Hydrogeology Report No. 22, (unpublished).
- Department of Health 2007, *Use of Herbicides in Water Catchment Areas*, Circular No: PSC 88, February 2007, Department of Health, Perth.
- Department of Water Various Dates, *Water Quality Protection Notes – Various Titles*, Department of Water, Perth, available <www.water.wa.gov.au> Water Quality > Publications > Water Quality Protection Notes.
- Government of Western Australia 1914, *Rights in Water and Irrigation Act*, Reprinted under the *Reprints Act 1984* as at 4 July 2006, available <www.slp.wa.gov.au/statutes/swans.nsf>.
- Government of Western Australia 1947, *Country Areas Water Supply Act*, Reprinted under the *Reprints Act 1984* as at 7 April 2006, available <www.slp.wa.gov.au/statutes/swans.nsf>.
- Kay, T & Diamond, R 2001, *A Hydrogeological Assessment of the Victoria Plains, Red Gully, Gingin Townsite and Eclipse Hill Subareas of Gingin Groundwater Area*, Water and Rivers Commission, Hydrogeology Report HR 156.
- Moncrieff, J.S 1989, *Hydrogeology of the Gillingarra Borehole Line*, Perth Basin: Western Australia Geological Survey, Report 26, Professional Papers for 1988, p. 105 – 126.
- Mory, A.J & Iasky, R.P 1996, *Stratigraphy and structure of the onshore Northern Perth Basin*, Western Australia: Western Australia Geological Survey, Report 46.
- National Health and Medical Research Council (NHMRC) & Natural Resource Management Ministerial Council (NRMMC) 2004, *National Water Quality Management Strategy: Australian Drinking Water Guidelines*, Australian

Government, Canberra, available
<www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.

NHMRC & NRMCC 2004b, *Water Made Clear – A consumer guide to accompany the Australian Drinking Water Guidelines 2004*, Australian Government, Canberra.

National Minimum Bore Specifications Committee 2003, *Minimum construction requirements for water bores in Australia*, 2nd edn, Land and Water Biodiversity Committee, Queensland, available
<www.water.wa.gov.au/portal/page/portal/LicensingWaterIndustryServices/Licensing/Publications/Content/MCRWBA.pdf>

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

Water and Rivers Commission 2003, *Statewide Policy No.13 – Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*, Water and Rivers Commission, Perth, available <www.water.wa.gov.au> > Policy.

Water Authority 1991, *Bindoon/Chittering Groundwater Scheme Review*, Water Resources Directorate, Groundwater and Environment Branch, Water Corporation, Perth.

Water Authority 1993, *Gingin Groundwater Area Management Plan*, Report No. WG160, Water Resources Directorate, Water Resources Planning and Allocation Branch, Water Corporation, Perth.

Water Corporation 2003, *Bindoon-Chittering Water Resource Management Operation Strategy*, Water Corporation, Perth.

Water Corporation 2005, *Bindoon – Chittering Water Reserve Drinking Water Source Protection Assessment*, Water Corporation, Perth.

Water Corporation 2006, *Annual Statement to Department of Water: Bindoon-Chittering*, Water Corporation, Perth.

Water Corporation 2006, *SG097 Source Protection Operations Manual*, Water Corporation, Perth.

Western Australian Planning Commission 1997, *State Planning Strategy*, State Government of Western Australia, Perth, available
<www.wapc.wa.gov.au/Publications/52.aspx>.

Western Australian Planning Commission 2003, *Statement of Planning Policy No. 2.7 – Public Drinking Water Source Policy*, Government Gazette WA, 10 June 2003,

pp. 2077-82, Government of Western Australia, Perth, available
<www.wapc.wa.gov.au/Publications/149.aspx>.

Western Australian Planning Commission 2006, State Planning Policy No. 2.9 –
Water Resources, Government Gazette WA, 19 December 2006, pp. 5707-22,
Government of Western Australian, Perth, available
< <http://www.wapc.wa.gov.au/Publications/1281.aspx> >.

Western Australian Planning Commission 2005, *Shire of Chittering: Town Planning
Scheme No 6 (District Zoning Scheme)*, Department for Planning and
Infrastructure, Perth, available <[www.wapc.wa.gov.au/Planning/Schemes/Local
Planning Schemes](http://www.wapc.wa.gov.au/Planning/Schemes/Local%20Planning%20Schemes)>.

Western Australian Planning Commission 2005, *Shire of Chittering: Local Planning
Strategy*, Department for Planning and Infrastructure, Perth, available
<[www.wapc.wa.gov.au/Planning/Schemes/Local Planning
Strategies](http://www.wapc.wa.gov.au/Planning/Schemes/Local%20Planning%20Strategies)>.

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

Contributors

This report was prepared by:

Contribution	Personnel	Title	Organisation
Supervision	Tony Laws	Branch Manager, Water Source Protection	Department of Water
	Nigel Mantle	Acting Program Manager, Water Source Protection	Department of Water
Report Preparation	Kellie Ketteringham	Environmental Officer, Water Source Protection	Department of Water
Report Liaison	Leanne Hartley	Senior NRMO Officer, Swan Avon Region	Department of Water
	Tran Huynh	Catchment Co-ordinator, Mid West-Gascoyne Region	Water Corporation
Drafting	Melanie Webb	GIS Officer	Department of Water
Photographs	Kellie Ketteringham	Environmental Officer, Water Source Protection	Department of Water

