



Department of Water
Government of Western Australia



Eneabba Water Reserve
drinking water source protection plan
Eneabba town water supply



Department of **Water**
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Eneabba town water supply

'Looking after all our water needs'

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Contents

Contents.....	iii
Preface.....	v
Summary.....	vi
1 Drinking water source overview	1
1.1 Existing water supply system	1
1.2 Water treatment	1
1.3 Catchment details	1
1.3.1 Physiography.....	1
1.3.2 Climate	2
1.3.3 Hydrogeology	2
1.4 Future water supply requirements	2
1.5 Protection and allocation	3
1.5.1 Existing water source protection.....	3
1.5.2 Current allocation licence	3
2 Water quality monitoring and contamination risks.....	7
2.1 Microbiological contaminants	7
2.2 Health related characteristics	8
2.3 Aesthetic characteristics	8
2.4 Groundwater bores	8
3 Land use assessment.....	11
3.1 Existing land uses and activities.....	11
3.1.1 Public purposes and recreation	11
3.1.2 Industrial.....	11
3.1.3 Mineral sand mining	12
3.1.4 Landfill	12
3.1.5 Roads and tracks.....	12
3.2 Proposed land uses and activities.....	13
4 Catchment protection strategy	23
4.1 Protection objectives.....	23
4.2 Proclaimed area.....	23
4.3 Priority areas.....	23
4.4 Protection zones	24
4.5 Land-use planning	26
4.6 Best management practices	26
4.7 Surveillance and by-law enforcement	27
4.8 Emergency response.....	27
4.9 Implementation of this plan.....	27
5 Recommendations	29
Appendices	31
Glossary.....	39
References and further reading.....	43

Appendices

Appendix A Water quality	31
Appendix B Photographs	35
Appendix C Summary of submissions.....	37

Figures

Figure 1 Eneabba Water Reserve locality map	4
Figure 2 Eneabba Water Reserve.....	5
Figure 3 Land use and tenure activities in the Eneabba Water Reserve.....	14
Figure 4 Priority areas and protection zones for Eneabba Water Reserve	25

Tables

Table 1 Land use, potential water quality risks and recommended protection strategies	15
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Preface

The Department of Water has prepared this Drinking Water Source Protection Plan to assess risks to water quality within the Eneabba Water Reserve and to recommend management strategies to avoid, minimise or manage those risks. The department is committed to protecting drinking water sources to meet public health requirements and ensure the supply of safe, good quality drinking water to consumers.

The Australian Drinking Water Guidelines recommend a risk-based, multiple barrier approach to protect public drinking water sources. Catchment protection is the first barrier, with subsequent barriers implemented at the water storage, treatment and distribution stages of a water supply system. Catchment protection requires an understanding of the catchment, the hazards and hazardous events that can compromise drinking water quality, and development of preventative strategies and operational controls to ensure the safest possible water supply.

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

This plan should be used to guide state and local government land use planning decisions. It should be recognised in the Shire of Carnamah's Town Planning Scheme, consistent with the Western Australian Planning Commission's Statement of Planning Policy No. 2.7—*Public Drinking Water Source Policy*. Other stakeholders should use this document as a guide for protecting the quality of water in the recommended Eneabba Water Reserve.

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

Stages in development of a plan		Comment
1	Prepare drinking water source protection assessment.	Prepared following catchment survey and preliminary information gathering.
2	Conduct stakeholder consultation.	Advice sought from key stakeholders using the assessment (from Stage 1) for information and discussion.
3	Prepare draft drinking water source protection plan.	Draft plan developed taking into account input from stakeholders and any additional advice received.
4	Release draft drinking water source protection plan.	Draft plan released for a six-week public consultation period.
5	Publish approved drinking water source protection plan.	Final plan published after considering advice received in submissions. It includes recommendations on how to protect water quality.

Summary

Eneabba is located in the Mid West Region of Western Australia on the Brand Highway, approximately 280 km north of Perth. Eneabba is supplied with drinking water from two Water Corporation bores located in the Eneabba Water Reserve, on the eastern side of the town site. Eneabba Water Reserve was proclaimed in 1992 under the *Country Areas Water Supply Act 1947* for the purpose of protecting the public drinking water source from potential contamination.

The bores draw water from the Yarragadee Formation, which is overlain by up to 30 m of sand and clay (unsaturated superficial formation). The bores are screened between 81 and 98 m below ground level and have a static water level of approximately 31 m below ground level.

The aquifer is unconfined in the vicinity of the bores and is therefore at risk of contamination from surrounding land uses. Land uses in the vicinity of the wellfield include mineral sand mining, recreational activities, a drum muster and waste oil recycling depot and a light industrial area.

It is proposed that the boundary of the Eneabba Water Reserve be amended in order to better reflect the capture zones of the bores. Priority areas have been assigned within the reserve and wellhead protection zones designated around each of the bores, in order to ensure protection of the drinking water source. These areas and zones recognise established approved land uses but may constrain expansion of those uses or the development of alternative future land uses.

The plan makes the following major recommendations:

- The water reserve boundary should be extended and the amended boundary gazetted under the *Country Areas Water Supply Act 1947*.
- The water reserve boundary, priority areas, wellhead protection zones and management principles outlined in this plan should be recognised in the Shire of Carnamah's Town Planning Scheme and other applicable schemes and strategies.
- Any development proposals that are inconsistent with the Water Quality Protection Note—*Land use compatibility in Public Drinking Water Source Areas* should be referred to the Department of Water for advice and recommendations.
- Best management practices for current and approved land uses within the boundary of the reserve should be implemented.

1 Drinking water source overview

1.1 Existing water supply system

Eneabba is located in the Mid West Region of Western Australia, approximately 280 km north of Perth in the Shire of Carnamah (see Figure 1). The town has a population of approximately 250 and was established to accommodate the workforce of mineral sands mines located to the south of the town site.

Eneabba wellfield is located on the eastern side of the town site (see Figure 2) and is used to supply potable water to consumers in Eneabba.

The wellfield is operated by the Water Corporation and consists of two production bores (2/75 and 1/89) and three observation wells (1, 2 and 1/75). The production bores are screened between 81 and 98 m in the Yarragadee Formation with a static water level of around 31 m below ground level. The location of the production bores is presented in Figure 2.

Bore 1/89 is the main water supply bore while 2/75 is used for stand-by supply as water abstracted from this bore contains elevated levels of iron. Water abstracted from the bores is treated and stored in ground level storage tanks prior to being pumped into an elevated storage tank for town water supply.

1.2 Water treatment

Raw water from the Eneabba bores is aerated and injected with chlorine to precipitate iron and manganese. These precipitated metals are removed with conventional sand filtration beds. Chlorination also provides a disinfection barrier.

It should be recognised that although treatment and disinfection are essential barriers to ensure a safe, good quality drinking water supply, catchment management is the fundamental first barrier for protecting water quality. This approach is endorsed by the Australian Drinking Water Guidelines (ADWG) (NHMRC & NRMCC 2004a) and reflects a risk-based, 'catchment to consumer', multiple barrier approach for providing safe drinking water. The combination of catchment protection and treatment delivers a safer drinking water source than either barrier could achieve individually.

1.3 Catchment details

1.3.1 Physiography

Eneabba is located on the Eneabba Plain, a sub-unit of the Swan Coastal Plain. The Eneabba Plain is a low-lying area between the Coastal Belt and the Gingin Scarp, with a width of about 16 km in the vicinity of Eneabba. It is built up of a series of early Pleistocene (or Late Tertiary) shoreline lagoon and dune deposits having locally high concentrations of heavy minerals.

1.3.2 Climate

Eneabba experiences a mild Mediterranean-type climate with hot, dry summers and cool, wet winters. Average maximum temperatures range from 19.6 °C in July to 36 °C in February. Average minimum temperatures range from 9 °C in August to 19.4 °C in February. The average annual long-term rainfall is approximately 504 mm (Bureau of Meteorology 2008).

1.3.3 Hydrogeology

The Eneabba wellfield is located in the northern Perth Basin within the Dandaragan Trough structural division of the basin. The Dandaragan Trough is the deepest part of the basin and contains a sequence of Permian to Quaternary sedimentary rocks.

In the Eneabba area, the youngest sediments are the superficial formations (up to 30 m thick) that consist of sand and clay. The superficial formations are underlain by the Yarragadee Formation, which is up to 2500 m thick.

The superficial formations are unsaturated at Eneabba because of the deep regional watertable (about 31 m below ground level).

The Yarragadee Formation forms a major multi-layered aquifer in the region and is part of an extensive regional groundwater flow system that contains large volumes of fresh to slightly brackish groundwater in storage. The aquifer is unconfined where the superficial formations are unsaturated (as is the case at Eneabba wellfield).

Groundwater recharge occurs directly from rainfall and has increased due to land clearing for agriculture. The watertable is rising at an annual rate of up to 0.25 m. Recharge also occurs in wet years from Eneabba Creek. The direction of groundwater flow in the aquifer is predominantly from the south to the north-west. Groundwater salinity is generally less than 1000 mg/L total dissolved solids but tends to increase with depth and toward the discharge area.

Approximately 20 000 megalitres (ML) is abstracted annually from the Yarragadee aquifer for mineral-sand mining and processing at the Eneabba mines. The Eneabba town water supply bores also draw water from the Yarragadee aquifer.

Groundwater resources in the Yarragadee Formation are extensive and with the exception of large abstractions at Eneabba, are currently virtually undeveloped. However, groundwater demand for irrigated agriculture is increasing rapidly.

1.4 Future water supply requirements

The existing bores are not currently being utilised to full capacity and the source is considered adequate to meet future demands.

1.5 Protection and allocation

1.5.1 Existing water source protection

Eneabba Water Reserve was proclaimed in 1992 under the *Country Areas Water Supply Act 1947* (the CAWS Act). The proclaimed water reserve consists of Crown Reserve 26075 and Eneabba Townsite Lot 396. By-laws can be applied under the CAWS Act to ensure protection of the water source against contamination.

1.5.2 Current allocation licence

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

The Eneabba groundwater resource lies within the Arrowsmith Groundwater Area which was proclaimed in 1975 under the RIWI Act.

The resource is managed in accordance with the department's Interim Sub-Regional Allocation Strategy, *Managing the Water Resources of the Arrowsmith Groundwater Area, WA* (Water and Rivers Commission 2002). The Water Corporation is licensed to draw 200 000 kL per year from the Eneabba wellfield for public water supply purposes, under Groundwater Well Licence 73006(4). Current abstraction is lower than this, with a volume of 93 884 kL abstracted in 2005–06.

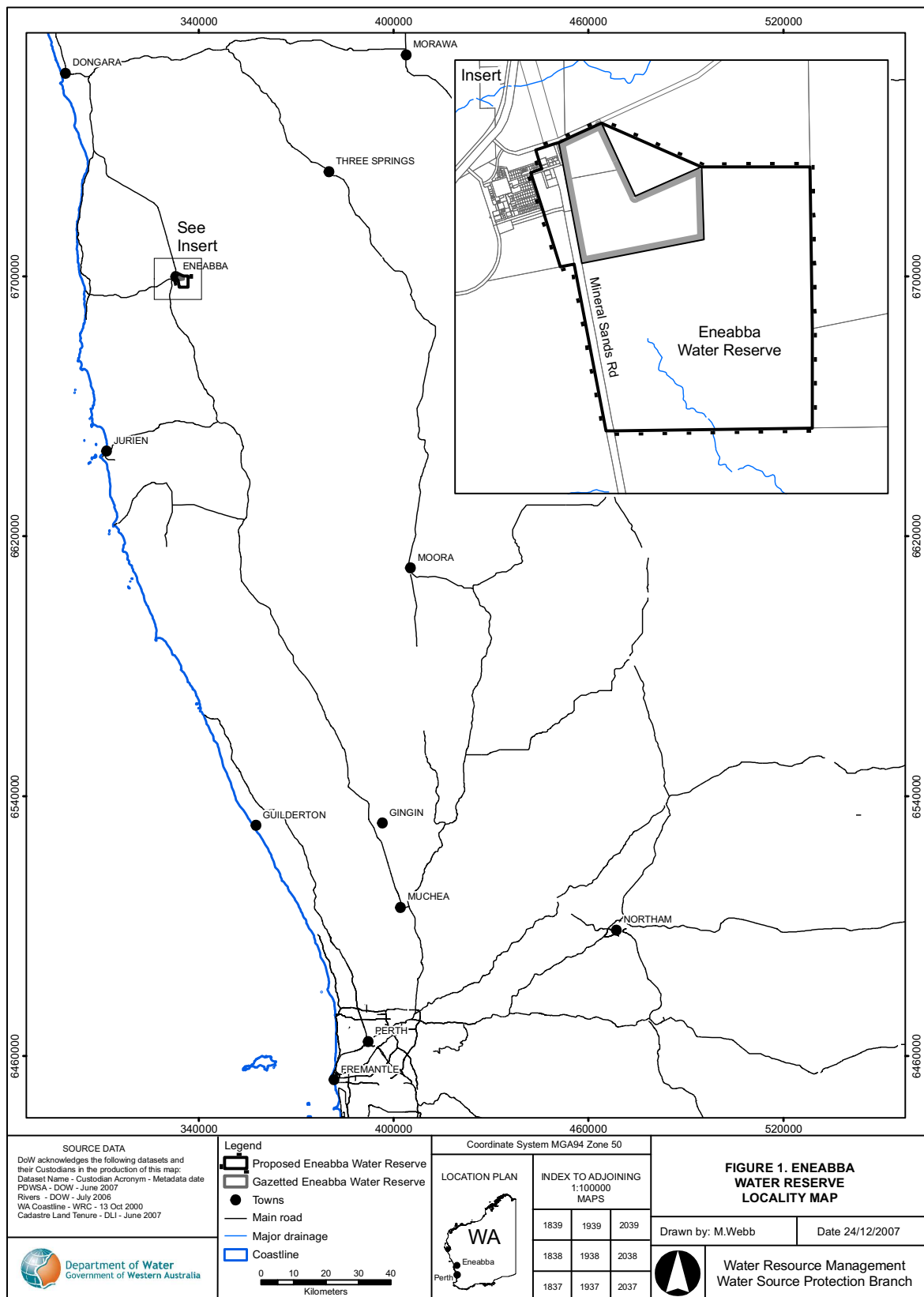


Figure 1 Eneabba Water Reserve locality map

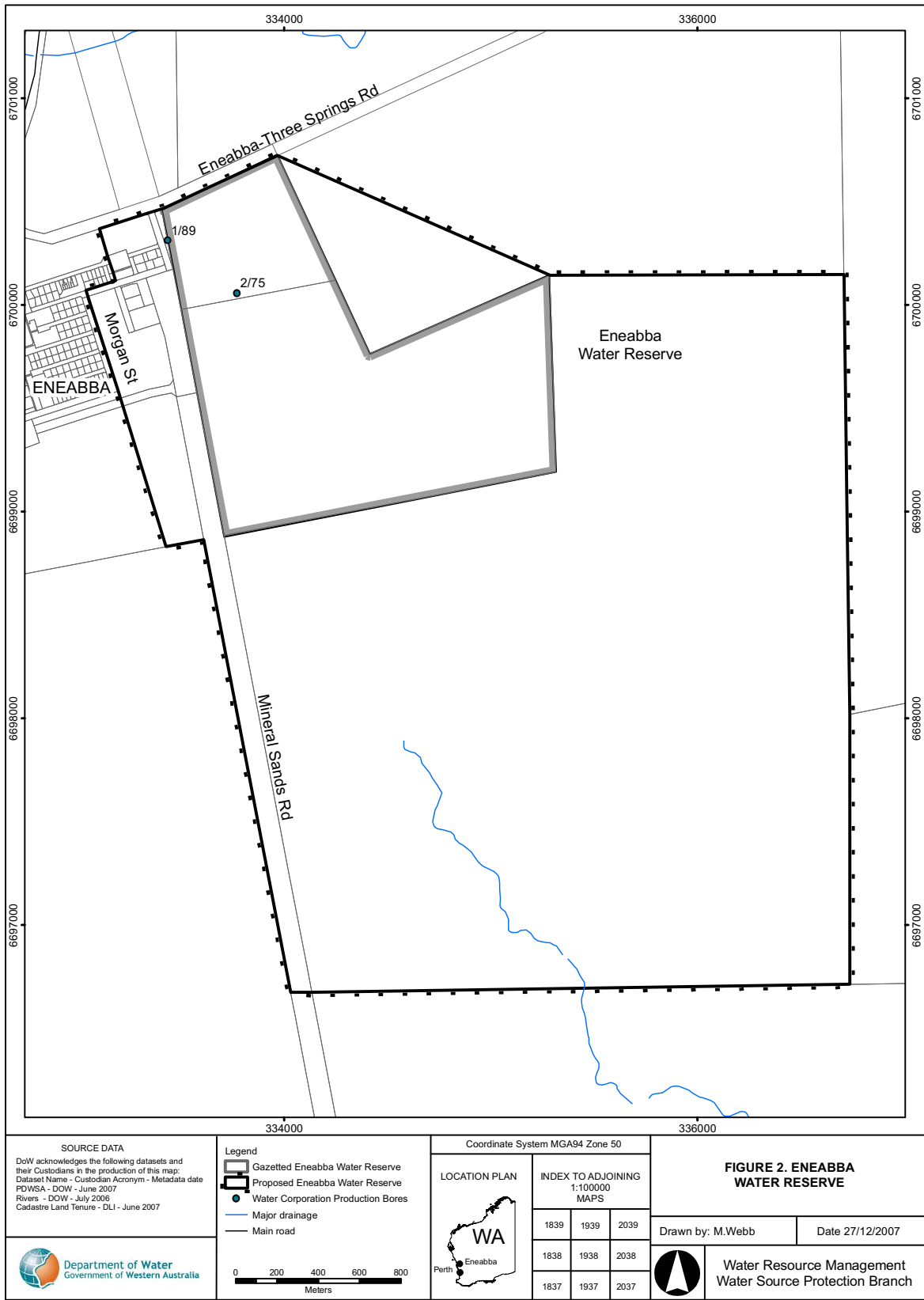


Figure 2 Eneabba Water Reserve

2 Water quality monitoring and contamination risks

A wide range of chemical, physical and microbiological factors can impact on water quality and therefore affect the provision of safe, good quality, aesthetically acceptable drinking water to consumers.

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

A water quality summary for the Eneabba wellfield from January 2002 to May 2007 is presented in Appendix A. For more information on water quality, see the Water Corporation's most recent *Drinking Water Quality Annual Report* at www.watercorporation.com.au > Water > Water Quality > Latest Report.

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

2.1 Microbiological contaminants

Pathogens are types of micro-organisms that are capable of causing diseases. These include bacteria, protozoa and viruses. In water supplies, pathogens that cause illness to humans are mostly found in the faeces of humans and domestic animals.

There are a number of pathogens that are commonly known to contaminate water supplies worldwide. These include bacteria (for example, *Salmonella*, *Escherichia coli* and *Cholera*), protozoa (for example, *Cryptosporidium*, *Giardia*) and viruses. *Escherichia coli* counts are a way of measuring these pathogens and are an indicator of faecal contamination.

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

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

2.2 Health related characteristics

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

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control nematodes), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides may occur as a result of accidental spills, incorrect or overuse and leakage from storage areas. In such cases, prompt action is required to notify relevant authorities and clean up the spill. Chlorpyrifos, an insecticide used to control mosquitoes, flies and various crop and household pests, has been detected in Eneabba's drinking water supply at low concentrations.

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

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

2.3 Aesthetic characteristics

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

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

Some properties such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes. The ADWG also set out aesthetic guidelines for these types of water quality characteristics.

2.4 Groundwater bores

Under the provisions of sections 26D and 5C of the RIWI Act, a licence is required to construct a bore or extract water (unless exempt under the RIWI Exemption and

Repeal (Section 26C) Order 2001) within a proclaimed groundwater area. The Eneabba Water Reserve is located within the Arrowsmith Groundwater Area.

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

It is important to ensure that any bores are appropriately located and constructed in order to prevent contamination and other impacts on the public drinking water source. This will be assessed through the Department of Water's water licensing process where applicable under the RIWI Act.

All bores should be constructed in accordance with *Minimum construction requirements for water bores in Australia* (National Minimum Bore Specifications Committee 2003).

3 Land use assessment

3.1 Existing land uses and activities

Table 1 describes the proposed protection strategies for the following land uses and activities which occur in the Eneabba Water Reserve. Figure 3 shows the land tenure and locations of activities described.

3.1.1 Public purposes and recreation

Crown Reserve 26075 is zoned for public purposes in the Shire of Carnamah's Town Planning Scheme (Western Australian Planning Commission 2006) and is currently covered with native vegetation and used for water supply purposes only (see Appendix B, Photo 2). This land use is not considered to pose a risk to the drinking water source.

Lot 396 is zoned for parks, recreation and conservation and is also predominantly used for water supply purposes. Motocross and rifle range facilities are present on this lot (in close proximity to bore 2/75). The rifle range facilities are currently used for police training purposes. The motocross facilities are not used by an official club; however, recreational riding by members of the community does occur. Motocross facilities can lead to hydrocarbon contamination from fuel and oil leaks and spills while rifle ranges can cause lead contamination from spent shots.

3.1.2 Industrial

Within the wellhead protection zone for bore 1/89 are a number of lots developed for light industrial purposes. These light industrial land uses include:

- a Main Roads WA depot site, (currently unused) previously used for storage of asphalt and kerosene. At this stage, Main Roads WA are unsure of the future usage of the site, although it is likely to be used for storage of road building materials and plant.
- the Shire of Carnamah works depot, currently used for machinery storage and includes workshop facilities for maintenance work
- various privately owned workshops and storage sheds

As many of these activities involve or have previously involved the storage of fuels, oils and other hydrocarbons there is potential for contamination of the drinking water with hydrocarbons from leaks and spills. There is also potential for contamination from spills and leaks of chemicals, such as solvents. The light industrial area is currently unsewered and all wastewater from toilet and kitchen facilities is disposed via septic tank systems. Wastewater disposal in septic tank systems poses a risk to the drinking water source through potential nutrient and pathogen contamination.

A drum muster and waste oil recycling site is located approximately 400 m south-west of bore 1/89. The drum muster is run by volunteers from the local Parents and Citizens Committee and is open twice a year. Triple-rinsing of plastic and metal drums is required before they are accepted. These drums are stored in a locked cage before being collected for recycling (see Appendix B, Photo 3). A waste oil recycling unit is on-site for oil disposal. Large drums containing oil are stored on a bunded, concrete platform before being collected for recycling. Risks to the drinking water source include hydrocarbon contamination from oil leaks and spills and pesticide contamination from any residue remaining in the drums. The potential for pesticide contamination is of particular concern, as very small quantities of pesticide can cause significant contamination of aquifers and even low concentrations of pesticides can be toxic to humans. The lot is also used for some machinery and materials storage (overflow from the depot site) as well as the storage of gravel.

Any future industrial land uses proposed within the industrial area should be in accordance with the Water Quality Protection Note—*Land use compatibility in Public Drinking Water Source Areas* (Department of Environment 2004).

3.1.3 Mineral sand mining

Mineral sand mining occurs to the north-east, east, south and south-west of the bores (see Appendix B, Photo 4), and is undertaken by Iluka Resources Ltd. Potential risks include fuel and oil leaks and spills, increased salinity from infiltration through tailings dams and contamination from acrylamide, which is present in the flocculants used in the mining process. The risk of contamination is considered to be low due to the distance from the bores and management through Department of Environment and Conservation licences. Naturally occurring radioactive elements are present in the sands. However, they are generally returned to the mine site in the same stable, inert form and are not considered to pose a risk to the water source.

3.1.4 Landfill

The Eneabba landfill is located approximately 3.8 km south of the bores (just outside of the proposed water reserve). It is an unmanned, Class II landfill site which has a trench for the disposal and burial of household and general wastes; a green waste disposal area; and a disposal area for scrap metal. Litter screen fencing separates the waste areas. Scrap metal is collected annually from this site for recycling. The landfill currently receives less than 250 tonnes of waste per year. However, the Shire of Carnamah may be expanding the capacity of the landfill in the future. Potential risks from this site include chemicals, nutrients and pathogens. The risk is considered to be low due to the distance from the bores.

3.1.5 Roads and tracks

Bulk haulage and other general traffic occur on the Brand Highway and Eneabba–Three Springs Road, with light traffic on Mineral Sands Road. The risk of

contamination from accidents and spills is low because the bores are located upstream of the roads and on elevated ground relative to the roads.

3.2 Proposed land uses and activities

The Shire of Carnamah are in the process of applying for a parcel of land (bound by Morgan, King and Parker streets) to be vested in the Shire. Proposed activities for this land include recreational activities and potentially some group housing. Any housing developed on this lot should be connected to deep sewerage to minimise the risk of pathogen and nutrient contamination which would otherwise be present with the use of septic tanks.

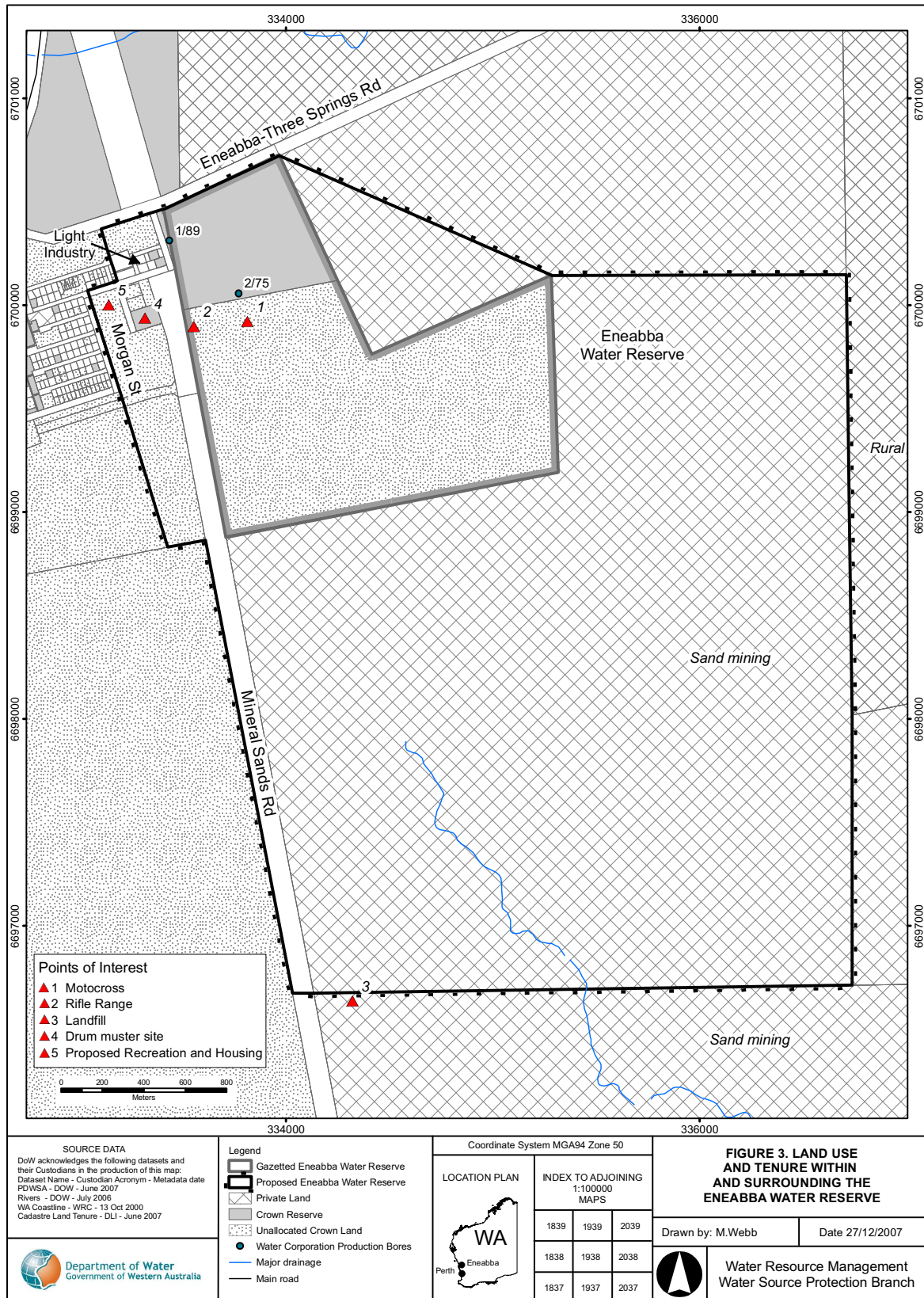


Figure 3 Land use and tenure activities in the Eneabba Water Reserve

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

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Drum muster and waste oil recycling facilities	Hydrocarbons from fuel and oil leaks and spills	Medium	<p>This site is within the capture zone of the existing bores.</p> <p>There is the potential for contamination from surface runoff due to the proximity of this site to the bores. Any accidents or spills during the transport of waste oil to or from the site have the potential to impact upon the drinking water source.</p>	<ul style="list-style-type: none"> • Water quality monitoring by Water Corporation • Concrete platform with bunding for oil disposal site • Pesticide drums required to be triple rinsed before acceptance 	<p>If possible, this facility should be relocated outside of the water reserve. The Eneabba landfill should be given consideration as a potential alternative site.</p> <p>In its current location the site should not be expanded and best management practice as recommended in the department's Water Quality Protection Note (WQPN), <i>Toxic and hazardous substances—storage and use</i> (DoW 2006g) should be followed.</p>
	Pesticides from residue in drums	Medium	<p>Even small quantities of pesticides can cause significant human health impacts.</p> <p>Risks from this site are reduced due to the small scale of operations and the fact that the site is only open twice a year.</p>		

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Light industrial area	Hydrocarbons and other chemicals from fuel, oil and solvent leaks and spills	Medium	<p>Light industrial uses in this area include depot sites, workshops and storage sheds.</p> <p>This area is within the wellhead protection zone of bore 1/89. The risk is slightly reduced as the activities are downstream of the bores.</p>	<ul style="list-style-type: none"> Water quality monitoring by Water Corporation 	<p>Best management practices as recommended in the following WQPNs should be implemented:</p> <ul style="list-style-type: none"> <i>Light industry near sensitive water resources</i> (DoW 2007a) <i>Mechanical servicing and workshops</i> (DoW 2006b) <i>Tanks for elevated fuel and chemical storage</i> (DoW 2006e) <i>Contaminant spills–emergency response</i> (DoW 2006a) <p>The potential for connection to deep sewerage as part of the infill program should be investigated.</p>
	Pathogens from wastewater disposal	High			
	Nutrients from wastewater disposal	Medium			

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Rifle range facility	Lead from spent shot	Low	A rifle range facility is located approximately 400 m south of bore 1/89 and 250 m south west of bore 2/75. The facility is currently only used for police training purposes; however, the potential exists for it to be used by an organised club.	<ul style="list-style-type: none"> Water quality monitoring by Water Corporation 	<p>Due to the proximity of these facilities to bore 2/75 it is recommended that relocation of these sites is investigated. It is recognised that the potential for relocation may depend on the availability of funding and a viable alternative site.</p> <p>In their current location, best management practices as recommended in the WQPN <i>Motorsport facilities near sensitive water resources</i> (DoW 2007b)</p>
Motocross facility	Hydrocarbons from fuel and oil spills	Low	<p>A motocross facility is located ~40 m south of bore 2/75 The facility is not used by an organised club, but it is used by some members of the community for recreational riding.</p> <p>There is potential for hydrocarbon contamination due to leaks and spills, particularly if motorbikes are refuelled on-site.</p>	<ul style="list-style-type: none"> Water quality monitoring by Water Corporation 	

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Roads	Hydrocarbons from accidents or leaks	Low	<p>Bulk haulage and general traffic occurs on Eneabba–Three Springs Road, with light traffic on Mineral Sands Road and roads in the light industrial area.</p> <p>These roads are within the capture zone of the existing bores. However, bores are located on elevated ground relative to the roads. Accidents and spills are rare with the Local Emergency Management Committee (LEMC) responding to incidents.</p>	<ul style="list-style-type: none"> • Water quality monitoring by Water Corporation • Sealed bores and fenced bore compounds • Signage at wellfield • LEMC response 	<ul style="list-style-type: none"> • Continue water quality monitoring program and LEMC response. • Follow best management practices recommended in the WQPN, <i>Roads near sensitive water resources</i> (DoW 2006d). • Road drainage should be directed away from the bores.
	Pesticides from accidents or leaks	Low			
	Nutrients from accidents or leaks	Low			

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Mineral sand mining	Hydrocarbons from fuel and oil leaks and spills	Low	<p>Mineral sands mining occurs to the north-east, east and south-west of the bores. Hydrocarbon storage and wastewater recharge is associated with this activity. The Iluka landfill has been rehabilitated and Iluka Resources currently use the Eneabba (Shire of Carnamah) landfill to dispose of wastes.</p> <p>Iluka Resources dewatering operations, tailings facilities and ponds may influence local hydraulic conductivity and salinity levels. Naturally occurring radioactive elements are present in the sands and are generally returned to the mine site in the stable, inert form in which they were mined.</p>	<ul style="list-style-type: none"> • Department of Environment and Conservation (DEC) licence requirements • Dangerous Goods licensing requirements • Water quality monitoring by Iluka Resources and Water Corporation • Distance to bores • Local Emergency Management Committee (LEMC) response 	<ul style="list-style-type: none"> • No mining should occur within the P1 area of Mining Tenements M70/267 and M70/879. • Mining can continue within the P2 area, with best management practices as recommended in the WQPN <i>Extractive Industries within Public Drinking Water Source Areas</i> (WRC 2000a) and <i>Water Quality Protection Guidelines (WQPG) Mining and mineral processing</i> (WRC various dates) • Fuel storage must be in accordance with the WQPG <i>Mining and mineral processing: Above-ground fuel and chemical storage</i> (WRC various dates) and <i>WQPN Tanks for temporary elevated fuel and chemical storage</i> (DoW 2006f) • Tailings should not be located in the P1 area. Tailings in the P2 area should only contain overburden from the ore extraction process. Solid waste (e.g. tyres) should be disposed of outside of the P2 area. • A minimum of 2 m undisturbed profile should be maintained
	Salinity from infiltration through tailings dams	Low			
	Acrylamide from flocculants used in the mining process	Low			

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
					<p>between the likely future maximum water level and the surface level in P2 areas.</p> <ul style="list-style-type: none"> • All spills/incidents reported under the <i>Environmental Protection Act 1986</i> should also be forwarded to the Department of Water. • Oil farming operations should comply with the relevant DEC licence condition(s). It is recommended that the oil farming operations be relocated outside of the water reserve. • Where possible the mining area within the water reserve should be rehabilitated to native vegetation post mining. If revegetation is progressed, the potential to reclassify the area to P1 should be considered during the next review of this plan. • Continue water quality monitoring program. Monitoring for acrylamide should be included in this program. Water monitoring could be discussed with Water Corporation to investigate the potential for joint monitoring arrangements.

Land use / activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Landfill	Chemicals	Low	<p>Eneabba landfill is located approximately 3.8 km south of the wellfield. The landfill receives domestic rubbish (Class II Category 64 landfill site), including household waste, green waste and scrap metal. The landfill currently receives less than 250 tonnes of waste per year.</p> <p>Groundwater flow is to the north-west, which reduces the risk to the bores.</p> <p>Distance from bores is considered great enough to reduce the risk associated with pathogens from the landfill.</p>	<ul style="list-style-type: none"> • DEC EP Licence requirements • Water quality monitoring by Water Corporation • Considerable distance from bores 	<ul style="list-style-type: none"> • Continue water quality monitoring program. • Follow best management practices.
	Nutrients	Low			
	Pathogens	Low			

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to protect the drinking water source in the interest of providing safe, good quality drinking water to the town of Eneabba.

4.2 Proclaimed area

Eneabba Water Reserve was proclaimed in 1992 under the *Country Areas Water Supply Act 1947* for the purpose of protecting the public drinking water source from potential contamination. The current gazetted boundary (see section 1.5.1) will be amended to better reflect the capture zone of the bores. The new proposed boundary is shown in Figure 2.

4.3 Priority areas

Priority areas are designated based on the strategic importance of the water source, its zoning, ownership and existing approved land uses. Further information on the priority classification system and detail on the compatibility of land uses and activities within each of the priority areas is provided in the Water Quality Protection Note—*Land use compatibility in Public Drinking Water Source Areas* (Department of Environment 2004).

The area covered by the current gazetted water reserve (Crown Reserve 26075 and Lot 396) as well as the additional area zoned for Parks, Recreation and Conservation to the west of Mineral Sands Road will be managed for Priority 1 (P1) source protection. This classification is appropriate for the following reasons.

- The Eneabba wellfield is the primary source of drinking water for the Eneabba town water supply.
- The land is under Crown ownership.
- Existing land uses are considered compatible with P1 source protection objectives.

Private land under ownership of Illuka Resources Ltd and unallocated crown land zoned for rural purposes is classified as Priority 2 (P2). Mineral sand mining and extensive agriculture are considered to be compatible land uses within a P2 area.

Land to the west of Mineral Sands Road zoned for industrial purposes is classified as Priority 3 (P3). The area of land proposed to be used for recreation and group housing by the Shire of Carnamah is also classified as P3. Light industrial, recreational and residential land uses are considered to be compatible with conditions (relating to best management practices) within P3 areas.

The priority areas for Eneabba Water Reserve are shown in Figure 4.

4.4 Protection zones

Wellhead Protection Zones (WHPZ) are defined around each bore (500 m in P1 areas and 300 m in P2 and P3 areas) in order to protect the drinking water source from contamination in the immediate vicinity of the bores. Within these zones, by-laws may prohibit, restrict or approve defined land uses and activities to prevent water source contamination or pollution. Special conditions, such as restrictions on storage and use of chemicals, may apply within these zones. The WHPZ do not extend outside the water reserve boundary. WHPZ for Eneabba wellfield are shown in Figure 4.

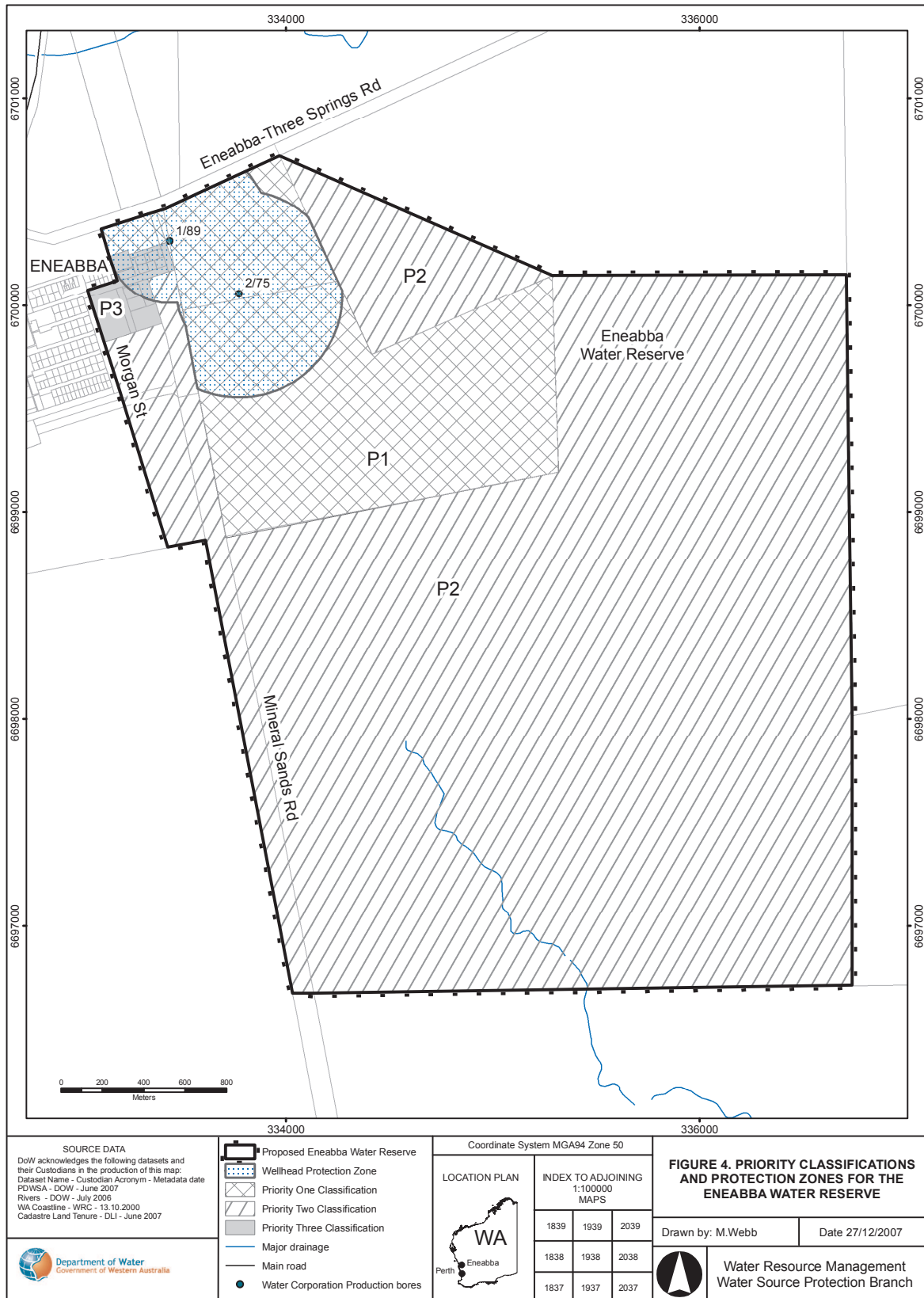


Figure 4 Priority areas and protection zones for Eneabba Water Reserve

4.5 Land-use planning

It is recognised under the *State Planning Strategy* (Western Australian Planning Commission 1997) that the establishment of appropriate protection mechanisms in statutory land use planning processes is necessary to secure the long-term protection of drinking water sources. As outlined in Statement of Planning Policy No. 2.7–*Public Drinking Water Source Policy* (Western Australian Planning Commission 2003) it is appropriate that the Eneabba Water Reserve, priority areas and protection zones be recognised in the Shire of Carnamah’s Town Planning Scheme. Any development proposals within the Eneabba Water Reserve that are inconsistent with advice in the Department of Water’s Water Quality Protection Note–*Land Use Compatibility in Public Drinking Water Source Areas* (Department of Environment 2004) or recommendations in this plan should be referred to the Department of Water.

The department’s protection strategy for PDWSAs provides for lawfully established and operated developments to continue despite their location or facilities posing a level of risk to water quality which would not be accepted for new developments. The department may negotiate with landowners/operators on measures to improve these facilities or processes to lessen the level of water contamination risk.

In critical areas close to water sources, the department may make an offer to purchase land or development rights where the level of contamination risk is considered significant enough to have the potential to compromise the quality of water resources.

4.6 Best management practices

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

There are guidelines available for many land uses in the form of industry codes of practice, environmental guidelines or Water Quality Protection Notes. These have been developed in consultation with stakeholders such as industry groups, producers, state government agencies and technical advisers. Examples include *Extractive Industries within Public Drinking Water Source Areas* (WRC 2000a), *Light industry near sensitive waters* (DoW 2007a) and *Toxic and hazardous substances–storage and use* (DoW 2006g). The guidelines help managers reduce the risk of their operations causing unacceptable environmental impacts. They are recommended as best practice for water quality protection.

Education and awareness (for example, signage and information material) are key mechanisms for water quality protection, especially for those people visiting the area

who are unfamiliar with the Eneabba Water Reserve. A brochure will be produced, describing the Eneabba Water Reserve, its location and the main threats to water quality protection. This brochure will be made available to the community to inform people in simple terms about the drinking water source and its protection.

4.7 Surveillance and by-law enforcement

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

The Department of Water considers by-law enforcement, through surveillance of land use activities in the PDWSA, as an important mechanism to protect water quality.

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

4.8 Emergency response

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

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

4.9 Implementation of this plan

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

Following publication of the Eneabba Water Reserve Drinking Water Source Protection Plan, an implementation strategy will be drawn up based on the recommendations in Table 1. It will describe timeframes for the recommended protection strategies and identify responsible stakeholders and sources of funding.

5 Recommendations

The following recommendations apply to the entire Eneabba Water Reserve. The bracketed agencies have a direct interest in implementation of the relevant recommendation.

- 1 Implement the recommended protection strategies as described in *Table 1: Land use, potential water quality risks and recommended protection strategies* of this Plan (*Applicable stakeholders*).
- 2 The boundary of the Eneabba Water Reserve should be amended (consistent with the proposed boundary in Figure 2) under the *Country Areas Water Supply Act 1947* (*Department of Water*).
- 3 Prepare an implementation strategy for this plan describing responsible stakeholders and timeframes for the recommended protection strategies (*Department of Water*).
- 4 The Shire of Carnamah's Town Planning Scheme should incorporate this plan and reflect the identified Eneabba Water Reserve boundary, its priority areas and protection zones (*Shire of Carnamah*).
- 5 All development proposals within the Eneabba Water Reserve that are inconsistent with the Water Quality Protection Note—*Land use compatibility in Public Drinking Water Source Areas* or Statement of Planning Policy No.2.7—*Public Drinking Water Source Policy* should be referred to the Department of Water for advice and recommendations (*Department for Planning and Infrastructure, Shire of Carnamah, developers, landowners*).
- 6 Applications to construct a bore and/or extract groundwater within or in close proximity to the Eneabba Water Reserve should be assessed to ensure that the bore is appropriately located and constructed. Best management practices should be recommended for the construction and maintenance of the bore to prevent potential contamination or reduction in water availability to the Public Drinking Water Source bores (*Department of Water*).
- 7 Incidents covered by WESTPLAN–HAZMAT in the Eneabba Water Reserve should be addressed through the following:
 - the Mid West-Gascoyne LEMC should be aware of the location and purpose of the Eneabba Water Reserve
 - the locality plan for the Eneabba Water Reserve is provided to the Fire and Rescue headquarters for the HAZMAT Emergency Advisory Team
 - the Water Corporation provides an advisory role during incidents in the Eneabba Water Reserve
 - personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Eneabba Water Reserve (*Department of Water, Water Corporation*).
- 8 Pursuant to Section 13(1) of the *Water and Rivers Commission Act 1995*, the Department of Water should consider delegating responsibility for the surveillance

and enforcement of the Eneabba Water Reserve to the Water Corporation (*Department of Water*).

- 9 The signs located along the boundary of the Eneabba Water Reserve should be maintained to define the location and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number (*Department of Water, Water Corporation*).
- 10 The water service provider should investigate relocation of the bores further from the town site as they become due for decommissioning (*Water Corporation*).
- 11 A review of this plan should be undertaken after five years in consultation with the Shire of Carnamah, the affected private property owners and other relevant stakeholders (*Department of Water*).

Appendices

Appendix A Water quality

The information provided in this appendix was prepared by the Water Corporation.

The Water Corporation has monitored the raw (source) water quality from the Eneabba borefield in accordance with the Australian Drinking Water Guidelines (ADWG) and interpretations agreed to with the Department of Health. The raw water is monitored regularly for:

- aesthetic characteristics (non-health related); and
- health related characteristics including:
 - health related chemicals; and
 - microbiological contaminants.

The following data is representative of the quality of raw water from the Eneabba borefield. In the absence of specific guidelines for raw water quality, the results have been compared with the ADWG values set for drinking water, which defines the quality requirements at the customer's tap. Results that exceed the ADWG have been shaded to give an indication of potential raw water quality issues associated with this source.

It is important to appreciate that this raw water data does not represent the quality of drinking water distributed to the public. Barriers such as storage and water treatment exist downstream of the raw water to ensure it meets the requirements of the ADWG. The values are taken from ongoing monitoring for the period January 2002 to May 2007.

Any water quality parameters that have been detected are reported; those that on occasion have exceeded the ADWG are shaded.

For more information on the quality of drinking water supplied to Eneabba refer to the most recent Water Corporation *Drinking Water Quality Annual Report* at www.watercorporation.com.au > Publications > Annual Reports > Drinking Water Quality Annual Report.

Aesthetic characteristics

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

Aesthetic detections for Eneabba borefield

Parameter	Units	ADWG Aesthetic Guideline Value*	Eneabba Borefield Raw Source SP	
			Range	Median
Chloride [†]	mg/L	250	335 – 375	355
Colour – True	TCU	15	<1 – 18	<1
Conductivity at 25°C	mS/m	NA	96 – 140	120
Copper [†]	mg/L	1	0.02	0.02
Hardness as CaCO ₃ [†]	mg/L	200	96 – 102	100
Iron unfiltered	mg/L	0.3	0.028 – 13	4.6
Manganese unfiltered	mg/L	0.1	<0.002 – 0.18	0.16
pH		6.5 – 8.5	5.57 – 6.77	5.845
Sodium [†]	mg/L	180	175 – 200	190
Sulphate [†]	mg/L	250	26 – 29	27
Total filterable suspended solids (TFSS) [†]	mg/L	500	664 – 722	693
Turbidity	NTU	5	<0.1 – 80	28.5

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

[†] Water quality data observed from three or less sampling occasions

Health related characteristics*Health parameters*

Raw water from Eneabba borefield is analysed for health related chemicals including inorganics, heavy metals, industrial hydrocarbons and pesticides. Health related water quality parameters are summarised in the following table.

Health related detections for Eneabba borefield

Parameter	Units	ADWG Health Guideline Value*	Eneabba Borefield Raw Source SP	
			Range	Median
Barium[†]	mg/L	0.7	0.2 – 0.21	0.2
Boron[†]	mg/L	4	0.03 – 0.05	0.044
Copper[†]	mg/L	2	0.02	0.02
Fluoride	mg/L	1.5	0.1 – 0.15	0.15
Manganese unfiltered	mg/L	0.5	<0.002 - 0.18	0.16
Nitrate as nitrogen[†]	mg/L	11.29	0.008 – 0.008	0.008
Nitrite as nitrogen[†]	mg/L	0.91	0.009 – 0.009	0.009
Sulphate[†]	mg/L	500	26 – 29	27
<i>Pesticides</i>				
Chlorpyrifos[†]	ug/L	10	<0.005 – 0.012	<0.006

* 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 (NHMRC & NRMCC 2004a).

Microbiological contaminants

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

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

Appendix B Photographs



Photo 1 Eneabba production bore 2/75



Photo 2 Bore compound and surrounding native bushland



Photo 3 Drum muster facility



Photo 4 Mineral sand mining

Appendix C Summary of submissions

The following table outlines the main submissions made during the 2007 release of the Eneabba Draft Drinking Water Source Protection Plan, the Department of Water's response to submissions and how this final plan has been changed to reflect the submissions.

Issue	Response	Change to Plan
Cost of amendment of the Shire of Carnamah's Town Planning Scheme (TPS) should be borne by the Department of Water.	Shire of Carnamah is not required to amend its TPS immediately. When the TPS is next reviewed the Eneabba Water Reserve should be included as a special control area.	No change in plan
Disagree with need to relocate the drum muster and oil recycling facility.	This site has been identified as presenting a contamination risk to the drinking water source, particularly from leaching of pesticide residues from the storage of chemical drums. If possible, the drum muster and oil recycling facilities should be relocated. The opportunity for this to occur should be investigated. It is recognised that relocation may be dependent on the availability of funding.	No change in plan
Recreational opportunities provided by the motocross and rifle range should not be written off. These sites still have some low level use.	The usage of these sites is noted. Motocross facilities can present contamination risk to drinking water sources due to the potential for hydrocarbon contamination from fuel leaks and spills. Rifle ranges can cause lead contamination from spent shot. Due to their proximity to bore 2/75 it is recommended that relocation of the these sites is investigated. It is, however, recognised that relocation may be unachievable, particularly in the case of the rifle range.	Updated section 3.1 and Table 1
Concerned about the encroachment of the boundary into the town site and restrictions on future land uses and development potential as a result of the priority classifications.	<p>The boundary of the water reserve is determined based on the existing bore locations and their recharge area in order to provide protection to the water supply.</p> <p>Priority areas have been reconsidered to better reflect the zoning designated in the Shire of Carnamah's Town Planning Scheme.</p>	Priority areas shown in Figure 4 have been amended. Section 4.3 has been updated.

Issue	Response	Change to Plan
Boundaries chosen do not seem to be consistent with the objective to protect the water source. Why has the area to the west of bore 1/89 not been included?	Boundary has been reconsidered and amended to include an additional area to the west of bore 1/89, as defined by a 300 m wellhead protection zone in order to provide better protection of groundwater sourced from this bore.	Boundary shown in Figures 1 to 4 has been updated.
Alternative bore site should be found.	The Water Corporation has been approached with regards to relocation of the bores and has agreed to investigate this option as the bores approach time for decommissioning.	Recommendation 10 added

Glossary

abstraction	pumping groundwater from an aquifer
ADWG	Australian Drinking Water Guidelines which outline guideline criteria for the quality of drinking water in Australia
Aesthetic guideline	an Australian Drinking Water Guidelines value which is the concentration or measure of a water quality characteristic that is associated with acceptability of water to the consumer, e.g. appearance, taste and odour (NHMRC & NRMCC 2004a).
AHD	Australian Height Datum is the height of land in metres above mean sea level. For example this is +0.026 m at Fremantle
allocation	quantity of water permitted to be abstracted by a licence, usually specified in kilolitres per year (kL/year)
ANZECC	Australian and New Zealand Environment Conservation Council
aquifer	geological formation or group of formations able to receive, store and transmit significant quantities of water
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
bore	a narrow, lined hole (also known as a well) drilled to monitor or draw groundwater
borefield	a group of bores used to monitor or withdraw groundwater
catchment	area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater
CAWS Act	<i>Country Areas and Water Supply Act 1947</i>
confined aquifer	an aquifer that is confined between non-porous rock formations (such as shale and siltstone) and therefore contains water under pressure
HAZMAT	hazardous materials
Health guideline	an Australian Drinking Water Guideline value which 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 (NHMRC & NRMCC 2004a)

hydrogeology	the study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality
leaching / leachate	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.
LEMC	Local Emergency Management Committee
mS/m	milliSiemens per metre: a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity
NHMRC	National Health and Medical Research Council
NTU	Nephelometric turbidity units: a measure of turbidity in water
nutrients	minerals dissolved in water, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) which provide nutrition (food) for plant growth. Total nutrient levels include the inorganic forms of an element plus any bound in organic molecules.
oocysts	cells containing reproductive spores
pathogen	a disease producing organism that can cause sickness and sometimes death through the consumption of water contaminated by pathogens, including bacteria (such as <i>Escherichia coli</i>), protozoa (such as <i>Cryptosporidium</i> and <i>Giardia</i>) and viruses)
pesticides	collective name for a variety of insecticides, fungicides, herbicides, algicides, fumigants and rodenticides used to kill organisms
pH	a logarithmic scale for expressing the acidity or alkalinity of a solution. A pH below 7 indicates an acidic solution and above 7 indicates an alkaline solution.
Pleistocene	a geologic period, usually thought of as the Ice Age, which began about 1.6 million years ago and ended with the melting of the large continental glaciers creating the modern climatic pattern about 11 500 years ago
pollution	Water pollution occurs when waste products or other substances (for example, 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	includes all underground water pollution control areas, catchment

Drinking Water Source Area)	areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> and the <i>Country Areas Water Supply Act 1947</i>
Quaternary	the geological time period from 1.6 million years ago to the present day, which includes the Pleistocene and Holocene
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.
RIWI Act	<i>Rights in Water and Irrigation Act 1914</i>
runoff	water that flows over the surface from a catchment area, including streams
stormwater	rainwater which has run off the ground surface, roads and paved areas and is usually carried away by drains
TCU	true colour units: a measure of colour in water
Tertiary	the period of geological time between 65 and 1.6 million years ago
TFSS	total filterable suspended solids by summation
treatment	application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes including drinking and discharge to the environment
turbidity	cloudiness or haziness of water caused by the presence of fine suspended matter
unconfined aquifer	an aquifer in which the upper surface of water is lower than the top of the aquifer itself. The upper surface of the groundwater within the aquifer is called the watertable.
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	physical, chemical and biological measures of water
Water Reserve	an area proclaimed under the <i>Country Areas Water Supply Act 1947</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909</i> for

	the purpose of protecting a drinking water supply
watertable	the upper saturated level of the unconfined groundwater
wellfield	a group of bores to monitor or withdraw groundwater
Wellhead	the top of a well (or bore) used to draw groundwater
WHPZ (Wellhead Protection Zone)	a buffer zone around drinking water bores. These are circular with a radius of 500 m in priority 1 areas and 300 m in priority 2 and priority 3.
WESTPLAN- HAZMAT	Western Australian Plan for Hazardous Materials

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