



Department of Water
Government of Western Australia



Camballin Water Reserve Drinking Water Source Protection Plan Camballin Town Water Supply



Camballin Water Reserve
Drinking Water Source Protection Plan
Camballin Town Water Supply

Prepared by
Water Resources Division
Department of Water

Department of Water
Water Resource Protection Report Series
REPORT NO. WRP 59
June, 2006

Acknowledgments

Contribution	Personnel	Title	Organisation
Project Liaison	Peter Coghlan	Supervising Engineer	Water Corporation
Supervision	Stephen Watson	Program Manager, Protection Planning	Department of Water
Report Preparation	David Boyd	Principal Consultant	Water Corporation
	Christa Loos	Environmental Officer	Department of Water
Drafting	John Winterbourne	Planning Information Officer	Water Corporation
	Dianne Abbott	Drafting Officer	Department of Water
	Melanie Webb	Drafting Officer	Department of Water

For more information contact:

Program Manager, Protection Planning
 Water Source Protection Branch, Department of Water
 4th Floor, The Atrium
 PO Box K822
 Perth WA 6842

Telephone (08) 6364 6500

Facsimile (08) 6364 6525

Recommended Reference

The recommended reference for this publication is: Department of Water, 2006, *Camballin Water Reserve: Drinking Water Source Protection Plan – Camballin Town Water Supply*, Department of Water, Government of Western Australia, Water Resource Protection Series Report No. WRP 59.

This document is available in alternative formats such as audio tape, computer disk, large print, Braille and other languages.

We welcome your feedback

A publication feedback form can be found at the back of this publication, or online at www.water.wa.gov.au/public/feedback/

Printed on recycled stock.
 June, 2006

Foreword

The Department of Water (the Department) has prepared this Drinking Water Source Protection Plan (DWSPP) to report on the activities and risks to water quality within the Camballin Water Reserve and to recommend management strategies to minimise the identified risks.

A safe drinking water supply is critical to the wellbeing of a community and catchment protection is necessary to help avoid, minimise or manage risks to water quality in Public Drinking Water Source Areas (PDWSA). The Department is committed to protecting these areas to ensure the continued supply of 'safe, good quality drinking water' to consumers to protect public health now and in the future.

The Australian Drinking Water Guidelines recommend a multiple barrier 'catchment to consumer' approach to protect public drinking water. The protection and management of a PDWSA is the 'first barrier', with subsequent barriers implemented at the water storage, treatment and distribution stages of a drinking 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 necessary to ensure the safest possible raw water supply (ie before treatment).

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

The Plan should be used to guide State and Local Government land use planning decisions in Western Australia. This DWSPP should be recognised in the Shire of Derby-West Kimberley Town Planning Scheme and other local planning strategies and plans, 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 and the Department's Water Quality Protection Note *Protecting Drinking Water Source Areas* as a guide for protecting the quality of water in the PDWSA.

The process involved in the preparation of a DWSPP is as follows:

Stages in development of a DWSPP	Comment
1 Prepare 'Drinking Water Source Protection Assessment' document	The assessment document is prepared following a catchment survey and preliminary information gathering from State and Local Government Agency stakeholders (this stage is completed by the Department or a Water Service Provider).
2 Undertake stakeholder consultation	Advice sought from key stakeholders. If a Stage 1 Assessment is available it will be used as a tool for background information and discussion.
3 Prepare Draft DWSPP	Draft DWSPP developed taking into account input from identified stakeholders and any additional relevant information on the catchment.
4 Release Draft DWSPP for public comment	Draft DWSPP released for a six week public consultation period.
5 Publish DWSPP	The Plan is published after considering advice received in submissions on the Draft Plan. Recommendations to protect the drinking water reserve are provided. The Plan is available from the Department's website: http://drinkingwater.water.wa.gov.au .

Contents

Summary	1
1 Introduction.....	2
1.1 Water supply system.....	2
1.2 Future water supply system	2
1.3 Water resource allocation	3
1.3.1 Current allocation licence.....	3
2 Water Reserve description	5
2.1 Climate	5
2.2 Physiography	5
2.3 Hydrogeology.....	5
3 Water quality and treatment.....	7
3.1 Water quality	7
3.2 Water treatment	8
4 Land tenure and contamination risks	10
4.1 Existing land tenure and land uses	10
4.2 Potential contamination risks	10
4.2.1 Existing wellfield.....	10
4.2.2 Water Corporation depot.....	11
4.2.3 Power station	11
4.2.4 Industry	12
4.2.5 Other land uses.....	12
5 Protection strategies.....	13
5.1 Protection objectives	13
5.2 Potential water quality risks.....	13
5.3 Proclamation of water reserve.....	14
5.4 Priority classification.....	14
5.4.1 Proposed priority classification for Camballin Water Reserve.....	14
5.4.2 Wellhead Protection Zone (WHPZ).....	15
5.5 Land use planning.....	15
5.6 Surveillance and by-law enforcement	15
5.7 Best management practices.....	15
5.8 Emergency response	16
Recommendations.....	21

References and further reading	23
Acronyms	24
Glossary.....	25
Appendices	27

Appendices

Appendix 1 - Water Quality	29
Appendix 2 - Photos 1 - 5.....	33
Appendix 3 - Best management practice documents for activities in PDWSAs	36

Figures

Figure 1. Camballin locality map	4
Figure 2. Proposed Wellhead Protection Zones and priority classifications for Camballin Water Reserve	9

Tables

Table 1. Land use, potential water quality risks and recommended strategies	17
---	----

Summary

Camballin, in the West Kimberley region of Western Australia, obtains its water supply from a Water Corporation wellfield that draws water from the sandstone formation beneath the townsite.

The quality of the groundwater source is potentially at risk from existing land uses within the town. Vulnerability of the system is highest in the southern part of town where the aquifer is unconfined and shale layers found elsewhere in the system are absent. The Camballin wellfield is situated in this unconfined area.

This Plan has been developed to protect the water quality of this source. The Plan:

- recommends that the water reserve be proclaimed;
- identifies potential drinking water quality contamination risks from land use activities within the water reserve; and
- provides strategies to manage these potential risks whilst recognising the rights of landowners to continue established approved land use activities.

The majority of land surrounding Camballin Water Reserve is Unallocated Crown Land. Private landholdings are located to the north and east of the wellfield. Light industrial activities, a caravan park, general store, and urban residential developments that have a potential for contaminating the Camballin water supply are located within the Water Reserve.

The following strategies are recommended to protect the water quality of the Camballin Water Reserve:

- The Wellhead Protection Zone for the reserve needs to be clearly identified to ensure the appropriate level of protection for the drinking water source.
- All unallocated Crown land in the Water Reserve should be managed for Priority 1 source protection.
- The Water Reserve, including the Wellhead Protection Zone and Priority 1, 2 and 3 classifications, should be recognised in the Shire of Derby-West Kimberley Town Planning Scheme and other land planning strategies.
- The management principles outlined in this plan should be incorporated into the Shire of Derby-West Kimberley Town Planning Scheme and other land planning strategies.
- Best management practices for the current land uses in the Water Reserve should be implemented and maintained.

The above mentioned priority classification areas and the Wellhead Protection Zones provide guidance on appropriate land use planning decisions to protect drinking water resources. These areas and zones recognise established approved land uses but may constrain expansion of those uses, or development of alternative future land uses. Implementation of best management practices at the design, construction and operational stages are recommended for existing and future land use developments.

1 Introduction

The town of Camballin is located in the West Kimberley region of Western Australia, approximately 2400 kilometres north of Perth and 100 kilometres south-east of Derby near Liveringa Station (Figure 1). The public drinking water supply for Camballin is obtained from groundwater within the Poole Sandstone.

The majority of town inhabitants are Department of Education and Training officers who teach at the school in the nearby Looma Indigenous Community that is situated approximately 130 kilometres south-east of Derby. Other residents are involved in the local construction industry or the recently revived irrigation farm enterprise.

1.1 Water supply system

Groundwater is abstracted from the Water Corporation wellfield located within the townsite. Camballin is entirely dependent on this groundwater source.

The wellfield currently consists of two production bores (1/04 and 3/73) located in the south-western sector of the town (Figure 2), where the aquifer is unconfined. The bores that draw water from the Poole Sandstone aquifer are approximately 45 metres deep and are licensed to draw 50 000 kilolitres per annum. Bore 3 was decommissioned after being used over 40 years, and its replacement bore (1/04) was drilled adjacent to it in 2004. Bore 1/04 has been equipped in 2005 and commissioned in early 2006, following decommissioning of Bore 3. Of the bores drilled in 1973, only 3/73 was ever equipped and is still in operation. With demand never reaching projected consumption, bores 1/73 and 2/73 have not been required and were backfilled.

Between May 2002 and April 2004 an increased number of thermotolerant coliforms were detected in the raw water at Bore 3. These counts exceeded the Australian Drinking Water Guidelines (ADWG). An investigation to trace the source of the microorganisms was undertaken, but the results were inconclusive. Subsequently, Bore 3 was replaced with Bore 1/04 in early 2006. The raw water for the Camballin Town Water Supply is further treated by filtration and chlorination prior to distributing the water to the public.

1.2 Future water supply system

A review by the Water Corporation in 2005 did not identify any future increase in demand, and if unexpected increases did arise then these could be met by using the current bore arrangement.

Initial sampling of Bore 01/04 resulted in the detection of thermotolerant coliforms in the raw water similar to the counts at Bore 3. However, subsequent water samples taken and analysed have not indicated any thermotolerant coliforms. Further raw water samples were taken and analysed prior to commissioning Bore 1/04 to ensure the drinking water is safe for public consumption.

1.3 Water resource allocation

Groundwater resource use and conservation in Western Australia is administered by this Department in accordance with the *Rights in Water and Irrigation Act 1914 (RIWI)*. This Act requires compulsory licensing of all artesian wells throughout Western Australia. In addition, non-artesian wells require licensing in specific areas, proclaimed under the Act as Groundwater Areas.

Camballin is located within the Canning-Kimberley Groundwater Area. No allocation plan has been prepared for this Groundwater Area at this time.

1.3.1 Current allocation licence

The Water Corporation is licensed by the Department to draw 50 000 kilolitres per annum from two existing production bores from the Camballin wellfield for public drinking water supply purposes until 30 June 2009. The annual wellfield abstraction has ranged between 21 861 kilolitres and 40 829 kilolitres in the past 10 years. Currently 22 water services are provided by the Camballin Town Water Supply and annual production in 2004/2005 was close to 22 000 kilolitres.

The existing groundwater source is expected to supply sufficient water to the Camballin Town Water Scheme for the next five years.

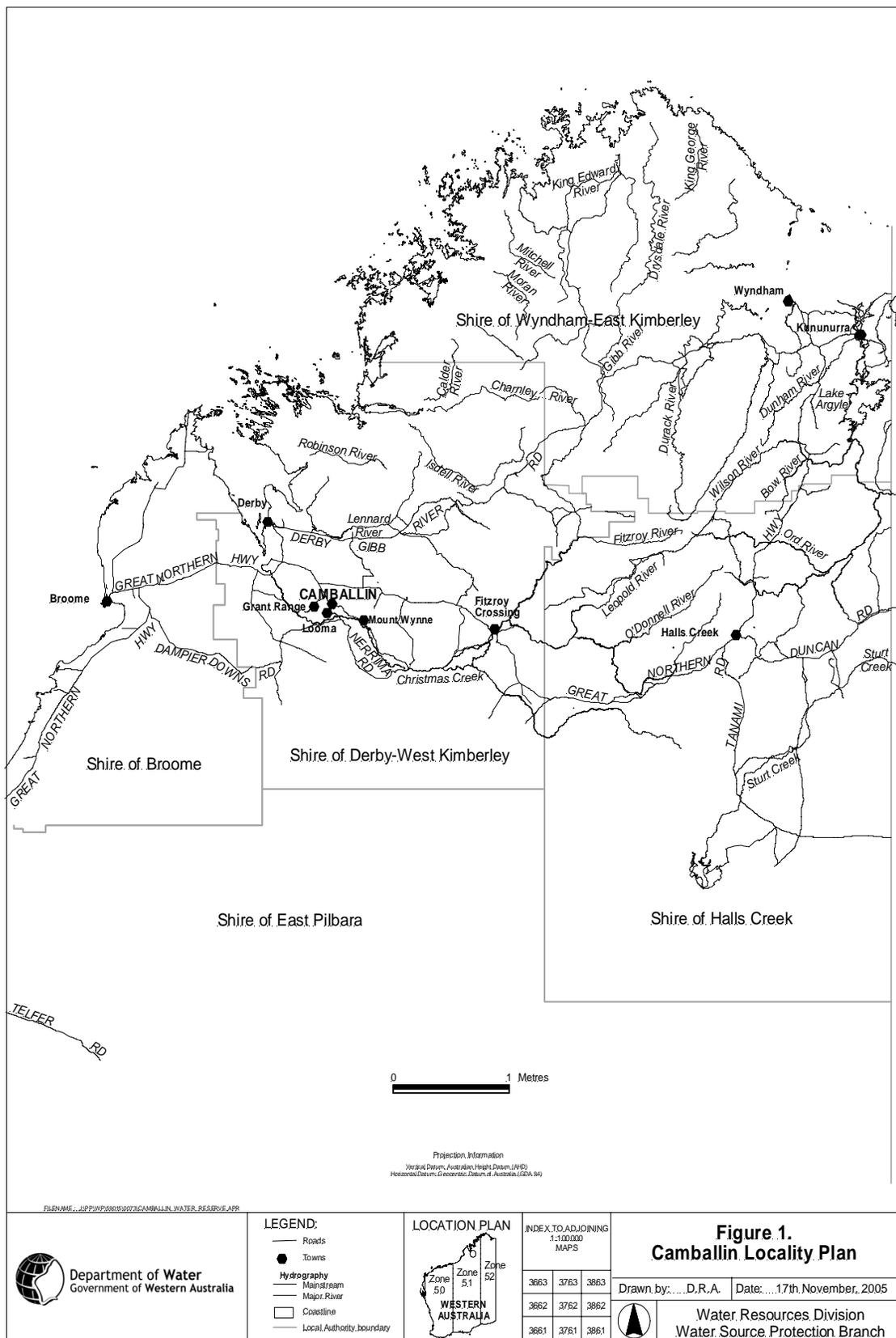


Figure 1. Camballin Locality Plan

2 Water Reserve description

2.1 Climate

The Camballin area experiences hot, rainy, monsoonal summers and warm, dry winters. The long term average annual rainfall is about 472 millimetres at Camballin and 547 millimetres at nearby Livingra station, but is extremely variable. It mostly occurs as heavy localised falls from tropical thunderstorms or from occasional cyclones, which can result in widespread flooding. Between 1998 and 2004 the annual rainfall in Camballin has varied between 334 millimetres and 924 millimetres, with an annual average of 604 millimetres.

The mean maximum daily temperature ranges between 29.6 degree Celsius in July and 36.5 degree Celsius in November, while mean minimum temperature is between 14.7 degree Celsius in July and 26.4 degree Celsius in December.

2.2 Physiography

The physiography of the Camballin area is dominated by the gently undulating plain of the Fitzroy Basin, with the most significant elevated landforms being Grant Range to the south west and Mt Wynne to the south east (Figure 1).

2.3 Hydrogeology

Camballin is located in the northern part of the Canning Basin that comprises Phanerozoic sediments up to 8 000 metres thick. The stratigraphic succession of the geological formations in the area is, from the surface, Quaternary alluvium, Nookenhah Formation, Poole Sandstone and the Grant Group.

The Camballin bores draw groundwater from the Poole Sandstone of the Canning Sedimentary Basin. The formation comprises mainly sandstone and siltstone and can form either unconfined or confined aquifer systems depending on the presence and thickness of shale sequences. This variation is evident in the local townsite bores. From the existing bore data it appears the aquifer is unconfined in the south-western sector of the town and possibly confined in the central and north western sectors. The extent of confinement in the eastern sector is unknown. Bores 1/04 and 3/73 are situated in the unconfined area. Because of the variability in confinement, it is reasonable to assume the source is vulnerable to contamination from overlying land uses.

The bores are drilled to depths of about 45 metres and the water level is about five metres below the natural ground surface.

The recharge to the aquifer most likely occurs during flood events where ephemeral creek systems traverse outcrops of the formation to the south of town to as far back as the Grant Range and Mount Wynne. Recharge also occurs through direct infiltration of rain during episodes of heavy downpours in areas where the shale is absent.

Areas east and south of the Water Reserve are regularly inundated with water after major flood events originating from Fitzroy River and its associated tributaries. There has been a number of recorded floods that have inundated the southern portion of Reserve 46707; the site where the wellfield is located.

Regional groundwater flow is believed to be north north-easterly, based on data from the Derby Hydrogeological Map.

3 Water quality and treatment

3.1 Water quality

A wide range of chemical, physical and microbiological constituents can affect the quality of drinking water. The water quality from the Camballin wellfield is monitored by the Water Corporation in accordance with the Australian Drinking Water Guidelines (ADWG). The program is outlined in the Camballin Water Resource Management Operation Strategy, currently covering the period from 1 March 2004 to 30 June 2009. The bores are tested on a monthly basis for microbiological contamination, and the health and aesthetic related chemicals in the raw water are tested on a monthly, three-monthly or annual basis, depending upon the type of chemical constituents.

Historically, the water has been of good quality, generally meeting ADWG values. The salinity in the production bores has remained stable at 200 mg/L Total Dissolved Solids (TDS) and shows no detrimental trends.

All health and aesthetic related chemical components of the raw water, with the exception of iron and manganese on occasions, are within guideline values. The high iron concentrations most likely result from the steel casing of the bores. Turbidity, which may reduce the effectiveness of disinfecting the drinking water, has been variable and at times has also exceeded the guideline levels. The fluoride concentrations were below the Department of Health's guideline recommended for fluoridated supplies. The Fluoridation Advisory Committee passed a recommendation that small water schemes, such as Camballin, are not required to be fluoridated and therefore the guideline does not apply.

During the period between May 2002 and April 2004 the number of thermotolerant coliforms detected in the raw water at Bore 3 ranged between one and 43. These counts exceeded the microbiological contamination benchmark (WHO, 1996). More intensive monitoring to validate those readings, and an investigation to trace the source of the microorganisms was undertaken, but the results were inconclusive. The increased number of thermotolerant coliforms may have originated from the septic tank system, which was situated at the Water Corporation Depot. This septic tank system was decommissioned and filled in 2004, and Bore 3 was replaced with Bore 1/04 in early 2006 (Figure 2). The raw water from Bore 1/04 is extracted from a wider screen at a depth between 31.15 and 43.15 metres below ground level. The raw water is further treated by filtration and chlorination prior to distributing the water to the public. The microbial values are not reflected in the treated, reticulated drinking water.

The monitoring program should be maintained to establish the long-term trends in water quality. Specific consideration should be given to the potential risk of microbial contamination of raw water (Bore 1/04 and 3/73) from the surrounding land uses in the Water Reserve, particularly after heavy rain or flood events.

A summary of the results of the raw water quality from the wellfield is provided in Appendix 1.

3.2 Water treatment

The water abstracted from the Camballin Water Reserve is passed through a sand filter and is then disinfected by chlorination before being supplied to the town.

It should be recognised that filtration and disinfection by chlorination generally reduces the iron content and turbidity, and removes microbiological contamination, but treatment processes alone cannot be relied upon. Where possible, contamination can and should be prevented or reduced through appropriate land use or activity controls in wellhead protection zones. This approach is endorsed by the ADWG and reflects a ‘catchment to consumer’ multiple barrier approach for the provision of safe drinking water to consumers.

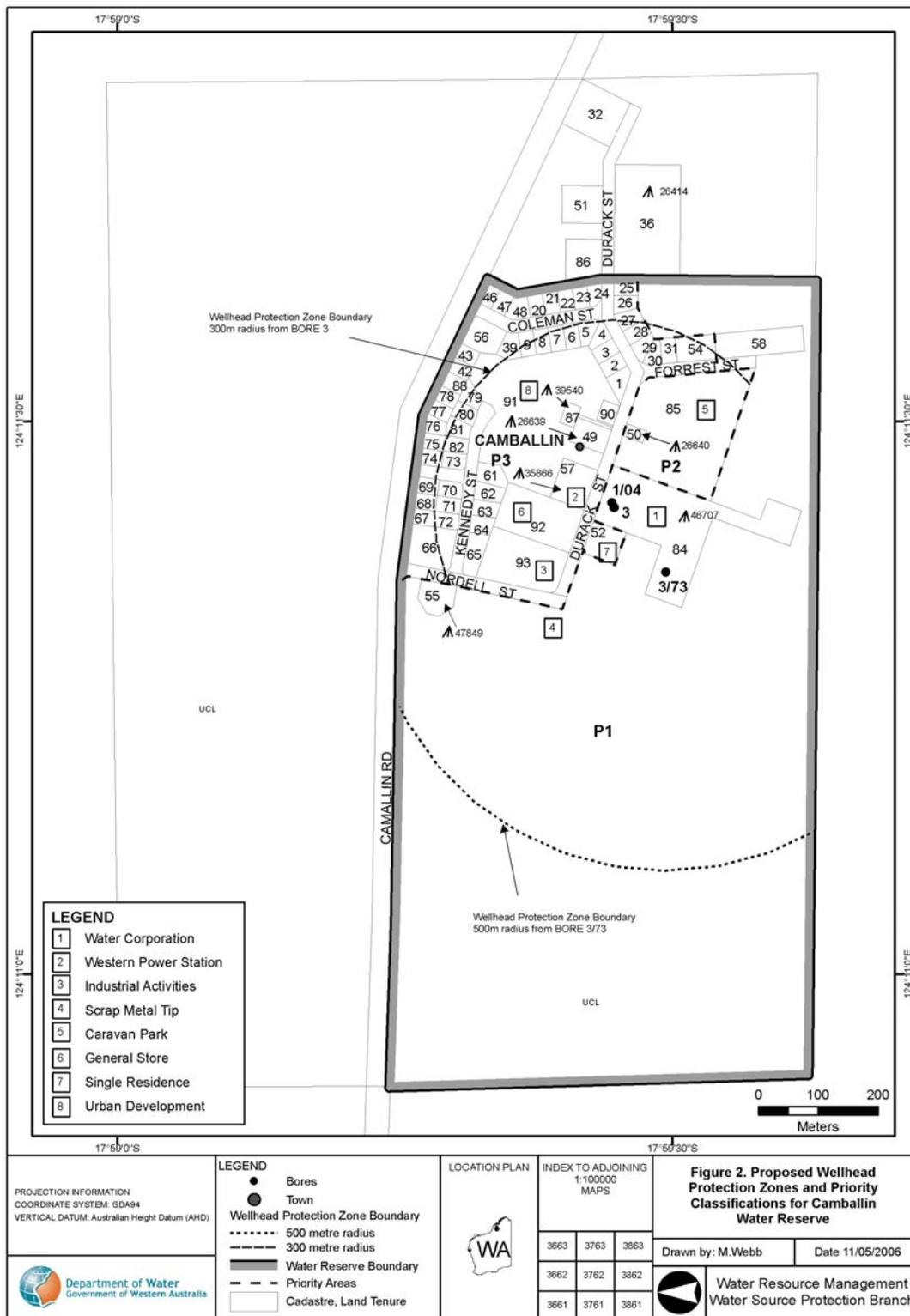


Figure 2. Wellhead Protection Zone and Priority Classification for Camballin Water Reserve

4 Land tenure and contamination risks

4.1 Existing land tenure and land uses

Land tenure in the vicinity of the production bores is predominantly light industrial with the urban zone located to the north and east and unallocated Crown land to the south and west. The land uses in the Water Reserve area consist of: light industrial activities, caravan park, general store, and urban residential development.

There is potential for contamination of the Camballin wellfield from these existing land uses. Any development proposals in the Water Reserve that are inconsistent with the Department's guidelines and Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas* should be referred to the Department of Water for advice and recommendation (available from <http://drinkingwater.water.wa.gov.au>).

4.2 Potential contamination risks

4.2.1 Existing wellfield

The Water Corporation depot, which has now been dismantled, was located on Reserve 46707 on the south side of Durack Street. Bore 1/04 (which replaced Bore 3) is sited in the north-west corner of the reserve and Bore 3/73 is located close to the south-western boundary.

The Water Corporation Depot has been used for storing fuels in underground and overhead storage tanks, the storage of cement products, and for the manufacture of concrete. Bore 1/04 is situated directly across the road from the power station and about 200 metres from a non-operational concrete batching site. The town caravan park is located east of the depot. The old Camballin Farms messhouse, 150 metres north of the decommissioned Bore 3 (Appendix 2, Photo 1), now operates as the general store and future development of this site may include roadhouse type services and accommodation. Roadhouse type services (ie service station, chemical storage, motor repair and intensification of effluent disposal systems) are undesirable land uses in a Water Reserve. Any new establishment or expansion of this land use would not be supported by the Department of Water. Further information relating to these topics is available from the Department's Water Quality Protection Notes via <http://drinkingwater.water.com.au>.

Bore 3/73 (currently in stand-by) is surrounded by vacant, mainly Unallocated Crown Land. The only house (Lot 52 Durack Street) away from the main residential area is located about 150 metres to the north, where there is evidence of stabling of horses in the past.

Land uses, activities and contaminant threats in the Camballin Water Reserve are shown in Figure 2.

4.2.2 Water Corporation depot

The reserve contained several derelict buildings, including the old depot office, single men's quarters and three storage sheds. The sheds contained stored cement products (these were used for batching concrete), maintenance materials such as plumbing fittings and paint, and unwanted building materials and scrap. Stockpiles of aggregate and rubbish from the manufacturing process were left on site. Other infrastructure included a disused septic tank system, overhead fuel storage tank (see Appendix 2, Photo 2), fuel bowser and underground fuel tank, diesel and oil drum rack with old drum stored on it, and mechanical servicing ramp and pit. Old vehicles and machinery were strewn around the property and were as close as 20 metres to Bore 3 (now decommissioned).

The Water Corporation advised that the derelict buildings, structures and unwanted materials have been removed, the septic tank system has been decommissioned and filled in, and the site has been cleaned up. It is planned to return the site to natural native bushland.

4.2.3 Power station

Horizon Power (previously Western Power) operates a diesel-fuelled power station for Camballin on the north side of Durack Street, directly opposite Bore 1/04. Up to 54 000 litres of fuel is stored in a constructed brick and concrete bund located about 100 metres from the decommissioned Bore 3 (Appendix 2, Photo 3). The power station is located down-gradient of the current wellfield and may be in an area where the aquifer is confined. However, this is a non-conforming land use, as the land activities associated with a power station are incompatible land uses in a Water Reserve.

The site has:

- a small workshop area located on a concrete hardstand without containment provisions;
- loose piles of construction and mechanical rubbish.

Work to the local power distribution system and its bunding upgrade was finalised in 2005. Improvements to the bunding and the completion of a kerbed transfer area with drainage containment assists in minimising the risk of contamination. The temporary fuel storage was removed as soon as the bunded tanks were back in operation. Further work is required to improve the workshop and to clean up the site.

Horizon Power plans to construct a new diesel generated power station closer to Looma to provide a more efficient and reliable electricity supply to both Camballin and Looma. It is anticipated that the power station will be operational in early 2007. Once the new power station is in operation, the old station in Camballin will be decommissioned and the site rehabilitated to prevent any contaminants (if present) entering the Camballin Water Reserve.

4.2.4 Industry

The major industry in recent years was centred around a concrete batching plant (now closed) and associated workshop set up on the old Camballin Farms depot at the corner of Durack and Nordell Streets, about 200 metres north west of Bore 1/04. The operation contained several potential sources of contaminants that may have impacted on the water quality of the production bores. They included:

- vehicles, equipment, materials and stockpiles used in the manufacturing process;
- materials stored in shed;
- unbunded overhead fuel storage tank, including fuel bowser;
- underground fuel tank;
- machinery; and
- single men's quarters and toilet facilities.

Those structures, fixtures and equipment were left in various states of disrepair by the previous owners. The site is occasionally used as transport depot for parking and servicing heavy vehicles that are used for temporary road construction in the region.

In Nordell Street, about 300 metres north of Bore 3/73 there is a scrap metal tip (Appendix 2, Photo 4) where off-casts and oil drums have been dumped on Unallocated Crown Land.

The threats to groundwater quality at these sites and the power station appear to be lessened by being down gradient from the production bores and by the likely presence of shale within the formation in this area, inhibiting direct recharge to the aquifer. Even so, upgrading of these sites and adoption of best management practices is encouraged to maximise protection of the aquifer.

4.2.5 Other land uses

Camballin is unsewered, which could potentially pose a risk to groundwater quality. However, the risk is significantly reduced because the majority of houses appear to be in an area that is unlikely to provide recharge to the production bores. Typical residential housing in Camballin is shown in Appendix 2, Photo 5.

The closest operational septic tank systems are associated with the caravan park to the east of Bore 1/04, the general store and unused single men's quarters to the north, and a house on lot 52 Durack Street. Any proposal to upgrade these sites should preclude any increase in septic tank density, should require an upgrade of the existing on-site effluent disposal system or/and the relocation of the system to maximise the distance to the production bores.

Further risk assessment needs to be undertaken if proposals to improve the caravan park or general store include provision of retail fuel supply services. This would require underground storage systems, creating a potential source of significant groundwater contamination that is extremely difficult to remediate.

5 Protection strategies

5.1 Protection objectives

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

The priority classifications for Camballin 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.

The Department will encourage non-conforming land uses to adopt best management practices to minimise risk to water resources, through government and industry based guidelines.

5.2 Potential water quality risks

Experience in Western Australia and overseas shows a strong link between groundwater quality and land uses in the catchment. Groundwater is a valuable resource, which if contaminated or polluted, is very expensive to treat and sometimes impossible to clean up. If activities have to occur above important groundwater sources, they should be ideally activities with low contamination risks.

The potential risks to groundwater quality with land use activities in the recharge areas include chemical or fuel spills, pathogens and nutrient contamination. The most common and widespread health risk associated with drinking water is microbial contamination, either by direct or indirect contact with human or animal faeces. Drinking water should not contain microorganisms, chemicals or other substances at a level capable of causing disease.

Table 1 (see page 17) identifies the potential water quality risks associated with the existing land uses in the Camballin Water Reserve area and recommends protection strategies for managing the risks.

The potential water quality risks were identified and the resulting management priorities were designated using a risk assessment process. Strategies have been developed in line with the Australian Drinking Water Guidelines, 2004.

There are a number of barriers in a water distribution system that may be implemented to ensure the safety of drinking water. The primary barrier is to protect the drinking water source against the risk of contamination in the first instance.

The recommended strategies balance the need to protect water quality for the community in the long-term, with the rights of landholders to continue to use land for lawful purposes.

5.3 Proclamation of water reserve

The proposed Camballin Water Reserve will be proclaimed under the *Country 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. The proposed Camballin Water Reserve is shown in Figure 2. It covers the majority of developed land within the town and the vacant Crown Land to the south and west. The sector east of the main residential area has been excluded because it is outside the area contributing recharge to the wellfield.

5.4 Priority classification

The protection of Public Drinking Water Source Areas (PDWSAs) relies on statutory measures available in water resource management and land use planning legislation. Their purpose is to manage and protect any water source used for public drinking water supplies. PDWSAs include Underground Water Pollution Areas, Water Reserves and Catchment Areas. 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 Department's Water Quality Protection Notes *Land use compatibility within PDWSA* and *Protecting Public Drinking Water Source Areas* (see Reference Section).

5.4.1 Proposed priority classification for Camballin Water Reserve

The area south of Durack Street and west of Forrest Street overlies the section of the aquifer that appears to be generally unconfined. Because it includes the up gradient capture zones of existing bores and covers the area where future bores could be sited, the Crown land should be managed for Priority 1 protection. The caravan park should be managed for Priority 2 protection and the only other private property, Lot 52 Durack Street, as Priority 3 (Figure 2). To maximise protection under these classifications, the Water Corporation depot site and Western Power site (after closure) should be returned to local native bushland, and the caravan park should not be intensified.

The area north of Durack Street should be managed for Priority 3 source protection because it is dominated by existing industrial and commercial activities critical to the town's existence and also includes the majority of the residential housing. Groundwater west of Coleman Street may be confined to some degree indicating this part of the townsite may not contribute recharge to the drinking water supply bores. Urban lots in the eastern sector appear to be outside the capture zone of the bores, but the aquifer is possibly unconfined in this area. This provides potential for degradation of water quality in the longer term. If needed, future bores should be located inside the Priority 1 area to the west or south at a maximum possible distance from the town, thereby avoiding the influence of the land uses from the existing land uses in Priority 2 and 3 areas.

The urban lots east of Forrest Street and south of Durack Street are to be included as part of this Priority 3 area. The Crown land south of these properties should be classified for Priority 1 drinking water protection.

5.4.2 Wellhead Protection Zone (WHPZ)

Wellhead protection zones are defined around each bore (500 metres radius in Priority 1 areas and 300 metres radius in Priority 2 and 3 areas) in which activities are to be managed to maximise protection against contamination in the immediate vicinity of the production bores. These zones do not extend outside the boundary of the proposed Water Reserve (Figure 2).

5.5 Land use planning

Establishing appropriate protection mechanisms in statutory land use planning processes is essential to secure the long-term protection of water sources.

The Department's priority classification system, associated water quality objectives and ultimate land use controls aim to avoid, minimise or manage the risk of groundwater contamination, depending on the vulnerability of the source to contamination, the strategic nature of the source and the existing land use in the area.

The Camballin Water Reserve and priority classifications should be recognised in the Shire of Derby-West Kimberley's Town Planning Scheme and associated planning approval processes.

5.6 Surveillance and by-law enforcement

Groundwater quality monitoring of the source should recognise potential contamination risks from land use and ensure key characteristic parameters are included. The current monitoring programs applicable for the Camballin Water Reserve were discussed in Section 3.1.

Education (eg signs and informative material) is a key mechanism used by the Department to assist in increasing public awareness of the need to protect drinking water quality and to highlight water quality protection measures to people. Information on available material and management advice can be obtained by contacting the Department or regional office.

5.7 Best management practices

There are opportunities to significantly reduce risks to water quality by carefully considering site design and management practices. The adoption of best management practices for land use activities is encouraged to help protect water quality.

To assist the adoption of sound environmental practices, guidelines for specific industries are being progressively developed in conjunction with other agencies (eg Department of Agriculture, Department of Environment) and the relevant peak industry body (eg Chamber of Minerals and Energy, Chamber of Commerce and Industry). These guidelines incorporate a practical, common sense approach to environmental management issues and are aimed at avoiding any unreasonable burden to the industry.

These and other departments' guidance documents are recommended to landowners and managers as best practice for water quality protection. They can be viewed on the internet via the Department's Internet site at <http://drinkingwater.water.wa.gov.au>. Other Best Management Practice documents are provided in Appendix 3.

5.8 Emergency response

Escape of chemicals during unforeseen incidents and use of chemicals during emergency response can cause groundwater contamination. The Shire of Derby-West Kimberley's Local Emergency Management Advisory Committee (through the Kimberley Emergency Management District) should be familiar with the location and purpose of the Camballin Water Reserve. A locality plan should be provided to the Fire and Rescue Services headquarters for the HAZMAT Emergency Advisory Team. The Department should have an advisory role in any HAZMAT incident in the Camballin Water Reserve.

Personnel who deal with WESTPLAN - HAZMAT incidents within the area should be given ready access to a locality map of the Water Reserve. These personnel should receive training to ensure an understanding of the potential impacts of spills on the groundwater resource.

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

Land Use / Activity	Potential water quality risks		Management consideration	Current preventative measures	Recommended protection strategies
	Hazard	Management Priority			
Water Corporation depot	Nutrients and bacteria from past ablation facilities and septic tank system. Past contamination from hydrocarbons and other chemicals (leakage from underground storage or overhead fuel storage tanks).	Medium	All structures (buildings and fuel storage tanks) have been removed from the site, and the septic tank system has been decommissioned and filled in. The site to be protected for P1 priority water source protection, where a 500 metre Wellhead Protection Zone applies.	None	<i>Rehabilitate site</i> <ul style="list-style-type: none"> • Decontaminate site (if necessary) in accordance with Department of Environment's Contaminated Sites Management Series (2004). • Return site to local native bushland. • Adopt proposed drinking water source priority classification and Wellhead Protection Zones. • Regional office - Department of Water to liaise with officers from Water Corporation to ensure the site is rehabilitated.
Horizon Power Station (previously Western Power)	Contamination from hydrocarbons and other chemicals.	Medium	Down-gradient of current production bores and may be in an area where aquifer is confined. The site to be protected for P3 water source protection, where a 300 metre Wellhead Protection Zone applies. Up to 54 000 litres of fuel can be stored on site. Power Stations are incompatible land uses in Public Drinking Water Source Areas.	Improvements include bunding of fuel storage and contained transfer area.	Manage as non-conforming land use <ul style="list-style-type: none"> • Until Power Station is closed in early 2007. • Adopt best management practices for operating site. • Support changes in land use within existing approvals that reduce groundwater contamination risks. <i>Post closure of Power Station</i> <ul style="list-style-type: none"> • Remove all infrastructure and contaminant sources, and decontaminate site (if necessary) in accordance with Department of Environment's Contaminated Sites Management Series (2004). • Regional office - Department of Water to liaise with officers from Horizon Power to ensure the site is rehabilitated.

Table 1. continued

Land Use / Activity	Potential water quality risks		Management consideration	Current preventative measures	Recommended protection strategies
	Hazard	Management Priority			
Arian Industries (Concrete batching plant - currently closed)	Nutrients and bacteria from ablation facilities and septic tank system. Contamination from hydrocarbons and other chemicals.	Medium	Down-gradient of bores and may be in an area where aquifer is confined. The site to be protected for P3 drinking water source protection, where a 300 metre Wellhead Protection Zone applies. The site is situated in the 300-metre Wellhead Protection Zone.	None	<p><i>Acceptable activity with controls in a Public Drinking Water Source Area (P3).</i></p> <ul style="list-style-type: none"> Ensure facility complies with Department of Water standards. Adopt best management practices for maintaining the site. Oppose intensification or expansion of land use through planning approval process. Any development proposals to be referred to the Department of Water for advice and recommendation. Support changes in land use within existing approvals that reduce groundwater contamination risks.
Scrap metal tip	Leachate from scrap and hydrocarbon contamination from old oil drums.	Low	Down-gradient of current production bores. The site to be protected for P1 drinking water source protection, where a 500 metre Wellhead Protection Zone applies.	None	<p><i>Unacceptable in current condition</i></p> <ul style="list-style-type: none"> Remove all scrap metal and unwanted material. Regional office - Department of Water to liaise with Shire of Derby West-Kimberley to ensure scrap metal is removed. Decontaminate site (if necessary) in accordance with Department of Environment's Contaminated Sites Management Series (2004).

Table 1. continued

Land Use / Activity	Potential water quality risks		Management consideration	Current preventative measures	Recommended protection strategies
	Hazard	Management Priority			
Caravan park	Nutrients and bacteria from ablution facilities and septic tank system.	Medium	Manageable at current low use levels. The site to be protected for P2 drinking water source protection, where a 300 metre Wellhead Protection Zone applies. The site is situated in the 300-metre Wellhead Protection Zone.	None	<p><i>Manage as non-conforming land use</i></p> <ul style="list-style-type: none"> No increase in septic tank density. Oppose intensification of land use through planning approval process. Any development proposals to be referred to the Department of Water for advice and recommendation. Support changes in land use within existing approvals that reduce groundwater contamination risks. Promote water quality protection via signs to ensure public is aware of Public Drinking Water Reserve.
Camballin Store and single men's quarters	Nutrients and bacteria from ablution facilities and septic tank system.	Low	Down-gradient of bores and may be in an area where aquifer is confined. The site to be protected for P3 drinking water source protection, where a 300 metre Wellhead Protection Zone applies. The site is situated in the 300-metre Wellhead Protection Zone. Low patronage of store and single men's quarters currently not used.	None	<p><i>Acceptable activity with controls.</i></p> <ul style="list-style-type: none"> No increase in septic tank density. Ensure development is adequately controlled through planning approval process. Any development proposals that are inconsistent with the Department's guidelines and Water Quality Protection Note <i>Land Use Compatibility in Public Drinking Water Source Areas</i> should be referred to the Department of Water for advice and recommendation. Promote water quality protection via signs to ensure public is aware of Public Drinking Water Reserve.

Table 1. continued

Land Use / Activity	Potential water quality risks		Management consideration	Current preventative measures	Recommended protection strategies
	Hazard	Management Priority			
Residential area	Nutrients and bacteria from septic tank systems, fertiliser and pesticide use on lawns.	Low	<p>Unlikely to contribute recharge to existing water supply bores.</p> <p>The residential area to be protected for P3 drinking water source protection, where a 300 metre Wellhead Protection Zone applies.</p> <p>A number of residences are situated in the 300-metre Wellhead Protection Zone.</p> <p>Area in which aquifer may be confined or outside bore capture zone.</p>	None	<p><i>Acceptable activity with controls</i></p> <ul style="list-style-type: none"> • Ensure planning approval process adequately controls development. • Adopt best management practices on site (Examples are provided in Appendix 3). • Encourage connection to deep sewerage through planning approval process (when available). • Further subdivision to be consistent with Draft Country Sewerage Policy 1999. • Promote water source protection.
Lot 52 Durack Street	Nutrients and bacteria from septic tank system	Medium	<p>Residence about 100 metres west of Bore 1/04.</p> <p>The site to be protected for P3 priority drinking water source protection, where a 300 metre Wellhead Protection Zone applies.</p> <p>The site is situated in the 300-metre Wellhead Protection Zone.</p>	None	<p><i>Acceptable activity with controls</i></p> <ul style="list-style-type: none"> • Adopt best management practices on site (examples are provided in Appendix 3). • Oppose intensification of land use through planning approval process. • Support changes in land use within existing approvals that reduce groundwater contamination risks.

Recommendations

1. The proposed Camballin Water Reserve is to be proclaimed under the *Country Areas Water Supply Act 1947* (Department of Water).
2. The Shire of Derby-West Kimberley should incorporate the management principles outlined in this plan in its Town Planning Scheme (TPS) and associated planning approvals processes, and the TPS should reflect the Wellhead Protection Zones and Priority 1, 2 and 3 classifications assigned within the Water Reserve (Shire of Derby-West Kimberley).
3. Development and works proposals in the Camballin Water Reserve that are inconsistent with the Department's guidelines and Water Quality Protection Note: *Land Use Compatibility in Public Drinking Water Source Areas* (as amended from time to time) should be referred to the Department of Water for advice and recommendation (Shire of Derby-West Kimberley, Department for Planning and Infrastructure).
4. The strategies detailed in Table 1. *Land use, potential water quality risks and recommended strategies* should be adopted by those with responsibility for the recommended protection strategy (Stakeholders).
5. Signs should be maintained along the boundaries of the proposed Water Reserve to define the areas and to promote public awareness of the importance of protecting drinking water quality (Water Corporation).
6. The water quality monitoring program for the production bores should be maintained and regularly reviewed to ensure key characteristic indicators (physical, chemical and particularly microbiological characteristics) are monitored. Specific consideration to be given to the potential risk of microbial contamination of raw water (Bore1/04 and 3/73) from the surrounding land uses in the Water Reserve, particularly after heavy rain or flood events. Continue to review water quality analysis to detect any trends (Water Corporation).
7. The surveillance program should be maintained to identify any incompatible land uses or potential contaminant threats within the Water Reserve (Water Corporation).
8. Incidents covered by WESTPLAN – HAZMAT in the Camballin Water Reserve should be addressed through the following measures:
 - a. The Shire of Derby-West Kimberley Local Emergency Management Advisory Committee (through the Kimberley Emergency Management District) being familiar with the location and purpose of the Camballin Water Reserve.
 - b. The locality plan for the Camballin Water Reserve being provided to the Fire and Rescue Services headquarters for use by the HAZMAT Emergency Advisory Team.
 - c. The Water Corporation advising the HAZMAT Emergency Advisory Team during incidents in the Camballin Water Reserve.

- d. Personnel dealing with WESTPLAN – HAZMAT incidents in the area being given ready access to a locality map of the Water Reserve area and training to understand the potential impacts of spills on the groundwater quality

(Department of Water, Department of Environment and Fire and Emergency Services Authority of Western Australia).

9. The Water Corporation should rehabilitate its depot site under consideration of the strategies detailed in *Table 1. Land use, potential water quality risks and recommended strategies*, and return the site to local native bushland (Water Corporation).
10. Western Power should rehabilitate its power station site and remove all contamination threats to the water reserve after closure of the station in early 2007. The site should be returned to local native bushland (Western Power).
11. Implementation of these recommendations should be reviewed periodically after this plan is endorsed. A full review of this protection plan should be undertaken after five years (Department of Water).

References and further reading

Allen A.D., 1985, *Outline of the Hydrogeology of the Camballin Area, West Kimberley*, Hydrogeology Report No. 2679, GS 282/73 (unpublished).

Agriculture and Resource Management Council of Australia and New Zealand and Australian and New Zealand Environment and Conservation Council, 1996, *Draft Rural Land Uses and Water Quality, A Community Resource Document*, ARMCANZ and ANZECC.

Baddock L., 2001, *Camballin Water Supply*, Small Technical Report, Water Corporation IPB House File No. 1081-1 (unpublished).

Boyd D.W., 1982, *Camballin Groundwater System Review*, Groundwater Management Group, Water Resources Branch, Public Works Western Australia.

Burkett D., 1998, *Camballin Water Resource Management Operation Strategy*, Report No. A4-611, Water Corporation of Western Australia.

Country Source Planning Section, 1994, *Water Resources Planning, Town Water Scheme Summary Report for Camballin*, Water Authority of Western Australia.

Department of Health, 1999, *Draft Country Sewerage Policy*, Department of Health (unpublished).

Department of Environment¹, 2004, *Water Protection Quality Note: Land use compatibility in public drinking water source areas*, available from <http://drinkingwater.water.wa.gov.au>.

Department of Water, 2006, *Water Protection Quality Note Land use planning in public drinking water source areas*, available from <http://drinkingwater.water.wa.gov.au>.

Department of Water, 2006, *Water Protection Quality Note Protecting public drinking water source areas*, available from <http://drinkingwater.water.wa.gov.au>.

Geldreich E.E., 1996, *Pathogenic Agents in Freshwater Resources*, Hydrological Processes, Volume 10, pp 315-333.

Grimmond, T.R., Radford A.J. and Brownridge T., 1988, *Giardia carriage in aboriginal and non-aboriginal children attending urban day-care centres in South Australia*, Australian Pediatric Journal, Volume 24, pp 304-305.

McPhar Geophysics Pty Ltd., 1973, *Australian Cattle Co. Ltd, Groundwater availability and water bore specifications, Camballin Area, Kimberley, W.A., May 1973*, McPhar Geophysics Pty Ltd.

National Health and Medical Research Council and Agriculture and Resource Management Council of Australia and New Zealand, 1996, *Australian Drinking Water Guidelines*, NH&MRC and ARMCANZ.

¹ The new Department of Water has assumed primary responsible for managing the State's water resources, and is now the custodian of the Water Quality Protection Notes and other drinking water related guidance documents.

Acronyms

ADWG	Australian Drinking Water Guidelines
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CAWS	<i>Country Areas Water Supply Act 1947</i>
DWSPP	Drinking Water Source Protection Plan
GL	Gigalitre, a thousand million litres
HAZMAT	Hazardous materials
NHMRC	National Health and Medical Research Council
P1	Priority 1 - priority classification for land use
P2	Priority 2 - priority classification for land use
P3	Priority 3 - priority classification for land use
PDWSA	Public Drinking Water Source Area
RIWI	<i>Rights in Water and Irrigation Act 1914</i>
WHO	World Health Organisation
WHPZ	Wellhead Protection Zone

Glossary

Aesthetic Guideline	NHMRC guideline level ascribed to acceptable aesthetic quality of drinking water.
Abstraction	Pumping groundwater from an aquifer.
Allocation	The quantity of groundwater permitted to be abstracted by a well licence, usually specified in kilolitres/year (kL/a).
Aquifer	A geological formation or group of formations able to receive, store and transmit significant quantities of water.
Bore	A narrow, lined hole drilled to monitor or withdraw groundwater.
Confined Aquifer	An aquifer that is confined between shale and siltstone beds and therefore contains water under pressure.
Effluent	The liquid, solid or gaseous wastes discharged by a process, treated or untreated.
Groundwater	Water which occupies the pores and crevices of rock or soil.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
LGA	Local Government Authority (in this case Shire of Derby-West Kimberley)
Leaching / Leachate	The process by which materials such as organic matter and mineral salts are washed out of a layer of soil or dumped material by being dissolved or suspended in percolating rainwater; the material washed out is known as leachate. Leachate can pollute groundwater and waterways.
Nutrients	Minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorus (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
Pesticides	Collective name for a variety of insecticides, fungicides, herbicides, algaecides, fumigants and rodenticides used to kill organisms.
Pollution	Water pollution occurs when waste products or other substances, eg effluent, litter, refuse, sewage or contaminated runoff, change the physical, chemical, biological or thermal properties of the water, adversely affecting water quality, living species and beneficial uses.
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.
Stormwater	Rainwater that has run off the ground surface, roads, paved areas etc and is usually carried away by drains.
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 containing water, the upper surface of which is lower than the top of the aquifer. The upper surface of the groundwater within the aquifer is called the watertable.
Water Quality	The physical, chemical and biological measures of water.
Watertable	The upper saturated level of the unconfined groundwater.
Wellfield	A group of bores to monitor or withdraw groundwater.

Appendices

Appendix 1 Water quality

Appendix 2 Photos

Appendix 3 Best management practice documents for activities in PDWSPAs

Appendix 1 - Water Quality

The Water Corporation has monitored the raw (source) water quality from the Camballin Bores 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. Health related characteristics

- Microbiological contaminants
- Health related chemicals

b. Aesthetic characteristics – (Non-health related)

Following is data representative of the quality of raw water from the Camballin water sources. In the absence of specific guidelines for raw water quality, the results have been compared with ADWG values set for drinking water. Results that exceed 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 that would be distributed to the public. Following treatment the drinking water supplied to the Camballin Town Water Supply will comply with ADWG microbiological, health and aesthetic requirements. For more information on the quality of drinking water supplied refer to the most recent Water Corporation Drinking Water Quality Annual Report at <http://www.watercorporation.com.au/dwq/index.cfm>.

a. Health related characteristics - Camballin bores raw water

- Microbiological contaminants

Thermotolerant coliform counts are used as an indicator of the degree of faecal contamination of the raw water from warm-blooded animals. A count less than 20 colony forming units (cfu) per 100 mL is typically associated with low levels of faecal contamination and is used as a microbiological contamination benchmark (WHO, 1996).

Microbiological testing of the raw water from the Camballin Bores has been conducted on a monthly basis since April 2002. Since then Camballin Bore 3 was sampled 29 times, Bore 3/73 30 times, and Bore 1/04 5 times. Positive thermotolerant coliform counts were recorded in 12.5% of samples. Two of the raw water samples from Bore 3 (7% of raw water samples taken from Bore 3) had thermotolerant coliform counts greater than 20 cfu/100mL.

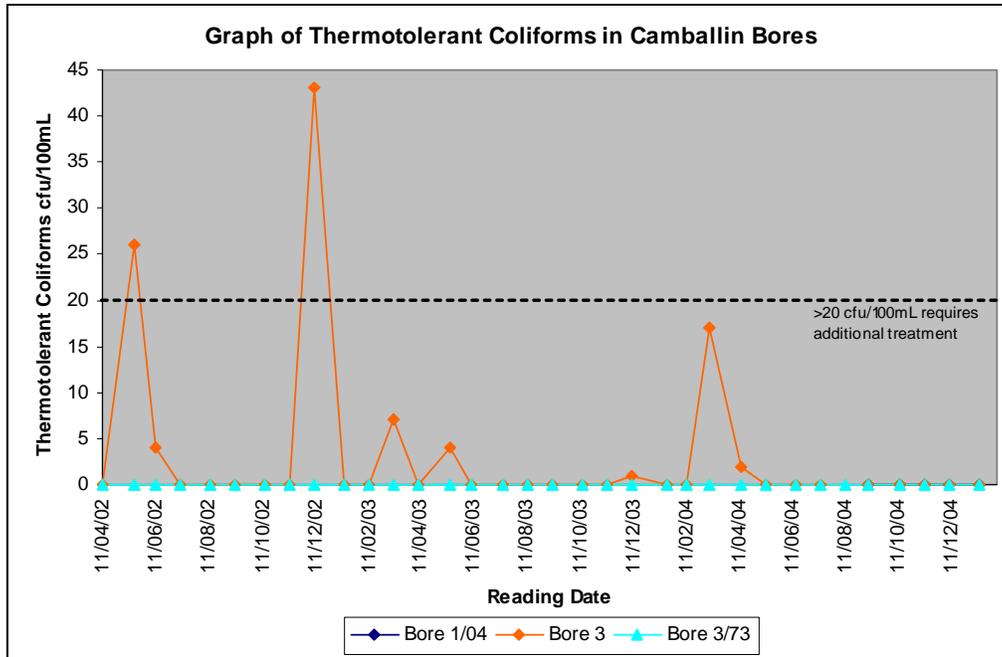


Figure 1. Thermotolerant coliforms in Camballin bores

- Health Related Chemicals

The raw water from Camballin is analysed for health related chemicals. Health related chemicals include inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters that have been measured at detectable levels in the sources up to September 2005 are summarised in the following table. All values are in milligrams per litre (mg/L). Monitoring is ongoing.

Table 2. Range of monitored values

Parameter	Range of monitored values			1996 AWDG Health Guideline Value ^
	Min-Max			
	Median			
	Bore 3	Bore 3/73	Bore 1/04	
Metals				
Arsenic	ND - 0.004 ND	ND - 0.002 ND	NT	0.007mg/L
Barium	0.038 - 0.42 0.1	0.04 - 0.095 0.095	NT	0.7 mg/L
Boron	ND - 0.08 0.063	0.06 - 0.07 0.06	NT	4 mg/L
Inorganic				
Fluoride	0.2 - 0.3 0.25	0.2 - 0.35 0.3	NT	1.5 mg/L
Nitrate + Nitrite (as N)	ND - 1.13 ND	ND - 0.28 ND	0.011*	11.3 mg/L

^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.

ND is Not Detected

NT is Not Tested

*One test result only

The raw water from Camballin Bores complies with ADWG health guidelines.

b. Aesthetic characteristics - Camballin bores raw water

Aesthetic water quality analyses for raw water from Camballin are summarised in the following table. The values are taken from ongoing raw water monitoring up to September 2005. All values are in milligrams per litre (mg/L) unless stated otherwise. The water quality parameters that have on occasion exceeded the ADWG aesthetic guideline for supplied drinking water are bolded.

Table 3. Range of monitored values

Parameter	Range of monitored values			1996 AWDG Aesthetic Guideline Value ^
	Min-Max Median			
	Bore 3	Bore 3/73	Bore 1/04	
Salinity (TFSS less CO ₂)	180 - 232 200	186 - 221 202	NT	1 000 mg/L
Hardness (CaCO ₃)	35 - 75.4 45	40 - 65.3 42.5	45*	200 mg/L
Turbidity	ND - 160 0.8	ND - 60 0.8	0.4*	5 NTU
pH	6.43 - 8.4 6.6	6.42 - 8.4 6.6	6.5*	6.5-8.5
Colour	1 - 10 2	ND - 9 2	ND*	15 TCU
Iron (unfiltered)	ND - 15 0.55	ND - 5.5 0.7	0.183*	0.3 mg/L
Manganese (unfiltered)	ND - 0.16 0.032	ND - 0.103 0.03	0.026*	0.1 mg/L
Aluminium (unfiltered)	ND - 0.03 ND	ND - 0.02 ND	ND*	0.2 mg/L

^An aesthetic 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.

ND is Not Detected

NT is Not Tested

*One test result only

The water from the Camballin Bores complies with ADWG aesthetic guidelines with the exception of elevated iron (unfiltered) levels, and isolated manganese (unfiltered) levels. The raw water is treated by filtration and pre-chlorination which decreases these levels to an acceptable tolerance, as determined by ADWG.

Appendix 2 - Photos



Photo 1. Camballin – Bore 3 (now decommissioned, Water Corporation depot Buildings in background).



Photo 2. Past fuel storage at Water Corporation depot (this above-ground tank has been removed from the site – incompatible land use in a PDWSA (P1)).



Photo 3. Horizon Power fuel storage at Camballin. The site will be decommissioned and rehabilitated in 2007, once the Looma Power Station is operational.



Photo 4. Scrap metal tip at Camballin.



Photo 5. Typical residential housing in Camballin.

Appendix 3 - Best management practice documents for activities in PDWSAs

Stormwater management:

Overland runoff should not be channelled into waterways via constructed stormwater infrastructure, ie pipes and constructed channels. Infiltration into soil should be aided at every opportunity.

- Department of Environment, 2005, *Decision Process for Stormwater Management in WA*. Available from <http://stormwater.environment.wa.gov.au>.
- Department of Environment, 2004, *Stormwater Management Manual for WA*. Available from <http://stormwater.environment.wa.gov.au>.
- Department of Environment¹, 2002, Water Quality Protection Note *Stormwater management at industrial sites*. Available from <http://drinkingwater.water.wa.gov.au>.

Buffers:

Vegetated buffers should be maintained along all streamlines, whether or not currently flowing.

- Department of Water, 2006, Water Quality Protection Note *Vegetation buffers to sensitive water resources (draft)*, Department of Environment. Available from <http://drinkingwater.water.wa.gov.au>.
- Department of Environment, 2002, *River Restoration Manual – Guides to the Nature, Protection, Rehabilitation and Long-term Management of Waterways in Western Australia*. Available from <http://waterways.environment.wa.gov.au>, select publications>manual>river restoration.
- National Health & Medical Research Council and Agriculture & Resource Management Council of Australia and New Zealand, 2004, *Australian Drinking Water Guidelines*, NHMRC and ARMCANZ. Available from www.nhmrc.gov.au/publications/synopses/eh19syn.htm.
- Water and Rivers Commission, 2001, Water Note 23 – *Determining the Foreshore Reserve*. Available from <http://waterways.environment.wa.gov.au>, select publications>facts sheets>water notes.
- Water and Rivers Commission, 2000, Foreshore Policy No. 1 – Identifying the foreshore area. Available from <http://waterways.environment.wa.gov.au>, select publications>policies>foreshore policies.

¹ The new Department of Water has assumed primary responsible for managing the State's water resources, and is now the custodian of the Water Quality Protection Notes and other drinking water related guidance documents.

- Water and Rivers Commission, 2000, *Draft Policy: Waterways WA – A Policy for Statewide Management of waterways in WA*. Available from <http://waterways.environment.wa.gov.au>, select publications>policies>statewide policies.

Pesticide application:

Pesticide application should be minimised in Water Reserve areas. For specific needs of crops and best practice contact Department of Agriculture.

- Department of Agriculture, 2005, *Code of Practice for the use of Agricultural and veterinary chemicals in WA*. Available from www.agric.wa.gov.au.
- Department of Health, 1993, Public Service Circular 88 *Use of Herbicides in Water Catchment Areas*. Government of Western Australia. Available from www.population.health.wa.gov.au/environmental/resources/use%20of%20herbicides%20in%20water%20catchment%20areas.pdf.
- Water and Rivers Commission¹, 2000, Statewide Policy No. 2 *Pesticide Use in public drinking water source areas*, Water and Rivers Commission. Available from <http://drinkingwater.water.wa.gov.au>.

Nutrient application:

Should be minimised in Water Reserve areas. For specific needs of crops contact Department of Agriculture.

- Department of Environment¹, 1998, Water Quality Protection Note *Nutrient and irrigation management plans*, Department of Environment. Available from <http://drinkingwater.water.wa.gov.au>.

Recreation in PDWSAs:

- Department of Environment¹, 2003, Statewide Policy No. 13 *Policy and Guidelines for Recreation within Public Drinking Water Source Areas on Crown Land*. Water and Rivers Commission. Available from <http://drinkingwater.water.wa.gov.au>.

Major roads, roads and tracks, infrastructure maintenance:

Drainage must be controlled to prevent soil erosion and minimise sediment transport. Chemical application to control vegetation should be minimised.

- Department of Environment¹, 2005, Water Quality Protection Note *Roads in sensitive environments*. Available from <http://drinkingwater.water.wa.gov.au>.

¹ The new Department of Water has assumed primary responsible for managing the State's water resources, and is now the custodian of the Water Quality Protection Notes and other drinking water related guidance documents.

Chemical and fuel storage:

- Department of Water, 2006, Water Quality Protection Note *Toxic and hazardous substances storages and use*, Department of Water.
- Department of Water, 2006, Water Quality Protection Note *Contaminant spills – emergency response*, Department of Water.
- Department of Water, 2006, Water Quality Protection Note *Tanks for temporary elevated fuel and chemical storage*, Department of Water.
- Department of Water, 2006, Water Quality Protection Note *Tanks for underground chemical storage*, Department of Water.
- Department of Water, 2006, Water Quality Protection Note *Tanks for elevated chemical storage*, Department of Water.
- Department of Environment¹, 1998, Water Quality Protection Note *Temporary skid mounted fuel transfer and storage within Public Drinking Water Source Areas*, Water and Rivers Commission.
- Department of Water, 2006, Water Quality Protection Note *Chemical blending*. Department of Water.

Available from <http://drinkingwater.water.wa.gov.au>.

Mechanical servicing and workshops:

- Department of Water, 2006, Water Quality Protection Note *Mechanical servicing and workshops*, Department of Water.
- Department of Water, 2006, Water Quality Protection Note *Radiator repair and reconditioning*, Department of Water.
- Department of Water, 2006, Water Quality Protection Note *Mechanical equipment wash-down*, Department of Water.

Available from <http://drinkingwater.water.wa.gov.au>, select Publications>Guidelines> Water Quality Protection Notes.

Publication feedback form

The Department of Water welcomes feedback to help us improve the quality and effectiveness of our publications. Your assistance in completing this form would be greatly appreciated.

Please consider each question carefully and rate them on a 1 to 5 scale, where 1 is poor and 5 is excellent (please circle the appropriate number).

How did you rate the quality of information?

1 2 3 4 5

How did you rate the design and presentation of this publication?

1 2 3 4 5

How can it be improved?

.....

How effective did you find the tables and figures in communicating the data?

1 2 3 4 5

How can they be improved?

.....
.....
.....

If you would like to see this publication in other formats, please specify. (e.g. CD)

.....

Please cut along the dotted line on the left and return your completed response to:

**Publications Coordinator
Department of Water
PO Box K822
Perth WA 6842
Fax: (08) 6364 6500**

