



Important information

The *Kalbarri Water Reserve drinking water source protection plan* (2006, WRP no.64) was reviewed in 2019.

Please ensure you read the *Kalbarri Water Reserve drinking water source protection review* (2019, WRP no.191) alongside the 2006 plan to obtain all of the information about this drinking water source.

The 2019 review considers changes that have occurred in and around the Kalbarri Water Reserve since the completion of the *Kalbarri Water Reserve drinking water source protection plan*. Additional recommendations have been prepared to ensure the ongoing protection of this public drinking water source area:

- removing the wellhead protection zone (WHPZ) for Kalbarri bore 1/86
- extending the WHPZs for Port Kalbarri bores 1/97 and 2/97 over the Kalbarri National Park
- reviewing the boundary of the Kalbarri Water Reserve near bore 1/86 when it is permanently decommissioned
- ensuring best management practices are implemented during construction and operation of the solar thermal power station.

You can find the 2019 *Kalbarri Water Reserve drinking water source protection review* at www.dwer.wa.gov.au or by contacting the Department of Water and Environmental Regulation on +61 8 6364 7000 or drinkingwater@dwer.wa.gov.au.



Department of Water
Government of Western Australia

Kalbarri Water Reserve Drinking Water Source Protection Plan

Kalbarri and Port Kalbarri Town Water Supply



Please note

The *Kalbarri Water Reserve drinking water source protection plan* was released in June 2006. Minor amendments were made to this plan in December 2008, primarily concerning descriptions of land uses, the implementation of recommendations and integration with the management of the Kalbarri National Park. A full review of this plan was not undertaken in 2008.

The contamination risks to the drinking water source and the recommended protection strategies were not reviewed in 2008.

The boundaries of the water reserve, priority areas and wellhead protection zones were not re-assessed and remain unchanged. The classifications of priority areas within the water reserve also remain unchanged.

If you have any questions about the amendments to this plan, please contact:

Geraldton regional office
Department of Water
Telephone: 9965 7400

Water Source Protection branch
Department of Water
Telephone: 6364 7600



Department of **Water**
Government of **Western Australia**

Kalbarri Water Reserve

Drinking Water Source Protection Plan

Kalbarri and Port Kalbarri Town Water Supply

Prepared by

Department of Water

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Acknowledgments

Contribution	Personnel	Title	Organisation
Program Direction	Tony Laws	Manager, Water Source Protection	Department of Water
Supervision	Stephen Watson	Program Manager, Protection Planning	Department of Water
Report Preparation	Steve Chase	Water Resource Planner	Department of Water
	George Foulsham	Water Resource Planner	Department of Water
	Peter Novak	Environmental Officer	Department of Water
Drafting	Andrew Dennison	GIS Officer	Department of Environment
	Melanie Webb	GIS Officer	Department of Water

For more information contact:

Program Manager, Protection Planning

Water Source Protection Branch

Department of Water

Level 4, The Atrium

168 St George's Terrace

PERTH WA 6000

Telephone: (08) 6364 7600

Facsimile: (08) 6364 7601

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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/

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Murchison River Mouth

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Foreword

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

A safe drinking water supply is critical to the well-being of the community and catchment protection is necessary to help avoid, minimise or manage risks to water quality in public drinking water source areas. The Department of Water 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 public drinking water source areas 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 necessary to ensure the safest possible raw water supply (ie before treatment).

This plan details the location and boundary of the drinking water catchment, which provides potable water to the Kalbarri and Port Kalbarri town water supply. It discusses existing and future usage of the water source, describes the water supply system, identifies risks and recommends management approaches to maximise protection of the catchment.

The plan should be used to guide State and local government land use planning decisions in Western Australia. This plan should be recognised in the Shire of Northampton Local 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. It should also be used in the management of the Kalbarri National Park. Other stakeholders should use this document as a guide for protecting the quality of water in the public drinking water source area.

The process involved in the preparation of a Drinking Water Source Protection Plan is as follows:

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

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Summary

Kalbarri is located in the Shire of Northampton on the mid west coast of Western Australia, approximately 585 km north of Perth. The town and the surrounding region obtain their water supply from groundwater bores situated generally south east of town. The catchment area for the borefield is substantially within the Kalbarri National Park. The national park is vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation for conservation and recreation. The rest of the catchment is subject to management by the Shire of Northampton and includes land zoned for light and general industry and for rural activities.

The Kalbarri Water Reserve was proclaimed in 1988 to protect the groundwater from contamination. The revised boundaries proposed in this plan are based on hydrogeological assessment and consultation with stakeholders.

This plan reviews existing protection boundaries for the town water supply source for Kalbarri and Port Kalbarri to better reflect recharge areas and public water supply bore capture zones. Priority classifications have been designated to ensure consistency with the Department of Water's framework for public drinking water source protection.

The quality of the groundwater resource is potentially at risk from increased development around the Kalbarri townsite and Port Kalbarri. The vulnerability of the groundwater system is high because the aquifer is unconfined and is recharged directly by rainfall therefore it can be readily contaminated by commonly used fertilisers, pesticides, chemicals and fuels.

The boundaries and priority classifications of the revised Kalbarri Water Reserve have been designated to align with the capture zones of the existing public supply bores and recognise current land uses. The new protection area also allows for future expansion of the borefield and removes unnecessary constraints on areas not required for public drinking water source protection.

A range of recommendations are put forward in this plan to help reduce the potential for contamination. Any major development proposals that may affect the quality of this drinking water source should be referred to the Department of Water for comment. The plan should also be reflected in all land use planning strategies for the area, including the Shire of Northampton's Local Planning Scheme and *Conservation and Land Management Act 1984* management plans for the Kalbarri National Park.

1 Introduction

1.1 Kalbarri and Port Kalbarri

The town of Kalbarri is located on the mid west coast of Western Australia, approximately 585 km north of Perth (Figure 1). The new Port Kalbarri development is situated 5 km south of Kalbarri.

The town has a resident population of about 1,300, a tourist population of about 3,000 and its economy is mainly based on commercial fishing and tourism.

This plan has previously been released for comment to stakeholders including the Water Corporation, Shire of Northampton, Landcorp, Department for Planning and Infrastructure, Department of Environment and Conservation, The Department of Agriculture, Conservation Council of WA, Department of Health, Aboriginal interests, private land owners and industry representatives. The comments received were considered and have been addressed in the preparation of this plan.

1.2 The current Water Reserve

Public drinking water supply for Kalbarri and Port Kalbarri is supplied from bores operated by the Water Corporation. All the production bores draw water from the Tumblegooda Sandstone aquifer.

Bores are located within the gazetted Kalbarri Water Reserve. The current Water Reserve encompasses the town of Kalbarri as well as areas to the south and east (Figure 2). This area was proclaimed under the *Country Areas Water Supply Act 1947* in April 1988. Since this time greater understanding of the local groundwater system and direction of flow has prompted a review of the boundaries of the Water Reserve as outlined in this plan.

The new Water Reserve will have less developable land and more Crown reserve than the current Water Reserve. There has been no previous priority classifications assigned to the Kalbarri Water Reserve.

There is no existing groundwater quality protection plan for the area. The Geraldton Region Plan (Western Australian Planning Commission, 1999) (which is due for review) recognises part of the existing Water Reserve as an “Environmental Management Priority Area” or an area needing protection to maintain its environmental qualities. The Geraldton Region Plan seeks to provide a framework for the future management, protection and coordination of regional planning in the mid west region.

1.3 The current water supply system

Groundwater for the town of Kalbarri is abstracted from four Water Corporation production bores 1/98, 1/86, 2/86 and 3/86 located about 2 km south east of the townsite. Note that bore 3/69 has been replaced by bore 1/98. There are also two monitoring bores in operation (1/69 and 2/79). The water from the production bores is pumped via an aerator to a 2500 m³ storage tank, from which it is passed through a chlorinator and gravity fed to the town reticulation system.

Groundwater for Port Kalbarri is abstracted from two Water Corporation production bores (1/97 and 2/97) located about 5 km south of the Kalbarri townsite and 2 km east of the intersection of Explorer Avenue and Boundary Road. The production bores are located 150 m apart. Water from Port Kalbarri is not aerated. There is also a monitoring bore 3/97 located in the same vicinity.

1.4 The current allocation licence

The Kalbarri Scheme is operated under Groundwater Well Licence No. 55393 which has a licensed allocation of 500,000 kL per annum. The Port Kalbarri scheme is operated under Groundwater Well Licence No. 105392 and has a licensed allocation of 35,000 kL per annum.

Groundwater resource utilisation and conservation in Western Australia is administered by the Department of Water in accordance with the *Rights in Water and Irrigation Act 1914*. This Act requires the compulsory licensing of all artesian wells throughout Western Australia. In addition, non-artesian wells require licensing in specific areas, proclaimed under the Act. Kalbarri is located within the proclaimed Gascoyne Groundwater Area.

The Gascoyne Groundwater Area is divided into twelve sub-areas based on groundwater flow systems to help manage the allocation of groundwater resources. The Kalbarri Groundwater Sub-Area covers a 20 km radius from the townsite.

The Department of Water is intending to prepare a Groundwater Management Plan for the Gascoyne Groundwater Area. The plan will summarise the groundwater resource characteristics and abstraction details of the Gascoyne Groundwater Area and develop groundwater management policies for each of the management sub-areas.

Historically total production from the Kalbarri borefield has ranged between 400,000 kL and 500,000 kL per annum, which is below the licensed allocation.

Production from the Port Kalbarri borefield has been well below the licensed allocation but is increasing each year. In 2004 production from the borefield was 12,260 kL which is approximately 35% of the licence allocation.

2 Future planning

2.1 Future water needs

Over the long term, a 3% annual population growth rate is predicted for Kalbarri and Port Kalbarri. Port Kalbarri in particular is set to grow significantly with further subdivisions planned for the area. Projected abstraction for Kalbarri suggests that the allocation will need to be reviewed in the coming years. The Port Kalbarri allocation is believed to be adequate in the short term.

2.2 Alternative sources

In 1997 the Water Corporation identified that the existing scheme would not meet predicted demand and commenced investigations for the drilling of new bores. Extra demand is expected to be met by drilling additional bores in the Kalbarri National Park to the north east and/or south east of the existing production bores and connecting to the existing reticulated system (Water Corporation 2000c). The location of these bores will need to take account of groundwater flows, sites of contamination risk and the impact of pumping on groundwater dynamics once operational.

3 The catchment

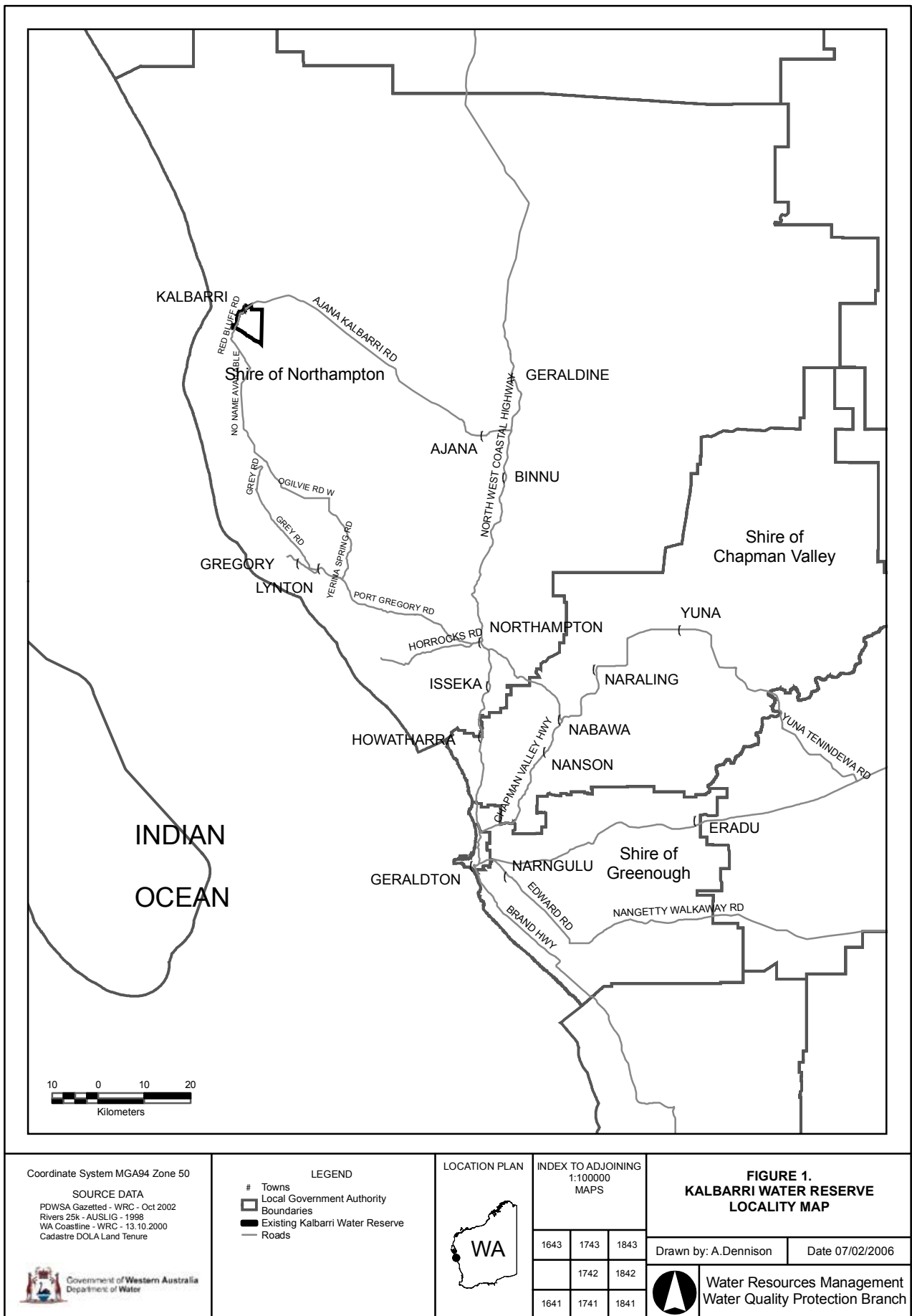
3.1 Climate

Kalbarri has a Mediterranean-type climate characterised by hot dry summers and mild wet winters. The average annual rainfall is approximately 380 mm. Most of the rainfall occurs during the winter months between May and August. The average annual evaporation is about 2,500 mm. Evaporation is greatest during the summer months of January and February, and lowest during the winter months. Average daily maximum and minimum temperatures in January are 31°C and 20°C and in July are 20°C and 10°C respectively.

3.2 Physiography

The land near Kalbarri rises steeply from the coast and the floodplain of the Murchison River toward a moderately dissected plateau about 5 km east of the town and to an elevation of about 140 m AHD. The plateau surface comprises gently undulating sandplain with scattered hills formed by Cretaceous sedimentary rocks, for example Meanarra Hill (204 m AHD). Remnants of the lateritic duricrust occur sporadically on the plateau. Numerous well developed creeks occur along the edge of the plateau and drain to the north west.

The coastline is characterised by cliffs capped by a limestone ridge which form a near unbroken sweep of precipitous cliffs, except at Kalbarri where they are cut by the Murchison River. Coastal limestone slopes gently to the east towards the sandplain. Massive sandstone (Tumblagooda Sandstone) forms rounded cliffs along the coast south of Kalbarri from Red Bluff to Bluff Point.



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Figure 1: Kalbarri locality plan

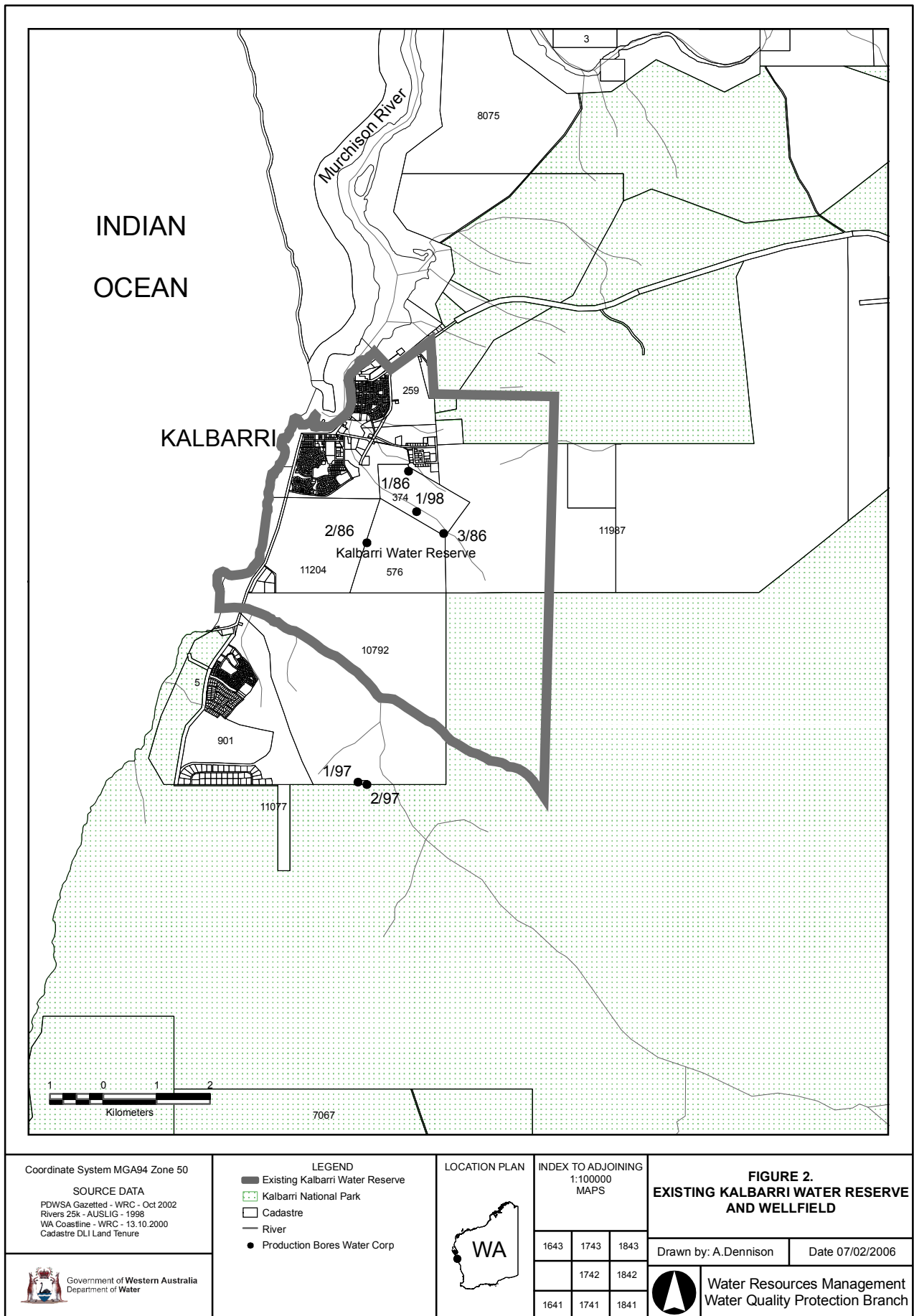


Figure 2: Existing Kalbarri Water Reserve

3.3 Hydrogeology

A regional groundwater flow system occurs in the Tumblagooda Sandstone and the overlying Wittecarra Sandstone, which is referred to as the Tumblagooda aquifer. Other perched aquifers also exist locally. The Tumblagooda aquifer is bound to the west by the Indian Ocean and Murchison River, and to the east by the Northampton Complex, about 45 km east of Kalbarri.

The Tumblagooda aquifer is composed predominantly of quartz sandstone and at Kalbarri it forms a major aquifer in the southern most part of the Carnarvon Basin. It is unconfined but further east and north the groundwater in the aquifer is confined beneath less permeable Cretaceous and Palaeozoic sediments. The Tumblagooda aquifer is heterogeneous and anisotropic with low primary porosity (intergranular) and groundwater movement is controlled by a well developed joint system. At Kalbarri, there are two sets of vertical joints, trending north-northeast and north west, and horizontal bedding-plane partings (Barnett, 1980).

Recharge to the Tumblagooda aquifer is mainly by direct percolation from rainfall where the aquifer outcrops and by leakage from the overlying sediments where the confining Kockatea Shale is absent. Most of the recharge occurs south east of Kalbarri on the sandplain and along the margin with the Northampton Complex. There is episodic recharge from the Murchison River in the east and from streams originating on the dissected plateau, as they do not flow during the whole year. The extent of recharge from streams draining the outcrop area appears to be minor since there is little marked effect on the watertable contours. Downward leakage from perched aquifers in Cretaceous and Palaeozoic formations through confining beds or by leakage along faults is thought to be small.

The Tumblagooda aquifer has low transmissivity. Pumping tests indicate evidence of a delayed yield, possibly resulting from groundwater contribution from the sandstone primary permeability or from leakage from a perched aquifer system in overlying sediments (double porosity).

Groundwater discharges mainly to the sea along the coastline and estuary of the Murchison River over a salt-water wedge. Local discharge from the Tumblagooda aquifer also maintains high-level spring flow and stream flow as indicated by the numerous springs in the Kalbarri area. A number of small springs emerge from bedding plane partings in the bed of the Murchison River below Ross Graham Lookout, about 32 km east-southeast of Kalbarri (Barnett, 1980).

The groundwater salinity measured in bores at Kalbarri in 2004 indicated that groundwater has a salinity of less than 400 mg/L Total Dissolved Solids (TDS) and a thin lens of brackish groundwater may locally occur at or near the water table. In general the groundwater salinity usually increases with depth near the coast due to the presence of a wedge shape of salt water underlying fresh water. In the Kalbarri area the groundwater salinity is known to decrease with depth in some bores (Hocking et al., 1982, and Allen, 1987). This is probably related to local permeability and salinity differences in the gently dipping sequences in the aquifer. Fresh groundwater is known to occur to at least 150 m below sea level near the current Kalbarri town water supply borefield.

3.4 Groundwater levels

The watertable slopes from the elevated area east of Kalbarri toward the sea and estuary of the Murchison River where groundwater discharge occurs. South of the Kalbarri townsite groundwater flow is westwards towards the Indian Ocean and north of the townsite the flow is north west towards the Murchison River. The watertable elevation may be as much as 150-200 m AHD in areas of outcrop along the Murchison River near the Northampton Complex (Allen, 1987). The watertable is 13 to 23 m deep at the town water supply borefield and close to the surface along the coast and in the floodplain of the Murchison River. Monitoring from the two borefields have shown water levels to be relatively stable.

4 Water quality and treatment

4.1 Monitoring program

Water quality monitoring of the town of Kalbarri's bores follows the program recommended in the Water Corporation's Kalbarri Water Resource Management Operation Strategy (WRMOS) 2001. Water quality monitoring of the Port Kalbarri bores follows the program recommended in the Water Corporation's Port Kalbarri WRMOS 1998. All production bore pumpage and microbiological monitoring is conducted monthly; water level, conductivity and temperature are monitored every three months; and a suite of potential contaminants are monitored annually.

4.2 Water quality

A wide range of chemical, physical and microbiological properties can affect the health values and aesthetic quality of drinking water. The groundwater quality within the Kalbarri and Port Kalbarri area is generally good. Water quality analyses for the Kalbarri and Port Kalbarri water sources undertaken by the Water Corporation for the period June 1999 to June 2004 are summarised in Appendix 1.

Contaminants of concern which exceed the Australian Drinking Water Guideline recommendations in the Kalbarri borefield raw water are all aesthetic components and include turbidity, pH and iron. Manganese and aluminium have also been detected at levels above the aesthetic guideline criteria in two bores. The occurrences of these chemicals are generally isolated and may be due in part to bore sampling procedures.

Contaminants of concern which exceed the Australian Drinking Water Guidelines in the Port Kalbarri borefield raw water include microbiological and aesthetic components. There has been one thermotolerant coliform count greater than 20 cfu/100 mL. Maximum monitored raw water values for pH and iron exceed the Australian Drinking Water Guidelines aesthetic value figures in the bores but are corrected through treatment.

There is no evidence of any significant anthropological derived contamination in the catchment at this stage. The contaminants that have been detected are all naturally occurring. Bore 1/86 is the most susceptible to contamination due to its close proximity to industry. Water quality data for this bore should be scrutinised closely as industry develops further in the vicinity.

4.3 Water treatment

Mixing and aeration of groundwater is used to correct for slightly acidic pH, high turbidity and elevated aluminium and iron concentrations in some bores (Water Corporation, 2000). All water is then disinfected by chlorination prior to supply as drinking water. Mixing water from the various bores helps ensure the water quality meets the Australian Drinking Water Guideline criteria for iron and aluminium.

It should be recognised that although disinfection by chlorination generally removes microbiological contamination, treatment processes alone cannot be relied upon. This is why the Australian Drinking Water Guidelines 'catchment to consumer' multiple barrier approach is important for the provision of safe drinking water to consumers.

5 Land uses and contamination

5.1 Existing land uses

Hazards associated with existing and proposed land uses and activities in the proposed Kalbarri Water Reserve and surrounds have been identified. Land use zones in the existing Water Reserve consist of:

- National Park and Crown reserves;
- various rural and semi-rural pursuits on land in private ownership;
- light industry;
- residential development; and
- recreation and tourism.

The risk posed by each hazard has been assessed and a catchment management rank of high, medium or low assigned. Land uses and contamination threats are shown in Figure 3 and drinking water quality risk assessment details are provided in Table 1. The rank assigned to identified hazards was determined by assessing the likelihood and consequences of the source being contaminated, whilst taking into account current preventive and management strategies for the catchment.

The risk assessment process was conducted in accordance with the Australian Drinking Water Guidelines recommendations. Refer to the Department of Water's Water Quality Protection Note *Risk Assessment of Public Drinking Water Source Areas* for further explanation of risk assessment in drinking water catchments, available via the internet at <www.water.wa.gov.au>.

The discussion and recommended strategies balance the need to protect water quality for the community now and into the future, with the rights of land holders to continue to use and develop their land consistent with local planning schemes.

5.1.1 National park and Crown reserves

Kalbarri National Park (Reserve No. 27004) was established in 1963 and covers an area of 183,004 ha. The national park is vested in the Conservation Commission of Western Australia and managed by the Department of Environment and Conservation (DEC) under the *Conservation and Land Management Act 1984*. The eastern part of the proposed Kalbarri Water Reserve is mostly within the Kalbarri National Park. The draft Kalbarri National Park management plan, which is being prepared by the Department of Environment and Conservation, remains on hold until other planning tasks are completed. The Department of Environment and Conservation will prepare its management plans in consultation with the Department of Water and Water Corporation, and submit them to the Minister for Water.

No apiarists, wildflower picking or seed collection occurs in the National Park. National Park tracks in the Water Reserve are used as fire access tracks and public access is not permitted on these tracks.

After a long period of consultation with State agencies and the public, the Shire of Northampton gained approval to excise all of Victoria Location (VL) 11987 from the adjacent National Park and manage it for "the purposes of recreation, gravel extraction and landfill." The Shire of Northampton's current landfill is located approximately 3 km

east of the industrial area within VL 11987, and is licensed by the Department of Environment and Conservation. Gravel extraction is also occurring within the reserve. The Shire of Northampton recently indicated future gravel extraction sites will be located outside the Kalbarri Water Reserve. The Shire relinquished clearing permits for planned gravel extraction sites within two wellhead protection zones in VL 11987 to protect water quality.

5.1.2 Rural

Victoria Location 10792 is privately owned and its south eastern corner is proposed to be classified as Priority 2 within the Kalbarri Water Reserve. It is currently zoned rural which, according to the Department of Water's Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Sources Areas*, is a compatible activity. The owners have earmarked the site for future development which will primarily be residential, with some commercial lots. The proposed development area has as its boundaries Stiles Road to the south and the Kalbarri National Park to the east.

The Water Corporation do not intend to locate production bores in this area in the near future. However, it was included within the public drinking water source area because it is a recharge area for production bores 1/97 and 2/97 near Port Kalbarri and any incompatible land uses could contaminate water being drawn from these bores.

5.1.3 Industrial

The existing Kalbarri industrial area is located north east of bore 1/86 (refer to Figure 3). Many of the existing activities are conditional and some are incompatible with the Department of Water's Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Sources Areas*. These activities will be allowed to continue but any new industry will need to seek approval prior to commencing. Development conditions should be set that minimise the contamination risk to water resources. Existing and future industry in the area should move towards best environmental management practices to protect groundwater quality.

The existing industrial area is unsewered and there are no plans to sewer the area in the immediate future, unless funding becomes available.

Application of fertiliser and pesticides occurs within the nursery which is located within the WHPZ of bore 1/86. During winter local flooding occurs and runoff potentially contaminated with pesticides may mix with water that recharges bore 1/86. Due to the nature of Kalbarri's semi-fractured aquifer there is the potential for contamination. The Department's WQPN Nurseries and Garden Centres provides advice on currently recommended environmental practice.

Due to the present frequency of sampling, it is possible that a contamination event may occur and not be detected thus placing resident's health at risk. Accordingly, the sampling frequency of bore 1/86 should be increased to account for potential rapid transport of contaminated water via preferential pathways.

Mixing and storage of chemicals occurs within the WHPZ of bore 1/86 on a number of privately owned industrial premises. This presents a potential contamination risk of chemical and fuel spills from vehicles and storage containers.

An uncapped, decommissioned landfill is located within the WHPZ of production bore 1/86 and in the north east corner of the industrial zone. Council records indicate administrative staff were not present during most of the time it was operational and as a consequence the landfill received most types of waste including liquid sludge waste,

refrigerants, asbestos and old hydrocarbon and pesticide containers.

The municipal wastewater treatment plant is considered to be outside the water catchment supplying the borefield. However, it needs to be managed in terms of treated effluent disposal. Currently the treated effluent is used on the golf course. However the golf course can only accept a finite supply. A new disposal site will need to be found to deal with excess treated effluent in the future. Preferably this should be outside the Water Reserve.

5.1.4 Residential

There is currently no residential zoned land within the proposed Kalbarri Water Reserve. There is a pocket of residential land north of production bore 1/86 and adjacent (west) to the industrial area, but this area has been excluded from the Kalbarri Water Reserve.

Table 1: Potential water quality risks in the Kalbarri Water Reserve and recommended response

Land Use / Activity	Hazard Source / Event	Hazard	Catchment Management Rank	Considerations for Management	Current and Future Water Reserve Protection Strategies and barriers
Roads and tracks	<p>Fuel and chemical leakage or spills</p> <p>Road verge weed control</p>	<p>Hydrocarbons and chemicals</p> <p>Herbicides</p>	<p>Medium</p> <p>Medium</p>	<p>There are Department of Environment and Conservation managed tourism roads and tracks in the National Park and Shire of Northampton managed roads in the industrial area. The roads in the Water Reserve are used predominantly for movement of local people, produce and supplies. Fuel and chemical spillage as a result of accidents poses a threat to water quality, however the probability of this occurring is low.</p> <p>National Park tracks are also used as fire access tracks and public access is not permitted on these.</p> <p>Roundup and Brush-off are used for road verge weed control by the Department of Environment and Conservation, mainly along tourist routes.</p> <p>Main Roads WA may also manage roads in the Water Reserve.</p>	<p>Current</p> <ul style="list-style-type: none"> • Fencing and signage around bore infrastructure • Department of Environment and Conservation and Shire road maintenance • HAZMAT procedures • Water quality monitoring • Detention time in aquifer • The Department of Environment and Conservation, Main Roads WA and the Shire of Northampton comply with the Department of Health's Public Service Circulatory – 88 <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> • Country Areas Water Supply Act 1947 By-law enforcement • Ranger patrols/ surveillance • New signage in the Water Reserve • Inspection of drain outlets • Emergency management plan for responding to major pollution events
Fire management - wildfires and controlled burns	Fire fighting foam	Nutrients	Medium	<p>Wildfires in the Water Reserve are rare. Typically there is about a 15 day total fire ban per year. Diammonium Phosphate may be used by the Department of Environment and Conservation and the Fire and Emergency Services Authority as a fire retardant. The proximity of production bores needs to be considered before application of chemical fire retardants.</p>	<p>Current</p> <ul style="list-style-type: none"> • Activity managed by the Department of Environment and Conservation and water quality issues considered in fire management plans and operations • Detention time in aquifer • Controlled burns and fire breaks help in reducing the impacts of fire

Land Use / Activity	Hazard Source / Event	Hazard	Catchment Management Rank	Considerations for Management	Current and Future Water Reserve Protection Strategies and barriers
Feral and native animals. 1080 baiting of feral animals	Faecal contamination / carcasses	Pathogens	Medium	There is some limited potential for pathogen contamination of bores from animal carcasses and faeces. Pigs are not considered a problem in this Water Reserve but there are a range of other animals found within the National Park. There is no intention to manage native animals and feral animal control is limited.	<p>Current</p> <ul style="list-style-type: none"> Activity managed by the Department of Environment and Conservation Detention time in aquifer Microbiological monitoring <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> Ranger patrols/ surveillance Fencing vulnerable areas (including bores and WHPZ)
Illegal rubbish dumping	Leaching of contaminants from rubbish Human activity	Nutrients, pesticides and chemicals Pathogens	High High	Some rubbish dumping occurs in the Water Reserve with rubbish removal managed by the Shire of Northampton and the Department of Environment and Conservation.	<p>Current</p> <ul style="list-style-type: none"> Activity monitored and rubbish removal managed by the Department of Environment and Conservation in the National Park and the Shire of Northampton on Shire land <i>Environmental Protection Act 1986</i> licencing of landfill Detention time in aquifer Monitoring program <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> Collection skips for recycling toxic materials Restricted access Ranger patrols/ surveillance <i>Country Areas Water Supply Act 1947</i> By-law enforcement New signage in the Water Reserve
Illegal camping and hunting	Human activity and lack of toilet facilities	Pathogens	Medium	Camping and illegal hunting in the water Reserve are reported to be rare.	<p>Current</p> <ul style="list-style-type: none"> Detention time in aquifer Microbiological sampling program Activity levels and visitor numbers are regulated by the Department of Environment and Conservation through permits and licences <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> Restricted access Ranger patrols/ surveillance <i>Country Areas Water Supply Act 1947</i> By-law enforcement New signage in the Water Reserve

Land Use / Activity	Hazard Source / Event	Hazard	Catchment Management Rank	Considerations for Management	Current and Future Water Reserve Protection Strategies and barriers
Tourism, recreational facilities and ranger residences	Fuel spills on roads and car parking areas Ablution facilities / septic systems	Hydrocarbons Pathogens	Medium High	The significance of the hazards associated with car parking areas and ablution blocks is reduced due to the depth to groundwater at this site. Ablutions facilities maintained by the Shire of Northampton and the Department of Environment and Conservation. These should comply with the Health Department's Regulations.	<p>Current</p> <ul style="list-style-type: none"> • Signage • Microbiological sampling program • Detention time in aquifer • Ablution facilities comply with appropriate Australian Standards and Health Department Regulations <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> • Ranger patrols/ surveillance • Stormwater management of road and carpark runoff
Gravel extraction	Spillage of fuel and hydraulic fluid from vehicles Human activity and lack of toilet facilities Rubbish dumping	Hydrocarbons and chemicals Pathogens Nutrients, pesticides and chemicals	Medium Medium High	Gravel extraction is an accepted activity in priority one areas and can be managed appropriately so as not to compromise water quality objectives. Illegal gravel extraction is also occurring which poses more of a risk because less control is exercised over potentially contaminating activities. The Shire of Northampton indicated they will manage the situation by restricting access for vehicles around the extraction area.	<p>Current</p> <ul style="list-style-type: none"> • Management guidelines (eg CALM 1993 Policy Statement No. 2 <i>Local Government Authority Access to Basic Raw Materials from State Forest and Timber Reserves</i>) • Emergency protocols • Detention time in aquifer • Monitoring program <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> • <i>Country Areas Water Supply Act 1947</i> By-law enforcement • Ranger patrols/ surveillance • New signage in the Water Reserve • Restricted access
Off road vehicle use (motorbikes and four-wheel drives)	Human activity and lack of toilet facilities Fuel spills from refuelling or from accidents	Pathogens Hydrocarbons	Medium Medium	Limited levels of activity are reported with the thick vegetation providing a natural barrier to access. Refuelling would not be common given much of the activity occurs close to town where petrol stations are available.	<p>Current</p> <ul style="list-style-type: none"> • Detention time in aquifer • Microbiological sampling program <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> • In conjunction with land managers; restricted access • Ranger patrols/ surveillance • <i>Country Areas Water Supply Act 1947</i> By-law enforcement • New signage in the Water Reserve

Land Use / Activity	Hazard Source / Event	Hazard	Catchment Management Rank	Considerations for Management	Current and Future Water Reserve Protection Strategies and barriers
Bushwalking and cycling	Human and domestic animal activity Litter	Pathogens Nutrients and pathogens	Medium Medium	Walk and bike trails are not provided within the Kalbarri Water Reserve. Activity levels in the Reserve are limited due to hot weather. The Department of Environment and Conservation has indicated that a walk trail through the water reserve may be proposed. There is no signage at present in the Reserve prohibiting rubbish dumping and polluting.	<p>Current</p> <ul style="list-style-type: none"> • Detention time in aquifer • Microbiological sampling program <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> • Ranger patrols/ surveillance • Restricted access • <i>Country Areas Water Supply Act 1947</i> By-law enforcement • New signage in the Water Reserve • The location and construction of future walk and bike trails should consider Water quality protection note <i>Tracks and trails near sensitive water resources</i>
Grazing and Pasture growth	Fertiliser application Animal excreta Pest control	Nutrients Pathogens and nutrients Pesticides	High High High	Fertilisers are generally applied annually with the potential to be applied very close to the Port Kalbarri bores. The bores are fenced preventing direct animal access around them. Animals excrete faeces increasing the risk of pathogen and nutrient contamination. Cattle excrement is a potential source of Giardia and Cryptosporidium.	<p>Current</p> <ul style="list-style-type: none"> • Fencing around bore structures • Detention time in aquifer • Microbiological sampling program • Compliance with <i>Health (Pesticides) Regulations 1956</i> and PSC 88 <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> • <i>Country Areas Water Supply Act 1947</i> By-law enforcement • Liaise with local farmers to ensure pesticides are stored, managed and applied according to the best management practices (ie Statewide Policy No. 2 <i>Pesticides Use in Public Drinking Water Source Areas</i>) • Maintain a WHPZ buffer around the bores • Research pesticide use in and around the Water Reserve to establish an accurate monitoring program

Land Use / Activity	Hazard Source / Event	Hazard	Catchment Management Rank	Considerations for Management	Current and Future Water Reserve Protection Strategies and barriers
Light and heavy industry	<p>Heavy metal and organic chemical use and spills</p> <p>Pest control and fertiliser application</p> <p>Fuel spills from machinery and bulk fuel storage</p> <p>Toilet facilities</p>	<p>Heavy metals and chemicals</p> <p>Pesticides and nutrients</p> <p>Chemicals and hydrocarbons</p> <p>Pathogens and nutrients</p>	<p>Medium</p> <p>Medium</p> <p>Medium</p> <p>High</p>	<p>Existing uses include auto repair, truck depot (liquid waste vehicles), hydroponic supplies, fertiliser distributor, nursery, cabinet makers and a salvage yard. Land is zoned for future industrial expansion.</p> <p>Application of fertilisers and pesticides occurs within the nursery which is located inside the WHPZ of bore 1/86. During winter local flooding occurs and stormwater runoff may present concerns.</p> <p>Mixing and storage of chemicals occurs within the WHPZ of bore 1/86 on a number of premises. There is the potential for fuel spills from vehicles and fuel storage containers.</p>	<p>Current</p> <ul style="list-style-type: none"> Production bores sampled biannually for pesticides and hydrocarbons and quarterly for nutrients Detention time in aquifer HAZMAT procedures <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> Country Areas Water Supply Act 1947 By-law enforcement Connect industry to deep sewerage A new monitoring bore upstream of bore 1/86 Industry should operate to best environmental management practice standards Regular inspection of industry sites to ensure chemicals and hydrocarbons are stored in accordance with the Department's Water Quality Protection Notes <i>Tanks for Above Ground Chemical Storage and Industrial Sites Near Sensitive Water Resources</i> Compliance with <i>Explosives and Dangerous Good Act 1961</i> Set up notification protocol emergency response planning for chemical spills Refuelling areas of truck depot to be appropriately banded
Wastewater treatment plant	Treated effluent reuse	Nutrients and pathogens	Medium	<p>The wastewater treatment plant is considered to be outside the catchment. The only risk identified from the plant is in the future use of the treated effluent. Currently treated effluent discharges to the golf course which is acceptable as groundwater flows away from the borefield. The golf course is unlikely to be able to accept increased quantities of treated effluent so a new discharge site may need to be identified.</p>	<p>Current</p> <ul style="list-style-type: none"> Lined pond system with regular integrity checks Overflow system to prevent accidental discharge to the environment Water quality sampling Water Corporation inspection and maintenance program Detention time in aquifer <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> Treated effluent management plant Effluent reuse outside Water Reserve

Land Use / Activity	Hazard Source / Event	Hazard	Catchment Management Rank	Considerations for Management	Current and Future Water Reserve Protection Strategies and barriers
Decommissioned landfill	Leaking of contaminants into groundwater	Nutrients, pathogens, pesticides, chemicals and heavy metals	High	The landfill is located within the WHPZ of bore 1/86. The landfill was used up until 2002 for green waste. There was illegal use of the landfill for contaminated soil, sludge, concrete, fuel containers, white goods, pesticide containers etc. The Shire of Northampton has permanently decommissioned the landfill.	<p>Current</p> <ul style="list-style-type: none"> • Closure of the facility • Signage • The Shire of Northampton management and maintenance • Detention time in aquifer <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> • Restricted access • Ranger patrols/ surveillance • <i>Country Areas Water Supply Act 1947</i> By-law enforcement • Investigate the extent of potential contamination risks posed by the site and remediation works if necessary • A new monitoring bore upstream of bore 1/86 • Sampling program should include testing for chemicals expected to be present from the landfill

Land Use / Activity	Hazard Source / Event	Hazard	Catchment Management Rank	Considerations for Management	Current and Future Water Reserve Protection Strategies and barriers
Current landfill	Leaching of contaminants into groundwater	Nutrients, pathogens, pesticides, chemicals and heavy metals	High	<p>The current landfill is approximately 2.5 km upstream of the Kalbarri bores. Placing of future bores will need to consider the impacts of the landfill. Distance to the water table is estimated to be approximately 50 m with semi permeable layers between the shallow waste columns and the water table. Hence the movement of contamination is likely to be attenuated significantly.</p> <p>A lined surface pond is used to treat effluent waste from septic tank pump out.</p>	<p>Current</p> <ul style="list-style-type: none"> The Shire of Northampton management and maintenance Distance from bores Detention time in aquifer One monitoring bore and water quality sampling program Limited opening hours Waste separation on site <i>Environmental Protection Act 1986</i> licencing and inspections <p>Suggested Future Strategies</p> <ul style="list-style-type: none"> Best environmental management practice and review of the landfill waste management plan Discontinue use of surface pongs for treatment of septic tank pump Ranger patrols/ surveillance Appropriate fencing Storage of batteries, chemical drums and other high risk substances on banded hard stand and transfer off site New monitoring bores Education and supervision of residents Sampling program should include testing for chemicals expected to be present from the landfill

5.2 Proposed land uses

5.2.1 National park and Crown reserve

Information contained within the draft Kalbarri National Park management plan indicates that some walk trails may pass through the Kalbarri Water Reserve. The management plan does not indicate locations of car parks or ablution facilities. Such facilities will pose a contamination risk depending on the number of visitors and car bays. The Department of Water has provided advice to the Department of Environment and Conservation requesting consideration of placement of these facilities in relation to future bore locations.

The Shire has suggested that they may seek to open up the eastern portion of reserve 11987 for recreation in the future. The Shire will continue to manage Victoria Location (VL) 11987 for the purposes of recreation, gravel extraction and landfill. The current landfill is expected to have approximately a 20 year life. There is allowance made for expansion of the landfill over time.

5.2.2 Rural

The owner of VL 10792 has advised that subdivision will be proposed some time in the future (similar to other locations that have already been approved and are currently being developed in the Shire of Northampton). VL 10792 is the only block of rural land within the Kalbarri Water Reserve.

5.2.3 Industrial

The Shire of Northampton is planning to expand the existing industrial area north and south. Land has been zoned accordingly and will be used for light to medium industry. The expansion should be managed carefully. Further industrial development should be connected to deep sewerage. Industry should also adhere to best environmental management practices in their operations.

5.2.4 Residential

The Shire of Northampton have indicated that they do not intend to develop any land within the Kalbarri Water Reserve for residential purposes. Some future residential zoning is planned to occur west of bore 2/86 on VL 11204 outside of the proposed public drinking water source area boundary indicated in Figure 3.

Normally bores located in P1 areas require a 500 m wellhead protection zone. It was decided prior to preparation of the Plan to reduce the WHPZ on the western side of production bore 2/86 from 500 m to 300 m in recognition of the Shire of Northampton's "Future Residential" zoning of this area and as it was down gradient of the bores.

It should be noted that the Water Corporation is continuing with its program to progressively provide full sewerage services in Kalbarri, in accordance with the State Infill Sewerage Program.

6 Protection strategies

6.1 Protection objectives

The objective of this plan is to protect drinking water quality for public health, while recognising current land use rights.

Proclaiming the Kalbarri Water Reserve will delineate the area considered important for the protection of the Town's water supply. It will allow the *Country Areas Water Supply Act 1947* by-laws to apply, be incorporated into the Local Planning Scheme and Structure Plan, and ensure that proposals for new development in this area are evaluated against drinking water quality protection objectives.

The Priority 1 classification covering most of the Water Reserve, in particular areas of National Park and Crown reserve, has the fundamental water quality objective of risk avoidance. The small area designated as Priority 2 has the objective of risk minimisation. The Priority 3 classification proposed for the landfill site, industrial area and rural zone has the objective of risk management.

6.2 Potential water quality risks

The potential risks to groundwater quality associated with activities in the recharge areas include chemical or fuel spills, pesticides, pathogens and nutrient contamination from fertilisers and other sources. Pathogens are rated as the most significant risk to public health as very low levels can still create an immediate threat. Water can be contaminated through human and animal contact with water or by faecal contamination. However, the risks are reduced in groundwater systems where residence time and the filtering effects of soil act to mitigate the threat.

Table 1 summarises the water quality risks and recommended protection measures associated with existing land uses and activities within the catchment which have the potential to pose some risk to the quality of the water source.

6.3 Proclaimed area

A proclaimed Water Reserve provides for the protection for the water source. Land uses occurring within the Water Reserve should comply with the Department's Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas*. Where a specific land use has not been covered it should be referred to the Department's Water Source Protection Branch for assessment.

A Water Reserve is not an exclusive use zoning and allows activities that comply with the Table or which were approved prior to the Water Reserve being proclaimed to continue. Country water reserves are proclaimed under the *Country Areas Water Supply Act 1947* and are normally classified as Special Control Areas under Local Planning Schemes in accordance with Statement of Planning Policy 2.7 *Public Drinking Water Source Policy*.

The Kalbarri Water Reserve will be amended to exclude the coastal area and Townsite. The Water Reserve will cover a broader area to the east of Town and extend further north and south, including the Port Kalbarri borefield. The size of the Water Reserve will increase approximately threefold.

The area has been modified to include not only the immediate recharge area but also areas of the wider catchment. It will allow for easterly extension of the borefield to meet future needs.

An outline of the existing and the new Water Reserve is shown in Figure 3. Proclaiming the Water Reserve ensures that the *Country Areas Water Supply Act 1947* By-laws can be applied and allows the Department of Water to manage potentially polluting land uses.

6.4 Priority classification

An explanation of the priority classification system and the detail of land use compatibility within each priority classification is provided in the Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas*. The following priority classifications are proposed for the Water Reserve.

Priority 1 - National Park and Victoria Location (VL) 11987

It is proposed to manage all of VL 11987 and the National Park as P1 except for an area surrounding the existing landfill (1200 m x 800 m) which is proposed to be managed as P3 based on discussions with the Shire of Northampton. The landfill is located about 3 km east of the industrial area and is forecast to be viable for approximately 20 years. The landfill was an existing activity before this plan was developed and on this basis will continue as a non-conforming land use activity.

P1 source protection areas are declared to ensure that there is no degradation of the water source. P1 areas are declared over land where the provision of the highest quality public drinking water is the prime beneficial land use.

Gravel/ sand/ clay extraction is also a pre-existing use in parts of VL 11987 and the activities are conditionally accepted in P1 areas.

The Shire of Northampton also have long term plans to use the eastern portion of VL 11987 within the proposed public drinking water source area boundary for recreation. The Department of Water recognise that the Shire of Northampton have already excised VL 11987 for this and other purposes. Accordingly, the Department of Water has agreed to consider contamination risks that could be introduced through recreation during a review of the priority classification proposed in this report when the Shire has more detail on the future use. Whether the review results in a reclassification from P1 to P2 will depend on the findings of the review undertaken at that time.

Priority 2 - Victoria Location 10792

Statement of Planning Policy (SPP) 2.7 *Public Drinking Water Source Policy* (WAPC, 2003) requires the Shire of Northampton and DPI to consider the proposed P2 classification when considering its future subdivision proposal into residential lots. Consistent with this SPP, the Shire of Northampton recently conducted a Local Planning Scheme amendment. The amendment zoned the area for "Future Development" but also noted that it is within the proposed Kalbarri Water Reserve and that any approved land use activities should be consistent with the Department of Water's Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Source Areas*. This document recommends the lot size for land without reticulated sewerage should be at least 2 ha in P2 areas.

The Water Corporation has indicated that it may decommission the existing Port Kalbarri bores depending on the condition of the borefield asset (eg bores and/or distribution system) and land use/development risks that are present in the future. Given this advice, current planning for the area has assumed that these bores will be decommissioned once development impinges on the bores. This timing has been estimated as 2040, which coincides with the estimated bore asset life. Alternatively, if planning pressure and benefits look to progress development before 2040, relocation of the existing bores at the expense of the developer and to the satisfaction of the Water Corporation, may be explored.

If the borefield asset is removed in the future, then the private land proposed as P2 in this Plan will no longer be required for source protection and the Plan would be reviewed to remove the constraints related to a P2 classification. Whether the future review results in a reclassification to P3 or removal altogether from the Kalbarri Water Reserve will depend on the findings of the review undertaken at that time.

Priority 3 - Industrial area and the Waste Water Treatment Plant

Land developed for industrial purposes within the Kalbarri Water Reserve should be managed in accordance with P3 management objectives and approval of any new land uses should be consistent with the Department of Water's Water Quality Protection Note *Land Use Compatibility in Public Drinking Water Sources Areas*. Existing activities will not be impacted but are strongly encouraged to adopt best management practices. Business within this area includes automotive repair shops, hydroponic supplies, a nursery, cabinet makers and a salvage yard.

6.5 Wellhead protection zones

Wellhead protection zones provide specific protection zones which are defined to protect a drinking water source from contamination in the immediate vicinity of bores. Statutes define land uses that can take place within these zones. Circular wellhead protection zones of 500 m radius should be established around each of the production bores within the P1 area. The western side of the wellhead protection zone around bore 2/86 should extend 300m. Development within these areas will be carefully assessed to address water quality risks. The wellhead protection zone is a key barrier in the 'catchment to consumer' multiple barrier approach for protecting the Water Reserve and its drinking water quality.

6.6 Land use planning

Establishing appropriate protection mechanisms in statutory land use planning processes is necessary to secure the long-term protection of drinking water sources. It is therefore appropriate that the Water Reserve and its Priority 1, 2 and 3 classifications be recognised in land planning strategies, such as the Local Planning Scheme and the Kalbarri National Park management plan. This approach is consistent with the WA Planning Commission Statement of Planning Policy 2.7 *Public Drinking Water Sources Policy* (WA Planning Commission, 2003).

The Department of Water provides advice on the compatibility of land uses within the proposed priority classification areas based on the WQPN *Land Use Compatibility in Public Drinking Water Source Areas*. Development and works proposals in the catchment that are likely to impact on water quality, or are inconsistent with the above land use table, should be referred to the Department of Water's Geraldton Office for

assessment and approval.

6.7 Best management practices

Best management practices for land use activities are encouraged to help protect water quality. These are often in the form of an industry code of practice or environmental guideline. They are usually developed in consultation with industry groups, relevant stakeholders and State government agencies. Best management practices can be developed for an individual enterprise or have a local or regional focus and must consider the full range of economic, social and environmental issues associated with land, water and vegetation use. Development of best management practices must also take into consideration the needs and concerns of users, consumers and the wider community (NHMRC, 2004).

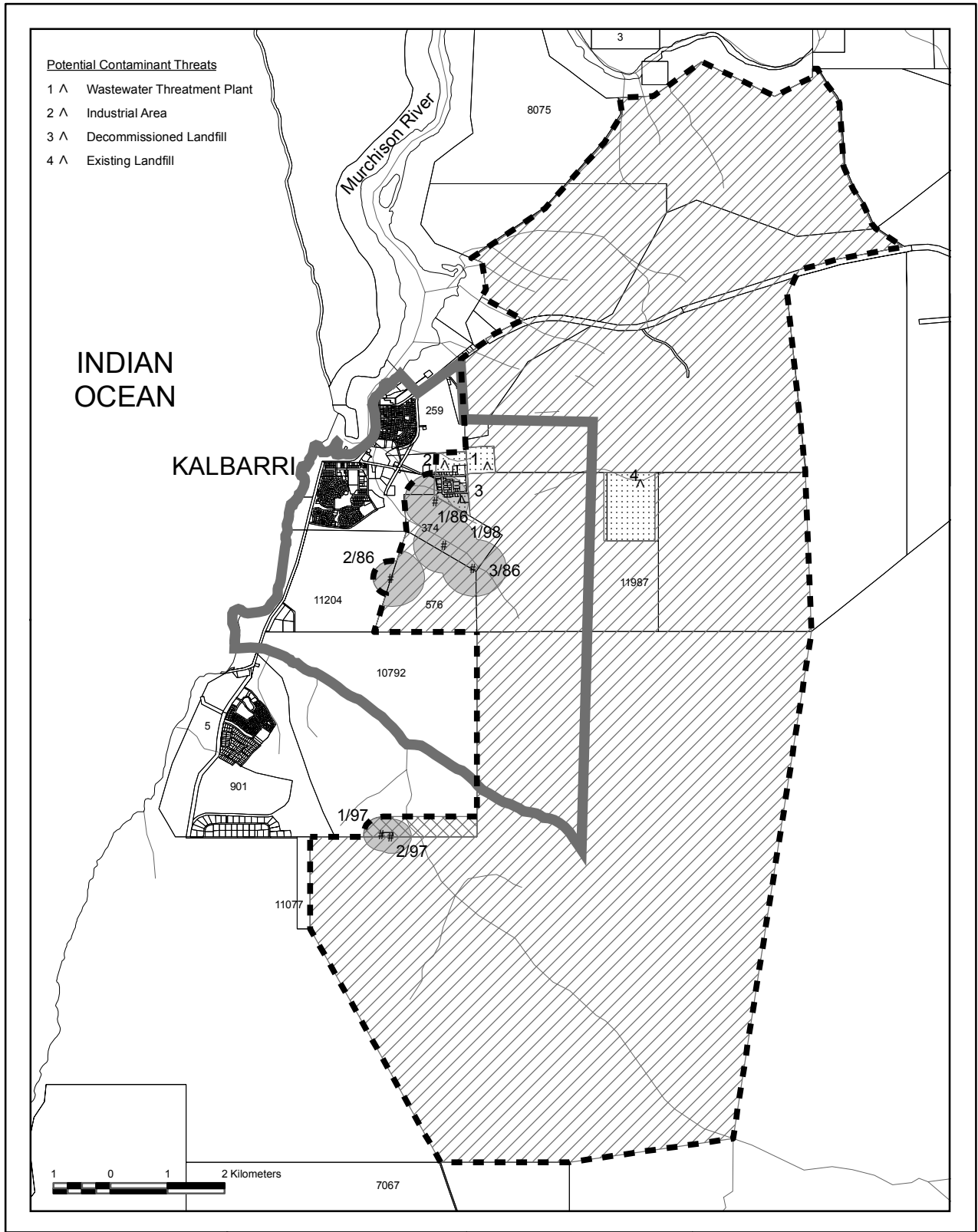
The potential risks to water quality due to existing land uses can be significantly reduced by the implementation of best management practices. For example, fencing to prohibit stock access to borefields, retention of buffers between production bores and land use activities and appropriate pesticide application practices (as detailed in Statewide Policy No.2 *Pesticide Use in Public Drinking Water Source Areas* (WRC, 2000). The implementation of best management practices for land use activities in the catchment is encouraged and expected to assist in protecting water quality.




6.8 Surveillance and By-law enforcement

On-ground surveillance of land uses and activities is an important mechanism in protecting the quality of drinking water sources. Water Corporation and Department of Environment and Conservation officers visiting the area, as well as the local community, should be aware of potential contamination risks and take appropriate actions where necessary. The use of signs and other informative materials is an important component of water quality protection to make visitors aware that they are in a public drinking water source area and that their activities could potentially affect the water quality. Once the Water Reserve is proclaimed under the *Country Areas Water Supply Act 1947*, the By-laws can be used to control potentially contaminating activities.

6.9 Emergency response

Escape of chemicals during unforeseen incidents and the use of chemicals during emergency response can cause groundwater contamination. Wildfire response for the national park, outside the gazetted fire emergency response zone, is the responsibility of the Department of Environment and Conservation. The Shire of Northampton Local Emergency Management Advisory Committee (through the Geraldton Emergency Management District) and the Department of Environment and Conservation should be familiar with the location and purpose of the Kalbarri Water Reserve. A locality plan should be provided to the Fire and Rescue Services headquarters for the HAZMAT Emergency Advisory Team. Personnel who deal with WESTPLAN - HAZMAT incidents within the area should receive training to ensure an understanding of the potential impacts of spills on the groundwater resource. The Regional Manager or assigned delegate of the Department of Water should have an advisory role in any HAZMAT incident in the Kalbarri Water Reserve.



<p>Coordinate System MGA94 Zone 50</p> <p>SOURCE DATA PDWSA Gazetted - WRC - Oct 2002 Rivers 25k - AUSLIG - 1998 WA Coastline - WRC - 13.10.2000 Cadastre DOLA Land Tenure</p> 	<p>LEGEND</p> <ul style="list-style-type: none"> — River # Production Bores Water Corp █ Existing Kalbarri Water Reserve ⋯ Recommended Kalbarri Water Reserve ▨ Proposed priority 1 ▩ Proposed priority 2 ▤ Proposed priority 3 	<p>LOCATION PLAN</p> 	<p>INDEX TO ADJOINING 1:100000 MAPS</p> <table border="1"> <tr> <td>1643</td> <td>1743</td> <td>1843</td> </tr> <tr> <td></td> <td>1742</td> <td>1842</td> </tr> <tr> <td>1641</td> <td>1741</td> <td>1841</td> </tr> </table>	1643	1743	1843		1742	1842	1641	1741	1841	<p align="center">FIGURE 3. KALBARRI WATER RESERVE AND POTENTIAL CONTAMINANT THREATS</p> <p>Drawn by: A. Dennison Date 06/02/2006</p>  <p>Water Resources Management Water Quality Protection Branch</p>
1643	1743	1843											
	1742	1842											
1641	1741	1841											

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Figure 3: Proposed Kalbarri Water Reserve and potential contaminant threats

Recommendations

The following recommendations are proposed to help protect the water quality of the Kalbarri Water Reserve.

1. The modified Kalbarri Water Reserve as outlined in Figure 3 should be gazetted and the existing Water Reserve de-proclaimed under the *Country Areas Water Supply Act 1947*.
2. Land planning strategies, local planning schemes and land management plans prepared by the Shire of Northampton, the Department for Planning and Infrastructure, the Department of Environment and Conservation or other relevant authorities should incorporate the management principles outlined in the Department of Water's *Land Use Compatibility in Public Drinking Water Source Areas* document, available at <<http://drinkingwater.water.wa.gov.au>>, and reflect the new Water Reserve, wellhead protection zones and Priority 1, 2 and 3 classifications provided in this Plan.
3. All significant land use development proposals within the Kalbarri Water Reserve, which are likely to impact on water quality, or are inconsistent with the Department of Water's *Land Use Compatibility in Public Drinking Water Source Areas*, and/or the Department of Water Policies, Guidelines and Water Quality Protection Notes, should be referred to the Department of Water by the Shire of Northampton, the Department for Planning and Infrastructure or the Department of Environment and Conservation.
4. Signs should be erected on the Water Reserve by the Water Corporation to define the location and promote public awareness of the need to protect water quality. Signs should include an emergency contact phone number.
5. The Department of Environment and Conservation and the Local Emergency Management Advisory Committee (through the Geraldton Emergency Management District) should be familiar with the location and purpose of the Kalbarri Water Reserve. Fire and Rescue Services headquarters and any other personnel dealing with WESTPLAN – HAZMAT incidents in the area should be given ready access to a locality map of the Water Reserve by the Department of Water and training to understand the potential impacts of spills on the groundwater resource. In the case of an incident within the Water Reserve, Water Corporation and the Department of Water staff should provide an advisory role to the HAZMAT Emergency Advisory Team.
6. The recommended management strategies for potential contaminant threats detailed in Table 1 should be implemented.
7. The Department of Water and the Water Corporation should develop a program of routine surveillance within the Water Reserve to identify and ameliorate potential contamination risks. Rangers working within the Water Reserve should assist with surveillance to help prevent contamination from occurring (Department of Environment and Conservation).
8. Access to four-wheel-drive and motorbike tracks within the Water Reserve should be minimised to reduce contamination risk (Department of Environment and Conservation).

9. Future extensions to the industrial area should be connected to deep sewerage (Water Corporation, Shire of Northampton, landholders). Options should be investigated for connecting the existing industrial area to deep sewerage (Water Corporation, landholders).
10. Stormwater runoff from the existing industrial area and any extensions of the industrial area should continue to be directed away from bore 1/86 (Shire of Northampton). Stormwater systems in the industrial area should be maintained regularly to ensure potential risks to water quality are minimised (Shire of Northampton).
11. All existing and future operators within the industrial area in the Water Reserve should apply to best practice to ensure risks to water quality are minimised.
12. Access to the decommissioned landfill should be restricted. The risk of ground water contamination from the decommissioned landfill should be investigated and remediation works carried out, to prevent contamination, as necessary (Shire of Northampton, Department of Environment and Conservation, Department of Water).
13. The completed waste columns of the existing landfill should be capped in accordance with the Department of Environment and Conservation licence. The waste management plan for the existing landfill should be reviewed and updated and should demonstrate operation to best environmental management practice standards.
14. An effluent management plan should be prepared by the Water Corporation for discharge of future excess treated wastewater from the Waste Water Treatment Plant, which exceeds the requirements of the golf course.

Appendix 1 - Kalbarri water quality analysis results

The Water Corporation has monitored the water quality (including baseline sampling of raw water) from Kalbarri in accordance with the requirements of SG010 Drinking Water Quality Management Manual and SG097 Source Protection Operations Manual, the Australian Drinking Water Guidelines and interpretations agreed to with the Department of Health. The water is regularly monitored for microbiological contamination, health related chemicals and aesthetic parameters.

The Australian Drinking Water Guidelines (2004) gives guidance on the quality of water that should be provided to consumers at the point of use. For more detail on the drinking water criteria that have been monitored together with the Australian Drinking Water Guideline values contact the Water Corporation or download the Water Corporation annual drinking water quality report which can be viewed at the Water Corporation website <www.watercorporation.com.au/publications/13/DWQAR03.pdf>.

The water quality analysis results can be broken down into the following sub-components consistent with the Australian Drinking Water Guidelines:

- **Microbiological contaminants:** are the most common and widespread health risk associated with drinking water. Microbiological contaminants are generally monitored by testing for two indicator organisms: thermotolerant coliforms (or alternatively *E. coli*) and total coliforms.
- **Chemical characteristics (health related):** a number of chemicals, both organic and inorganic, including some pesticides are toxic to humans or are suspected of causing cancer; some can also affect the aesthetic quality of water:
 1. **Inorganic chemicals:** in drinking water usually occur as dissolved salts such as carbonates and chlorides, attached to suspended materials such as clay particles, or complexes with naturally occurring compounds.
 2. **Organic chemicals:** are usually present in drinking water in very low concentrations and may occur naturally or as a result of human activities.

Physical characteristics (aesthetic related): are the appearance, taste, odour and 'feel' of the water. This determines what people experience when they drink the water and how they rate its quality. In general physical characteristics are not a direct public health concern, but they do affect the aesthetic quality of the water, which largely determines whether or not people are prepared to drink it.

In the absence of specific guidelines for raw water quality, results have been compared with the Australian Drinking Water Guideline values set for water that enters the distribution systems (after disinfection). Only health parameters that have been measured at detectable levels are listed, and all parameters that are higher than the Australian Drinking Water Guidelines have been shaded to give an indication of the potential water quality risks posed in the catchment. It is important to appreciate that the data does not indicate the quality of water distributed to the public as it represents pretreatment water quality results.

Microbiological contaminants

Microbiological testing of the raw water has been conducted on a monthly basis since December 2000. 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 from indigenous animals and is used as a microbiological contamination benchmark (WHO, 1996).

Positive thermotolerant coliform counts were recorded in 2% of the raw water samples from the Kalbarri borefield. There was a 1 cfu/100 mL reading in February 2003. There have been no thermotolerant coliform counts greater than 20 cfu/100 mL.

Health related chemical water quality data

Raw water from Kalbarri is analysed for health related chemicals. Health related chemicals include inorganics, heavy metals, industrial hydrocarbons and pesticides. A health related guideline value is the concentration or measure of a water quality characteristic that, based on present value, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & ARMCANZ 1996).

Health related water quality parameters that have been measured at detectable levels in the sources between June 1999 and June 2004 are summarised in Table 2. The borefield raw source is a mixture of water from the four production bores. Monitoring values from bore 1/86 are also provided as this bore is the closest to industry and the most at risk of contamination. All values are in milligrams per litre (mg/L) for inorganic chemicals and in micrograms per litre ($\mu\text{g/L}$) for pesticides.

Table 2: Health related water quality data at Kalbarri

Parameter	Range of Monitored Values		ADWG Health Value*
	Min-Max	Median	
Inorganic	Borefield raw source	1/86	
Manganese (unfiltered)	<0.002	<0.002-0.1 <0.002	0.5 mg/L
Fluoride	<0.1-0.1 <0.1	-	1.5 mg/L
Arsenic	<0.002-0.002 <0.002	<0.002-0.002 <0.002	0.007 mg/L
Mercury	<0.0005	<0.0005	0.001 mg/L
Silver	<0.02	<0.02	0.1 mg/L
Barium	0.12-0.28 0.13	0.06-0.13 0.095	0.7 mg/L
Boron	0.06-0.036 0.06	0.05-0.06 0.055	0.3 mg/L
Molybdenum	<0.0005	<0.0005	0.05 mg/L
Pesticides			
Pesticides	All sampling below PQL + Uncertainty		
Other			
Annual Radiological Dose	0.014	-	1 mSv/year

*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 – Not Detected

- No samples collected

Health related water quality parameters detected at Kalbarri were all within their

respective the Australian Drinking Water Guidelines guideline values and are therefore considered suitable for drinking water purposes. Health related parameters will continue to be monitored.

Aesthetic water quality data

Raw water from Kalbarri is analysed against aesthetic water quality guidelines (non-health related characteristics). Non-health related chemicals include physical characteristics and some organic and inorganic components. Non-health related water quality parameters that have been measured at detectable levels in the sources between June 1999 and June 2004 are summarised in Table 3.

Table 3: Aesthetic water quality data at Kalbarri

Parameter	Range of Monitored Values			ADWG Aesthetic Value [#]
	Min-Max	Median		
<i>Physical Characteristics</i>	Bore field raw source	1/86	1/98	
Turbidity	<0.1-0.4 <0.1	<0.1-2 0.1	<0.1-1.4 0.75	5 NTU
True colour	<1-2 <1	<1-1 <1	<1	15 HU
pH	5.65-5.92 5.76	5.64-6.45 5.78	5.6-5.8 5.67	6.5 – 8.5
Hardness	-	24-50 45	<0.2-0.8 0.8	200 mg/L
Inorganic				
Iron	<0.003-0.004 <0.003	<0.003-0.6 0.004	0.008-0.116 0.02	0.3 mg/L
Manganese	<0.002	<0.002-0.1 <0.002	<0.002-0.02 <0.008	0.1 mg/L
Aluminum	<0.008-0.014 0.013	<0.008	<0.008-0.02 <0.008	0.2 mg/L
<i>Physical Characteristics</i>	Range of Monitored Values			ADWG Aesthetic Value [#]
	Min-Max	Median		
	2/86	3/69	3/86	
Turbidity	<0.1-14 0.1	<0.1-55 0.3	0.2-28 0.4	5 NTU
True colour	<1-5 <1	<1-5 <1	<1	15 HU
pH	5.68-6.26 5.99	4.96-6.07 5.77	5.65-6.31 5.85	6.5 – 8.5
Hardness	72-80 75	48-60 53	40-84 44	200 mg/L
Inorganic				
Iron	<0.003-0.5 0.01	0.02-17 0.075	0.014-0.25 0.086	0.3 mg/L
Manganese	<0.002	<0.002-0.44 <0.002	<0.002-0.02 <0.002	0.1 mg/L
Aluminum	<0.008-2.1 <0.008	<0.008-0.03 <0.008	<0.008-0.009 <0.008	0.2 mg/L

Aesthetic guideline value is a level which ensures good quality water; that is, water which is aesthetically pleasing and safe and which will not harm fixtures and fittings.

█ – Exceeds the Australian Drinking Water Guidelines 1996 Aesthetic Value

ND – Not Detected

- No samples collected

Maximum monitored raw water values for turbidity, pH and iron exceed the Australian

Drinking Water Guidelines aesthetic value figures in most bores. Turbidity readings were one off results and can be managed through treatment. pH is a measure of water acidity (pH 7 is neutral) and is typically a characteristic of groundwater condition. Iron occurs naturally in water as a result of soil or rock in the catchment. Aeration and sedimentation assist with the treatment of pH and iron.

Maximum manganese and aluminium raw water values exceeded the Australian Drinking Water Guidelines aesthetic value in bores 3/69 and 2/86 respectively. Manganese in water can come from soil or rock in the catchment. Acid-soluble aluminium in water may originate from the addition of aluminium sulphate (Alum) in the water treatment process. Alum is a coagulant that is added when required to aid in the removal of colour and turbidity. These chemicals are unlikely to be the result of contaminating land uses and shandyng the water ensures that the composite water is well below guideline values.

Appendix 2 - Port Kalbarri water quality analysis results

The Water Corporation has monitored the water quality (including baseline sampling of raw water) from Port Kalbarri in accordance with the requirements of SG010 Drinking Water Quality Management Manual and SG097 Source Protection Operations Manual, the Australian Drinking Water Guidelines and interpretations agreed to with the Department of Health. The water is regularly monitored for microbiological contamination, health related chemicals and aesthetic parameters.

In the absence of specific guidelines for raw water quality, results have been compared with the Australian Drinking Water Guidelines values set for water that enters the distribution systems (after disinfection). Only health parameter that have been measured at detectable levels are listed, and all parameters that are higher than the Australian Drinking Water Guidelines have been shaded to give an indication of the potential water quality risks posed in the catchment. It is important to appreciate that the data does not indicate the quality of water distributed to the public as it represents pre-treatment water quality results.

Microbiological contaminants

Microbiological testing of the raw water has been conducted on a monthly basis since December 2000. 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 from indigenous animals and is used as a microbiological contamination benchmark (WHO, 1996).

Positive thermotolerant coliform counts were recorded in 6% of the raw water samples from the Port Kalbarri borefield. One of these samples had thermotolerant coliform counts greater than 20 cfu/100 mL, with a reading of just over 100 cfu/100 mL in June 2004. This may be a consequence of the sampling technique and should be investigated.

Health related chemical water quality data

Raw water from Port Kalbarri is analysed for health related chemicals. Health related chemicals include inorganics, heavy metals, industrial hydrocarbons and pesticides. A health related guideline value is the concentration or measure of a water quality characteristic that, based on present value, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & ARMCANZ 1996).

Health related water quality parameters that have been measured at detectable levels in the sources between June 1999 and June 2004 are summarised in Table 4. The borefield raw source is a mixture of water from the two production bores. The two individual bores do not get the full suite of water testing as it is the mixed water at the tank that is used as the standard. All values are in milligrams per litre (mg/L) for inorganic chemicals and in micrograms per litre ($\mu\text{g/L}$) for pesticides.

Table 4: Health related water quality data at Port Kalbarri

Parameter	Range of Monitored Values			ADWG Health Value*
	Min-Max Median			
<i>Inorganic</i>	Borefield raw source	1/97	2/97	
Manganese (unfiltered)	<0.002-0.095 0.06	0.055-0.095 0.079	0.046-0.067 0.055	0.5 mg/L
Fluoride	<0.1-0.15 0.1	-	-	1.5 mg/L
Arsenic	<0.002	-	-	0.007 mg/L
Mercury	<0.0005	-	-	0.001 mg/L
Silver	<0.02	-	-	0.1 mg/L
Barium	0.1-0.13 0.12	-	-	0.7 mg/L
Boron	0.055-0.14 0.12	-	-	0.3 mg/L
Molybdenum	<0.0005	-	-	0.05 mg/L
Pesticides				
Pesticides	No samples above PQL + Uncertainty			
Other				
Annual Radiological Dose	0.016			1 mSv/year

*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 – Not Detected

- No samples collected

Health related water quality parameters detected at Port Kalbarri were all within their respective Australian Drinking Water Guideline values and are therefore considered suitable for drinking water purposes. Health related parameters will continue to be monitored.

Aesthetic water quality data

Raw water from Port Kalbarri is analysed against aesthetic water quality guidelines (non-health related characteristics). Non-health related chemicals include physical characteristics and some organic and inorganic components. Non-health related water quality parameters that have been measured at detectable levels in the sources since June 1999 and June 2004 are summarised in Table 5.

Table 5: Aesthetic water quality data at Port Kalbarri

Parameter <i>Physical Characteristics</i>	Range of Monitored Values			ADWG Aesthetic Value [#]
	Bore field raw source	Min-Max Median		
		1/97	2/97	
Turbidity	<0.1-1.2 <0.1	<0.1-1.2 <0.1	0.2-4.6 1.2	5 NTU
True colour	<1-2 <1	<1	<1	15 HU
pH	5.63-6.43 5.79	5.69-5.97 5.86	5.65-5.9 5.75	6.5 – 8.5
Hardness	-	114-130 121	83-95 86	200 mg/L
Inorganic				
Iron	<0.003-0.004 <0.016	0.004-0.4 0.018	0.104-0.75 0.22	0.3 mg/L
Manganese	<0.002-0.095 0.06	0.055-0.095 0.079	0.046-0.067 0.055	0.1 mg/L
Aluminum	<0.008-0.046 <0.008	<0.008-0.008 <0.008	<0.008-0.009 <0.008	0.2 mg/L

Aesthetic guideline value is a level which ensures good quality water; that is, water which is aesthetically pleasing and safe and which will not harm fixtures and fittings.

■ – Exceeds the Australian Drinking Water Guidelines Aesthetic Value

ND – Not Detected

- No samples collected

Maximum monitored raw water values for pH and iron exceed the Australian Drinking Water Guidelines aesthetic value figures in the bores. pH is a measure of water acidity (pH 7 is neutral) and is typically a characteristic of groundwater condition. Iron occurs naturally in water as a result of soil or rock in the catchment. Treatment is effective in managing pH and iron issues in drinking water.

Glossary and acronyms

Abstraction	Pumping groundwater from an aquifer
ADWG	Australian Drinking Water Guidelines
Allocation	The quantity of groundwater permitted to be abstracted by a well licence, usually specified in kilolitres/year (kL/a)
Anisotropic	Having different properties in different directions
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 drilled 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
CAWS Act	Country Areas Water Supply Act 1947
Confined Aquifer	An aquifer that is confined between shale and siltstone beds and therefore contains water under pressure
DoE	Department of Environment
DoW	Department of Water
DWSP	Drinking Water Source Protection Plan
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
Ha	Hectare (10 000 m ²)
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality
kL	Kilolitre (1,000 L)
KWR	Kalbarri Water Reserve
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
m AHD	Australian Height Datum. Height in metres above Mean Sea Level +0.026 m at Fremantle
NHMRC	National Health and Medical Research Council
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
Perched	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
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
PDWSA	Public drinking water source area
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
Runoff	Water that flows over the surface from a catchment area, including streams
SPP	Statement of Planning Policy
Stormwater	Rainwater which has run off the ground surface, roads, paved areas etc and is usually carried away by drains
TDS	Total dissolved salts. Measurement of ions in solution
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
VL	Victoria Location
Wastewater	Water that has been used for some purpose and would normally be treated and discarded. Wastewater usually contains significant quantities of pollutant
Water Quality	The physical, chemical and biological measures of water
Watertable	The upper saturated level of the unconfined groundwater
Water Reserve	An area proclaimed under the Country Areas Water Supply Act 1947 or Metropolitan Water Supply, Sewerage and Drainage Act 1909 for the purposes of protection a drinking water supply

Wellfield	A group of bores to monitor or withdraw groundwater
WHO	World Health Organisation
WHPZ	Wellhead protection zone
WRMOS	Water Corporation's Kalbarri Water Resource Management Operation Strategy
WWTP	Wastewater treatment plant

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