



Government of Western Australia
Department of Water

Marble Bar Water Reserve

Drinking water source protection plan

Marble Bar town water supply



Looking after all our water needs

Water resource protection series
Report WRP 115
June 2010

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168 St Georges Terrace
Perth Western Australia 6000
Telephone +61 8 6364 7600
Facsimile +61 8 6364 7601
www.water.wa.gov.au

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For more information about this report, contact the Water Source Protection Branch on +61 6364 7600 or drinkingwater@water.wa.gov.au.

Cover photograph: *Aerial photograph of Marble Bar townsite and surrounds*

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Preface

How do we protect public drinking water source areas?

The Australian drinking water guidelines (ADWG) (NHMRC & NRMCC 2004a) outlines how we should protect drinking water in Australia. The ADWG recommends a ‘catchment to consumer’ framework that uses a risk-based, multiple-barrier approach. A similar approach is recommended by the World Health Organization in other countries worldwide.

The ‘catchment to consumer’ framework applies across the entire drinking water supply system, from the water source to your tap. It ensures a holistic assessment of risks to water quality to maximise the delivery of safe drinking water to consumers.

A risk-based approach means that we look at all the different risks to water quality, and how to address them. A multiple-barrier approach means that we use different barriers against contamination at different stages of a drinking water supply system. The first barrier is protecting the catchment (the whole area from which water flows into the borefield). This plan helps to do that. Other barriers against contamination include:

- storage of water
- treatment of water (e.g. chlorination)
- maintenance of pipes
- testing of water quality.

As water treatment practices evolve, many people think that we no longer need to protect the catchment because we can ‘engineer out the risks’. Nothing could be further from the truth (Krogh et. al 2008). Research and experience shows that a combination of catchment protection and water treatment is safer than relying on either barrier on its own. That’s why this drinking water source protection plan is important. It’s about protecting the catchment’s water quality now and in the future.

In Western Australia, the Department of Water protects public drinking water source areas (PDWSAs) by putting the ADWG into practice; writing plans, policies and guidelines; and providing input into land-use planning.

The *Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)* and the *Country Areas Water Supply Act 1947 (WA)* allow us to protect water. We proclaim PDWSAs under these Acts so that we can apply legislation and policy to protect water quality.

The ADWG outlines 12 elements to protect drinking water. This plan implements element two (assessment of the drinking water supply system) and element three (preventative measures for drinking water quality management). Plans have been, or are being written for all PDWSAs around the state. They give an overview of each

drinking water source and outline the risks to water quality and how to address them. Our regional offices work with the community, other government agencies and landowners to put the recommendations into practice.

We also define special areas within PDWSAs: priority areas and protection zones. There are three different priority areas, each representing a different level of risk to water quality. Protection zones surround drinking water extraction points, so that the most vulnerable areas may be protected from contamination. Under legislation, some activities are prohibited or restricted in protection zones.

If you would like more information about how we protect drinking water in Western Australia, go to <<http://drinkingwater.water.wa.gov.au>>.

Summary

This drinking water source protection plan aims to protect the quality of water in the Marble Bar Water Reserve. This will be achieved by identifying potential water quality contamination risks in the water reserve and implementing strategies to avoid, minimise or manage those risks.

The town of Marble Bar is located in Western Australia's Pilbara region, approximately 1500 km north-east of Perth and approximately 150 km south-east of Port Hedland. The town is within the Shire of East Pilbara, the administrative centre of which is Newman, some 242 km to the south of Marble Bar.

Marble Bar receives its water supply from Water Corporation bores located approximately 2–3 km west of the town, close to the banks of the Coongan River. The wellfield draws water from a fractured volcanic rock aquifer, at depths of approximately 40–55 m, and is mainly recharged from high rainfall events associated with summer thunderstorms and cyclones. Given the unconfined nature of the aquifer, it is vulnerable to contamination. The Water Corporation regularly monitors the wellfield's water quality.

The Marble Bar Water Reserve was proclaimed in 1972 under the *Country Areas Water Supply Act 1947 (WA)* for the purpose of public drinking water source protection.

In 2000, the Water and Rivers Commission completed a drinking water source protection plan for the Marble Bar Water Reserve. This drinking water source protection plan replaces the 2000 document.

A high priority during this plan's preparation was to consider whether the gazetted Marble Bar Water Reserve was still appropriate. The consequent finding has been to remove most of the eastern part of the current water reserve (approximately 50 per cent of the total area), including the townsite. The reason for removal of this area is that the town wellfield has not been used since 2001 and the Water Corporation has confirmed that it will not be used in the future.

The 'new' water reserve is comprised of various forms of Crown land including a number of crown leases (for mainly residential purposes) and land vested in the Shire of East Pilbara for recreation (including a rifle range and Marble Bar Pool).

The following actions are recommended to protect water quality within the Marble Bar Water Reserve:

- amendment of the existing Marble Bar Water Reserve boundary under the *Country Areas Water Supply Act 1947 (WA)*

- implementation of the protection strategies detailed in Appendix C of this drinking water source protection plan
- preparation of an implementation strategy for this plan to determine agreed timeframes and stakeholder responsibilities for the recommended protection strategies
- the Department of Water to delegate responsibility for monitoring and enforcement measures within the water reserve to the Water Corporation
- implementation of an ongoing surveillance program within the water reserve to identify any incompatible land uses or water quality contamination threats
- installation of signs along the water reserve's boundary to define the location and promote awareness of the need to protect drinking water quality
- the Department of Water to continue to liaise with the Department of Regional Development and Lands regarding any new leases that may be issued for locations 70, 72, 73 and 74 Garden Road
- the Department of Water/Water Corporation to liaise with Horizon Power as to whether the town power supply can be extended to Garden Road for the operation of the Coongan wellfield.

1 Drinking water source overview

1.1 Existing water supply system

Groundwater is drawn from the Coongan wellfield 2–3 km west of the town and adjacent to the Coongan River. This wellfield is drilled into fractured volcanic rock, at depths of 40–55 m, with the bores powered by on-site diesel generators (Water Corporation 2009). The raw water is chlorinated before entering a 2500 kL service tank, from where it is gravity-fed to the town's reticulated supply system (Water Corporation 2004).

The Water Corporation supplies drinking water to approximately 160 services in Marble Bar. The total annual consumption of drinking water is well below the maximum that is licensed to be drawn from the wellfield (see Section 1.6.2).

Figures 1, 2 and 4 in Appendix A show the location of the current Marble Bar Water Reserve and production bores.

1.2 Water treatment

The extracted raw water is chlorinated before being supplied to the town. This provides a disinfection barrier against possible microbiological contamination.

It should be recognised that although treatment and disinfection are essential barriers against contamination, management of the Coongan wellfield is the first step in protecting water quality and ensuring a safe, quality drinking-water supply for Marble Bar. This approach is endorsed by the *National water quality management strategy: Australian drinking water guidelines 6, 2004* (ADWG) (NHMRC & NRMCC 2004a) and reflects a risk-based, multiple-barrier approach for providing safe drinking water to consumers. This combination of catchment protection and water treatment will deliver a more reliably safe and lower-cost drinking water to consumers than either could achieve individually.

1.3 Catchment details

1.3.1 Physiography

The Marble Bar area is on a plateau about 200 m above sea level and is surrounded by rocky basalt hills supporting sparse vegetation. The Marble Bar townsite is in a small valley adjacent to Sandy Creek, which is a minor tributary of the Coongan River. The Coongan River is a major drainage feature of the region, flowing northwards to the De Grey River (Water & Rivers Commission 2000; Water Corporation 2004).

1.3.2 Climate

Marble Bar has an arid-type climate with an average annual rainfall of approximately 350 mm. Rainfall is unreliable and irregular, with most of it falling between December and April as a result of tropical thunderstorms and cyclonic activity (Water & Rivers Commission 2000).

1.3.3 Hydrogeology

Marble Bar is located on the eastern edge of the Pilbara Craton, which is underlain by a sequence of (mafic and felsic) lavas with minor sediments. It is uncertain whether the groundwater within this volcanic sequence forms a continuous watertable (Water & Rivers Commission 2000).

The Coongan wellfield draws from fractured volcanic rock on the Coongan River's eastern bank. Significant recharge occurs during high rainfall events (usually associated with summer thunderstorms and cyclones).

The direction of groundwater flow is closely related to surface drainage, which is in a north to north-westerly direction (Water & Rivers Commission 1996).

1.4 Future water supply requirements

It is expected that demand for the town's drinking water supply will remain at similar levels to the quantities supplied since the mid 1970s. Estimated available water is well in excess of the water consumed and the annual water entitlement licensed by the Department of Water (see Section 1.6.2) (Water Corporation 2004; Department of Water 2008).

1.5 Existing drinking water source protection

The Marble Bar Water Reserve was proclaimed in 1972 under the *Country Areas Water Supply Act 1947* (WA) for the purpose of public drinking water source protection. By-laws created under this Act enable the Department of Water to control potentially polluting activities, regulate land use, inspect premises and take the necessary steps to prevent or clean up pollution.

In 2000 the Water and Rivers Commission prepared the *Marble Bar Water Reserve drinking water source protection plan*. This document outlined the risks to water quality from land uses and activities, proposed an updated boundary for the water reserve and established priority areas (mostly priority 1 with the exception of the townsite, which was classified as priority 3) within the water reserve. This drinking water source protection plan builds on and replaces the 2000 plan.

The Shire of East Pilbara's *Town planning scheme no. 4* district zoning scheme (gazetted in 2005, and last updated in 2009), recognises the Marble Bar Water Reserve as a special control area. As such, the types of development supported are

described in the Department of Water's Water quality protection note (WQPN) no. 25: *Land use compatibility in public drinking water source areas*.

1.6 Department of Water management

1.6.1 Pilbara regional water plan

The Department of Water has prepared a draft *Pilbara regional water plan* to provide a strategic vision to guide the management of the region's water resources and water services. This is in accordance with the National Water Initiative signed by Western Australia in 2006 (Department of Water 2008).

1.6.2 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* (WA). The right to use and control surface water and groundwater is vested with the Crown under this Act. The Act requires licensing of groundwater abstraction (pumping water from a bore, spring or soak) within groundwater areas proclaimed under the Act and all artesian wells throughout the state. Marble Bar is within the Pilbara Groundwater Area, and was proclaimed under the Act in 1965.

The Water Corporation has a licence, valid until 2014, to draw 200 000 kL of water a year from the Marble Bar Water Reserve's Coongan wellfield. In January 2010 the Department of Water approved the operating strategy for this licence.

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 drinking water to consumers.

The Water Corporation regularly monitors the quality of raw water from the Coongan wellfield for microbiological, health-related and aesthetic (non-health-related) characteristics. This data shows the quality of water in the Marble Bar Water Reserve. An assessment of the drinking water quality once treated is also made against the ADWG to ensure safe, good quality drinking water is available to consumers. This assessment is made by an intergovernmental committee called the Advisory Committee for the Purity of Water that is chaired by the Department of Health.

A water quality summary for the Coongan wellfield from July 2004 to June 2009 is presented in Appendix B. For more information on water quality, see the Water Corporation's most recent drinking water quality annual report at www.watercorporation.com.au > What we do > Water quality > Water quality publications > Water quality annual report 2008–09.

Contamination risks relevant to drinking water sources are described below.

2.1 Microbiological

Pathogens are types of microorganisms that are capable of causing disease. These include bacteria, protozoa and viruses. In water supplies, pathogens that can cause illness are commonly found in the faeces of humans and domestic animals (such as dogs and cattle).

A number of pathogens are commonly known to contaminate water supplies worldwide. These include bacteria (e.g. salmonella, *Escherichia coli* and cholera), protozoa (e.g. *Cryptosporidium*, *Giardia*) and viruses. *E. coli* counts are a way to measure these pathogens and provide an indication of faecal contamination.

Pathogen contamination of a drinking water source is influenced by many factors including the existence of pathogen carriers (e.g. humans and domestic animals), the transfer to and movement of the pathogen in the water source and its ability to survive in the water. The percentage of humans in the world that carry pathogens varies. For example, it is estimated that between 0.6 to 4.3 per cent of people are infected with *Cryptosporidium* worldwide, and 7.4 per cent with *Giardia* (Geldreich 1996).

When people (while fishing, marroning, swimming or the like) or domestic animals come into contact with a body of water, pathogens may enter that water source. This primarily occurs through the direct transfer of faecal material (even a very small amount can cause contamination) or indirectly through runoff moving faecal material into the water.

The ability of pathogens to survive in surface water also differs between species. Salmonella may be viable for two to three months, *Giardia* may still infect after one month in the natural environment (Geldreich 1996) and *Cryptosporidium* oocysts (cells containing reproductive spores) may survive weeks to months in fresh water (NHMRC & NRMMC 2004a).

When people consume drinking water contaminated with pathogens the effects vary considerably, ranging from mild illness (such as stomach upset or diarrhoea) to hospitalisation and sometimes even death. During 2000, seven people died in Walkerton, Canada, because the town's groundwater source and supply was contaminated by a pathogenic strain of *E. coli* and campylobacter (NHMRC & NRMMC 2004b). Where possible, avoiding the introduction of pathogens into a water source is the most effective way to protect public health.

2.2 Health related

Land- and water-based uses and activities within a catchment can directly affect water quality and treatment. For example, off-road driving contributes to erosion and the uprooting of vegetation which can increase turbidity in surface water. This increased turbidity can subsequently reduce the effectiveness of treatment processes (such as disinfection).

Erosion results in the mobilisation of soil particles that are released into the air and tributaries, increasing the turbidity of the main water body. Pathogens can absorb onto these soil particles and may be shielded from the effects of disinfection. Increased turbidity also impacts on other environmental constituents: it smothers riparian vegetation and reduces the transfer of light within the water column, which in turn affects plant growth.

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

Pesticides include agricultural chemicals such as insecticides, herbicides, nematicides (used to control worms), rodenticides and miticides (used to control mites). Contamination of a drinking water source by pesticides (and other chemicals) may occur as a result of accidental spills, incorrect use or leakage from storage areas. In such cases, the relevant authorities should be notified promptly and the spill cleaned up.

Drinking water supplies can also be contaminated by nutrients (such as nitrogen) from fertiliser applications, faulty septic systems, leach drains and from domestic and feral animal faecal matter that washes through or over soil and into a water source. Nitrate and nitrite can be toxic to humans at high levels, with infants younger than three months being most susceptible (NHMRC & NRMMC 2004a).

Hydrocarbons (e.g. fuels, oils) are potentially toxic to humans, and harmful chemical by-products may be formed when they are combined with chlorine during the water-treatment process. Hydrocarbons can occur in water supplies as a result of spills and leakage from vehicles.

2.3 Aesthetic

Impurities in drinking water can affect its aesthetic qualities, including its appearance, taste, smell and feel. Such impurities are not necessarily hazardous to human health; for example, cloudy water with a distinctive odour or strong taste is not necessarily harmful to health, while clear, pleasant-tasting water may still contain harmful microorganisms (NHMRC & NRMMC 2004b).

Iron and dissolved organic matter can affect the colour and appearance of water and salinity can affect the taste. Some properties such as pH (a measure of acidity or alkalinity) can contribute to the corrosion and encrustation of pipes.

The ADWG sets aesthetic water quality criteria to meet the aesthetic requirements of consumers and to protect water supply infrastructure (such as pipes).

2.4 Groundwater bores

The Marble Bar Water Reserve is located within the Pilbara Groundwater Area, which is proclaimed under the *Rights in Water and Irrigation Act 1914* (WA). Under the provisions of sections 26D and 5C of the Act, a licence is required to construct a bore or abstract water within a proclaimed groundwater area (unless exempt under the Rights in Water and Irrigation Exemption and Repeal [Section 26C] Order 2001).

The Water Corporation operates drinking water bores in the Marble Bar Water Reserve. If bores for other purposes (e.g. irrigation, private household use) are drilled near a public drinking water supply bore, they can cause contamination of the drinking water source. For example, a poorly constructed private bore may introduce contaminants from surface leakage down the outside of the bore casing into an otherwise uncontaminated aquifer.

It is therefore important to ensure that any bores are appropriately located and constructed to prevent contamination of the public drinking water source. This has been assessed through the Department of Water's water licensing process (see Section 1.6.2), under the *Rights in Water and Irrigation Act 1914* (WA). 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

It is proposed that the current water reserve's boundary be amended by removing much of the eastern half of water reserve (see Figure 2). This is because the town wellfield has not been used for several years and the Water Corporation (as the water source provider) has indicated it will not be used in the future. Residential land in the townsite, a number of past gold mining and tailings sites, and a small area where a prospecting licence applies, are all located on land proposed to be removed from the water reserve.

The proposed Marble Bar Water Reserve is located over various forms of Crown land, comprising:

- several 1–3 ha lots on Garden Road, which are leased out for mostly residential purposes and are near the Coongan wellfield's production bores
- local authority reserves for recreation purposes including Marble Bar Pool and a rifle range
- other forms of Crown land, including a small area of unallocated Crown land and an area over which a mining exploration tenement applies approximately 3 km to the west of Coongan wellfield.

Current land uses and activities for the area of the proposed new water reserve are outlined below. This information has been summarised in Table 1 at the end of this section. This table also identifies the recommended management priorities for different hazards. Appendix C of this plan uses data in Table 1 and this section to recommend protection strategies for key stakeholders to consider.

3.1.1 Crown land leases

Locations 70, 72, 73, 74 and 143 are 1–3 ha Crown land lots adjacent to the Coongan River and close to the town's water supply production bores. For several decades these lots have been leased out for mostly residential purposes.

The Department of Regional Development and Lands (RDL) administers these leases. Recently RDL has been considering the renewal of these leases, as they have reached the end of their 21-year terms. The lease renewal process has involved consultation with the Department of Water on the protection of the town's drinking water source. Accordingly, the department has given advice on lease conditions to reflect that the land is part of a Priority 1 public drinking water source area (PDWSA), as follows:

- a single dwelling is allowed on each lease area, including a domestic garden (e.g. for aesthetic enjoyment and household vegetable growing)

- commercial operations that may result in contamination of the groundwater resource are not supported, unless written approval is received from the Department of Water
- the keeping of commercial or domestic livestock is not supported unless written approval is received from the Department of Water
- a bore for commercial use requires approval from the Department of Water
- storage of chemicals (e.g. fuels or pesticides) for commercial use, that may contaminate the water resource, is not allowed unless written approval is received from the Department of Water.

Until such time as RDL issues any new leases, a general condition of the lapsed leases is still in effect – requiring compliance with the statutes, by-laws and regulations of local or public authorities, such as the Department of Water.

3.1.2 Bore operation and maintenance

The Water Corporation operates four bores within the Coongan wellfield. These bores are powered by diesel generators, and thus diesel is stored on-site. This poses a hydrocarbon contamination risk to the water source from fuel tanker spills and accidents, as well as spills and leaks from diesel storage and transfer.

It is understood that Horizon Power is considering extending the town power supply to Garden Road. The hydrocarbon contamination risk to the water source would be reduced if the Coongan wellfield bores were operated using the town power supply. In the mean time, or if this is not possible, it is important that appropriate and adequate bunding of bore compound fuel tanks and generators is in place.

There are a number of disused bores within the proposed Marble Bar Water Reserve. It is important that all of these disused bores be capped.

3.1.4 Aboriginal sites of significance

Aboriginal sites of significance are those areas that Aboriginal people value as important and significant to their cultural heritage. The sites are significant because they link Aboriginal culture and tradition to place, land and people over time. These areas form an integral part of Aboriginal identity and the heritage of Western Australia. The *Aboriginal Heritage Act 1972* (WA) protects all Aboriginal sites in the state.

Marble Bar Pool (PO5721) is an Aboriginal site of significance within the proposed water reserve. For further information about these sites contact the Yamatji Maripa Barna Baba Maaja Aboriginal Corporation.

3.1.5 Native title

Native title is a form of land title that recognises the unique ties that some Aboriginal groups have to land. Native title exists where Aboriginal people have maintained a traditional connection with their lands and waters, since sovereignty, and where acts of government have not removed it.

The Marble Bar Water Reserve comprises a small part of a native title claim within the Pilbara. This claim is Njamal (WAD6028/98). For further information about this claim contact the Yamatji Marlpa Barna Baba Maaja Aboriginal Corporation.

3.1.6 Recreation

The rifle range is a few hundred metres east of the production bores, with the direction of groundwater flow being north to north-westerly. There is a medium contamination risk to the town water resource from this land use.

Reserve 24096 is located immediately to the Coongan wellfield's west, and is centred around Marble Bar Pool within the Coongan River. Marble Bar Pool is significant to the local Aboriginal people, and the town was named after the jasper formations present (originally mistaken for marble). There is a low risk to the town water resource from this area of the water reserve.

3.1.8 Other forms of Crown land

Lot 76 Garden Road, covering approximately 2 ha, is unallocated Crown land located immediately north of the Crown land leases described in Section 3.1.1.

Reserve 48969 is approximately 3 km to the west of the Coongan wellfield, and is down-gradient of the direction of groundwater flow. A mining exploration tenement (E45/1869) applies to this land, with its term ending in May 2012. Mining is compatible with conditions in Priority 1 PDWSAs. Possible future mining within this tenement would be a low risk to the town water resource, because it is both down-gradient and a considerable distance from the Coongan wellfield.

3.2 Proposed land uses and activities

The land uses and activities identified in this plan are not expected to change in the short term. Future land uses should be guided by this protection plan and recognise that the Marble Bar Water Reserve is protected under the *Country Areas Water Supply Act 1947* (WA). This Act may restrict or prevent some land uses from occurring in the water reserve to help protect water quality and public health.

The Water Corporation, the Shire of East Pilbara and the Department of Water need to coordinate land-use assessment and approvals in the water reserve. Future land uses within the water reserve are expected to be in accordance with the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source*

areas. Further information on development application referrals, the PDWSA water source protection framework, special control areas and relevant by-laws can be found in the Department of Water's WQPN no. 76: *Land use planning in public drinking water source areas*.

Table 1 Land use and potential water quality risks

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance
Crown land leases – for mainly residential purposes				
Locations 70, 72, 73 74 and 143	<ul style="list-style-type: none"> • Pathogens from septic tanks and domestic animals • Nutrients from septic tanks, fertilisers and domestic animals • Chemicals, including hydrocarbons in storage 	Medium	Lots less than 4 ha in size (not connected to deep sewer) are usually incompatible in a P1 area. However, this is a long-standing land use that was in place before the land became P1 and therefore can continue.	Water quality protection note (WQPN) no. 70: <i>Wastewater treatment – onsite domestic systems</i>
Roads and tracks				
Official roads	Hydrocarbon spills and leaks from vehicles	Low	All existing roads are acceptable. New <i>major</i> roads are generally incompatible within Priority 1 (P1) areas. Unsealed roads should be managed to control access.	WQPN no. 44: <i>Roads near sensitive water resources</i>
Off-road driving	Hydrocarbon spills and leaks from vehicles	Low – medium	Off-road driving is incompatible in P1 areas.	
Crown land – for recreation purposes				
Marble Bar Pool	<ul style="list-style-type: none"> • Pathogens and nutrients from swimming or dead fauna entering the water 	Low		

Land use/activity	Hazard	Management priority	Compatibility of land use/activity	Best management practice guidance
Rifle range	<ul style="list-style-type: none"> • Heavy metal (lead) contamination from spent shots • Pathogens and nutrients from human waste 	Medium	Rifle ranges are compatible with conditions in P2 areas.	WQPN no. 70: <i>Wastewater treatment – onsite domestic systems</i>
Bore operation and maintenance				
Diesel storage and transfer	Hydrocarbon spills and leaks	Medium	Fuel or chemical storage in above ground tanks is usually incompatible in P1 areas. However, as fuel storage is required to run the bores this can continue with best management practices.	WQPN no. 60: <i>Tanks for mobile fuel storage in public drinking water source areas</i> WQPN no. 10: <i>Contaminant spills: emergency response</i>
Uncapped bores	Pathogens from animal carcasses and faeces	Medium	n/a	Cap, and where appropriate, fence off uncapped bores

4 Catchment protection strategy

4.1 Protection objectives

The objective of this plan is to ensure that safe, reliable, good quality drinking water is available to consumers now and in the future. This plan aims to achieve this objective while recognising the rights of existing approved land uses to continue and operate within the water reserve.

The protection objectives for the Marble Bar Water Reserve are, where possible, to improve the quality of raw water abstracted from the production bores, identify land uses that pose a contamination risk and manage those land uses to reduce the risk to water quality.

4.2 Proclaimed area

The Marble Bar Water Reserve was proclaimed in 1972 under the *Country Areas Water Supply Act 1947* (WA) for the purpose of public drinking water source protection. The water reserve's boundary was proposed to be amended in 2000; however, proclamation of this proposed boundary has not occurred to date.

A high priority during this plan's preparation was to consider whether the gazetted Marble Bar Water Reserve or boundary proposed in 2000 was still appropriate. The consequent finding has been to remove most of the current water reserve's eastern part (approximately 50 per cent of the total area), including the Marble Bar townsite. This is based on the town wellfield not having been used since 2001, and the Water Corporation confirming it would not draw from this wellfield in the future. Furthermore, the recharge area for the Coongan wellfield is the Coongan River to the west. Surface water flows from high rainfall events, generally associated with summer thunderstorms and cyclones recharge the aquifer.

It is recommended that this plan's next review considers whether any more of the Coongan River's catchment area should be included in the Marble Bar Water Reserve.

For the current gazetted water reserve boundary, boundary proposed in 2000 and new proposed boundary changes see Figure 2.

4.3 Priority areas

The protection of PDWSAs relies on statutory measures available in legislation for water resource management and land-use planning. The Department of Water's policy for the protection of PDWSAs includes three risk-based priority areas:

- Priority 1 (P1) areas have the fundamental water quality objective of risk avoidance

- Priority 2 (P2) areas have the fundamental water quality objective of risk minimisation
- Priority 3 (P3) areas have the fundamental water quality objective of risk management.

The determination of priority areas is based on the strategic importance of the land or water source, the local planning-scheme zoning, the form of land tenure and existing approved land uses or activities. For further detail, please refer to the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas*.

The proposed priority areas for the Marble Bar Water Reserve have been determined in accordance with current Department of Water policy. These areas are described below and displayed in Figure 4. The department's WQPN no. 25: *Land use compatibility in public drinking water source areas* outlines activities that are 'acceptable', 'compatible with conditions' or 'incompatible' within the different priority areas. For an explanation of the background and support for protection of PDWSAs, please refer to WQPN no. 36: *Protecting public drinking water source areas*.

Historically the water reserve has been mostly P1, except for a P3 area over the Marble Bar townsite. This plan proposes that the townsite (and corresponding P3 area) and much of the existing water reserve's eastern side be removed. The P1 classification on the remainder of the water reserve will be retained; with the exception of the rifle range, which will be managed as P2.

These classifications are considered appropriate for the following reasons:

- the water resource is a sole supply for the town of Marble Bar and so should be afforded the highest level of protection
- the aquifer is unconfined and would be susceptible to contamination from intensification of land uses
- the existing land uses can be managed so that they are compatible with the management objectives of the priority areas.

4.4 Protection zones

In addition to priority areas, protection zones are defined to protect drinking water sources from contamination in the immediate vicinity of water extraction facilities. Specific conditions may apply within these zones such as restrictions on the storage of chemicals.

Wellhead protection zones (WHPZs) are generally circular (unless information is available to determine a different shape or size), with a 500 m radius around each production bore in a P1 area and a 300 m radius around each production bore in P2 and P3 areas. WHPZs do not extend outside the boundary of the water reserve.

The Marble Bar production bores are in a P1 area and have therefore been allocated WHPZs with a 500 m radius. See Figure 4 for the location of the WHPZs within the water reserve.

It is important that best management practices be employed for activities occurring within WHPZs. This includes some of the Garden Road Crown-land lease areas. Further information on best management practices can be found in Section 4.6: Best management practices and in Table 1.

4.5 Land-use planning

It is recognised under the Western Australian Planning Commission's (WAPC) *State planning strategy* (1997) that appropriate protection mechanisms in statutory land-use planning processes are necessary to secure the long-term protection of drinking water sources. As outlined in the WAPC's Statement of planning policy no. 2.7: *Public drinking water source policy* (2003), it is appropriate that the Marble Bar Water Reserve and its priority areas be recognised in the *Shire of East Pilbara town planning scheme*. Any development proposals within the Marble Bar Water Reserve that are inconsistent with advice in the Department of Water's WQPN no. 25: *Land use compatibility in public drinking water source areas* or recommendations in this plan, should be referred to the Department of Water for advice.

For further information on the integration of land-use planning and water source protection, please refer to the Department of Water's WQPN no. 36: *Protecting public drinking water source areas*.

The department's protection strategy for PDWSAs provides for lawfully established and operated developments to continue despite those facilities posing a potential level of risk to water quality that would not be accepted for new developments. The department will provide advice to landowners/operators on measures to improve these facilities and reduce water quality contamination risks.

4.6 Best management practices

There are opportunities to reduce water contamination risks by carefully considering design and management practices. To help protect water sources, the Department of Water will continue to encourage the adoption of best management practices for various land uses.

Guidelines on best management practices for many land uses are available in the form of industry codes of practice, environmental guidelines and water quality protection notes. They outline the recommended practices to ensure the protection of water quality and can thus help managers reduce any detrimental effects of their operations. Such guidelines have been developed in consultation with stakeholders such as industry groups, agricultural producers, state government agencies and technical advisers. Examples include WQPN no. 60: *Tanks for mobile fuel storage in public drinking water source areas* and WQPN no. 96: *Pest animal management in public drinking water source areas*.

Education and creating awareness (e.g. signage and information) are also key mechanisms for protecting water quality, especially for people visiting the area. A brochure will be produced once this plan is finalised, describing the Marble Bar Water Reserve, its location and the main threats to water quality. This brochure will be available to the community and will inform people in simple terms about the drinking water source and the need to protect it.

4.7 Surveillance and by-law enforcement

The quality of water in PDWSAs within country areas of the state is protected under the *Country Areas Water Supply Act 1947 (WA)*. Proclamation of PDWSAs 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 PDWSAs, to be an important mechanism to protect water quality.

Signs will be erected on the boundaries of this water reserve to educate and advise the public about activities that are prohibited or regulated. This plan recommends that the surveillance and by-law enforcement be delegated to the Water Corporation.

4.8 Emergency response

The escape of contaminants during unforeseen incidents and the use of chemicals during emergency responses can result in water contamination. The Shire of East Pilbara local emergency management committee (LEMC), through the Karratha emergency management district, should be familiar with the location and purpose of the Marble Bar Water Reserve. A locality plan should be provided to the fire and rescue services headquarters for the hazardous materials (HAZMAT) emergency advisory team. The Water Corporation should have an advisory role to the HAZMAT team for incidents in the Marble Bar 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 Marble Bar Water Reserve. These personnel should have an adequate understanding of the potential impacts of spills on this water resource.

4.9 Implementation of this plan

Table 1 identifies the potential water quality risks associated with existing land uses in the proposed Marble Bar Water Reserve. Further information and the recommended protection strategies to deal with those risks are outlined in Appendix C.

When the final *Marble Bar Water Reserve drinking water source protection plan* is complete, an implementation strategy will be drawn up based on the recommendations in Appendix C.

5 Recommendations

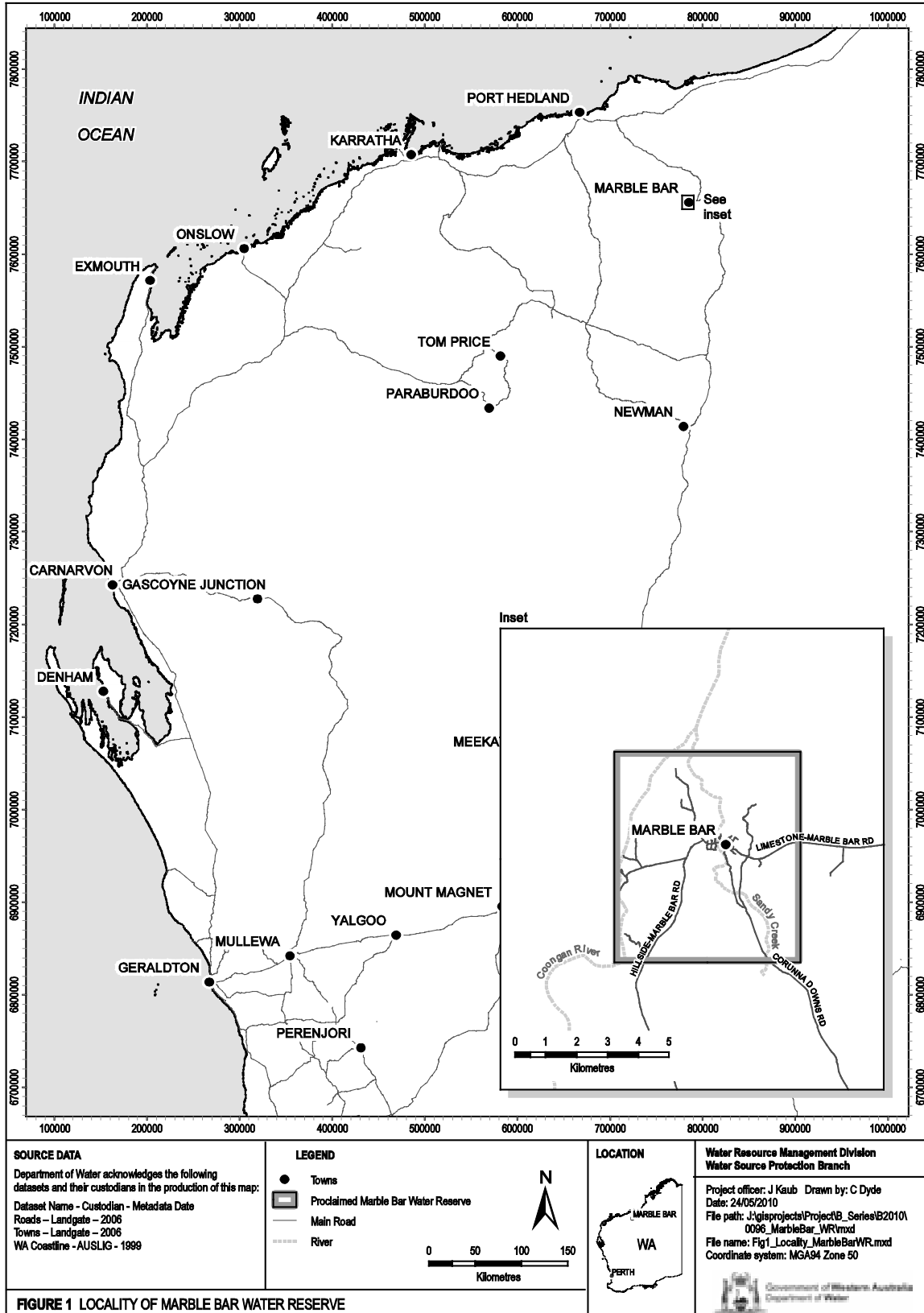
The following recommendations apply to the Marble Bar Water Reserve. The bracketed stakeholders are those expected to have an interest in the relevant recommendation being implemented.

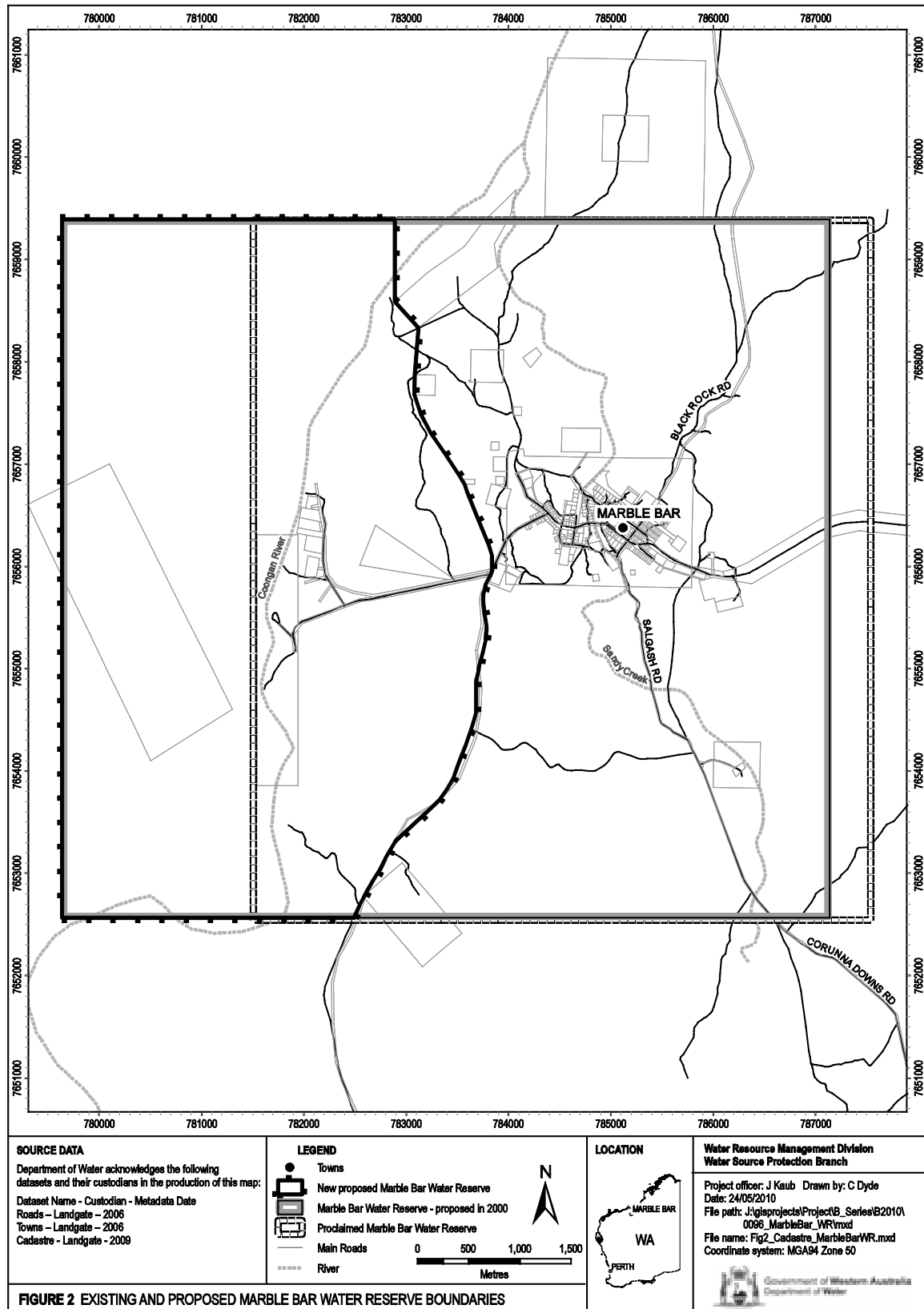
- 1 The boundary of the Marble Bar Water Reserve should be amended under the *Country Areas Water Supply Act 1947* (WA). (Department of Water)
- 2 When the water reserve boundary is amended under the *Country Areas Water Supply Act 1947*, the Shire of East Pilbara should also amend the boundary in the figures within the shire's *Town planning scheme no. 4*. (Shire of East Pilbara)
- 3 Develop an implementation strategy for this plan's recommendations (including the recommended protection strategies as detailed in Appendix C) showing responsible stakeholders and planned timeframes. (Department of Water, applicable stakeholders)
- 4 All development proposals within the water reserve that are inconsistent with the Department of Water's Water quality protection note no. 25: *Land use compatibility in public drinking water source areas*, recommendations in this plan, or water source protection provisions in the Shire of East Pilbara's *Town planning scheme no. 4*, should be referred to the Department of Water for advice and recommendations. (Department of Planning, Shire of East Pilbara, proponents of proposals)
- 5 Incidents covered by WESTPLAN–HAZMAT in the Marble Bar Water Reserve should be addressed by ensuring that:
 - the Shire of East Pilbara LEMC is aware of the location and purpose of the water reserve
 - the locality plan for the water reserve is provided to the FESA headquarters for the HAZMAT emergency advisory team
 - the Water Corporation acts in an advisory role during incidents in the water reserve
 - personnel dealing with WESTPLAN–HAZMAT incidents in the area have ready access to a locality map of the Marble Bar Water Reserve and information to help them recognise the potential impacts of spills on drinking water quality. (Department of Water)
- 6 The Department of Water to continue to liaise with the Department of Regional Development and Lands, to ensure that any new leases that may be issued for locations 70, 72, 73 and 74 Garden Road contain suitable conditions for the protection of the drinking water source. (Department of Water, Department of Regional Development and Lands)
- 7 The Department of Water to delegate responsibility for monitoring and enforcement measures within the Marble Bar Water Reserve to the Water Corporation. (Department of Water, Water Corporation)

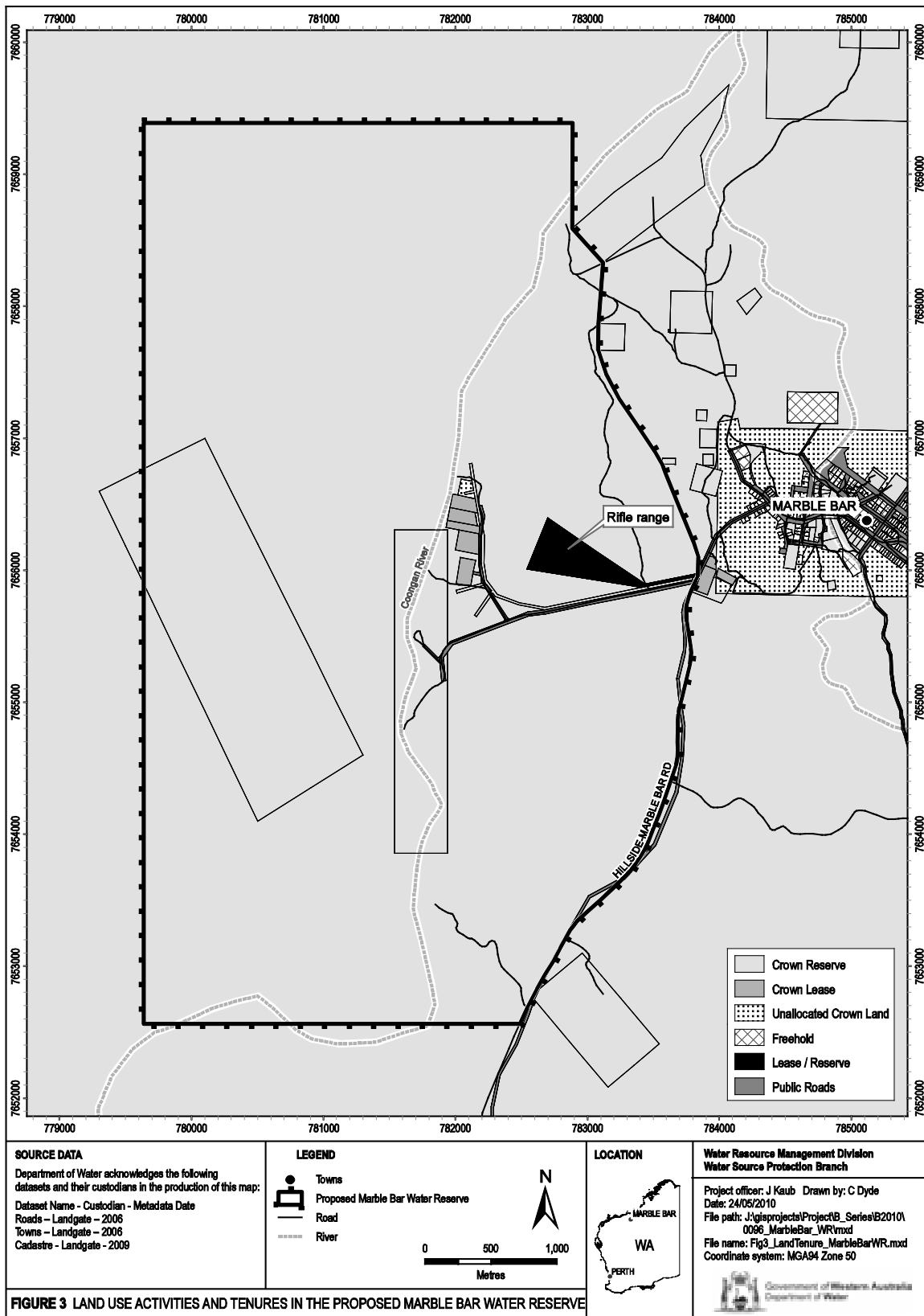
- 8 Implement an ongoing surveillance program within the water reserve, so that any incompatible land uses or water quality contamination threats may be identified. (Water Corporation)
- 9 Signs to be erected along the boundary of the Marble Bar Water Reserve to maintain and define the location, and promote awareness of the need to protect drinking water quality. Signs should include an emergency contact telephone number. (Water Corporation, Department of Water)
- 10 Horizon Power to consider extending the Marble Bar town power supply to Garden Road, so that the Coongan wellfield production and monitoring bores can be operated on mains power. (Horizon Power, Department of Water, Water Corporation)
- 11 A review of this plan should be undertaken after five years. (Department of Water)
- 12 When the plan is reviewed, consider whether the water reserve's boundaries adjacent to the Coongan River adequately reflect the actual recharge area of the Coongan wellfield. (Department of Water)

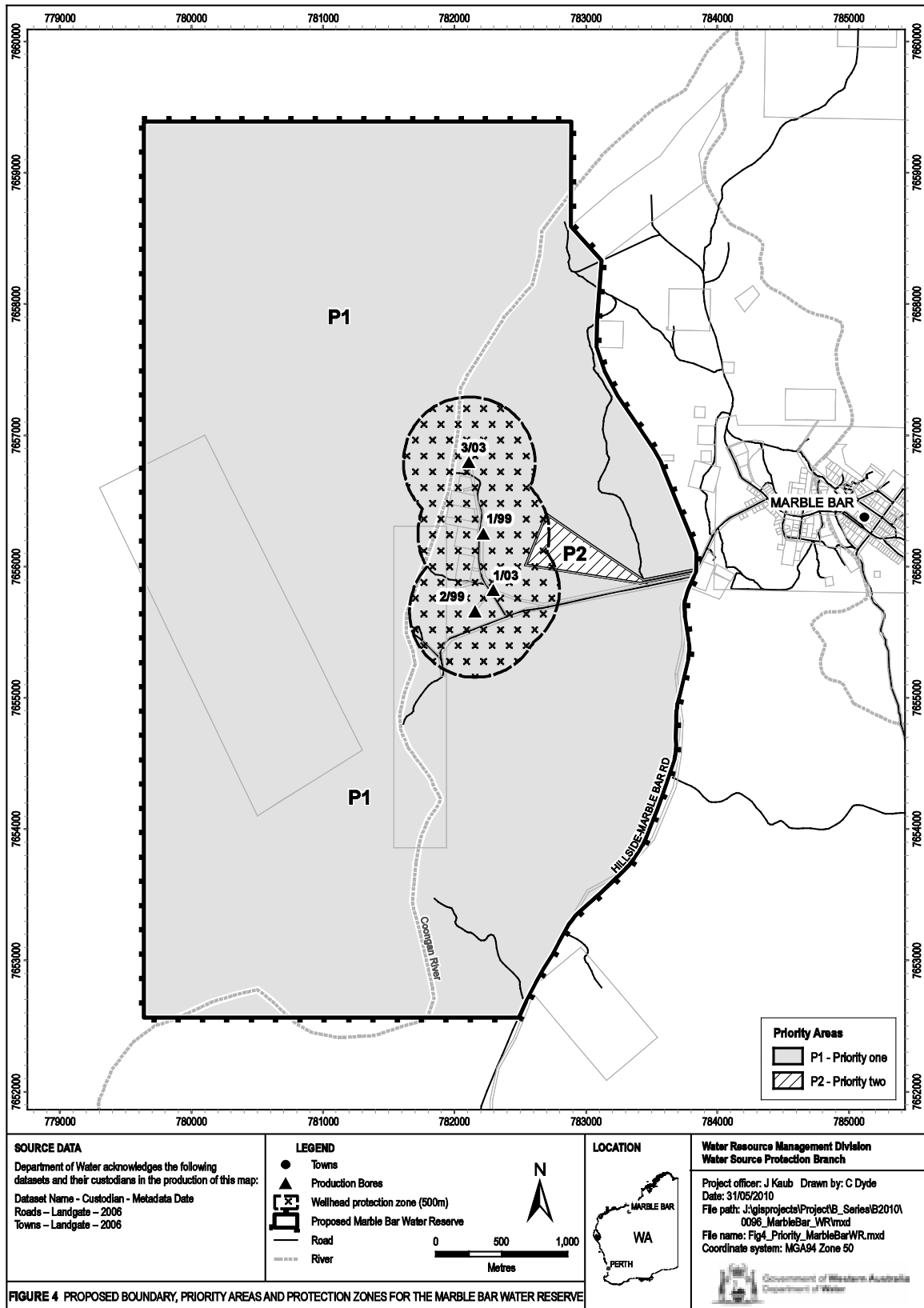
Appendices

Appendix A Figures









Appendix B Water quality data

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

The Water Corporation has monitored the raw (source) water quality from Marble Bar in accordance with the *National water quality management strategy: Australian drinking water guidelines 6, 2004* (ADWG) (NHMRC & NRMMC 2004a) and interpretations agreed to with the Department of Health. The raw water is monitored regularly for:

- aesthetic characteristics (non-health-related)
- health-related characteristics including
 - health-related chemicals
 - microbiological contaminants

The following data represents the quality of raw water from the Coongan wellfield. 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 the raw-water data presented 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 July 2004 to July 2009. 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 the Marble Bar refer to the most recent Water Corporation drinking water quality annual report at <www.watercorporation.com.au> What we do > Water quality > Water quality publications > Water quality annual report 2008–09.

Aesthetic

The aesthetic quality analyses for raw water from Marble Bar are summarised in the following table.

Aesthetic detections for Marble Bar

Parameter	Units	ADWG aesthetic guideline value*	Range of monitored values		
			Min-Max Med		
			Bore 1/99	Bore 2/99	Bore 7/74
Aluminium unfiltered	mg/L	N/A	<0.008–0.01 <0.008	<0.008–0.01 <0.008	<0.008–0.01 <0.008
Chloride	mg/L	0–250	180–230 200	235–245 240	360–525 380
Conductivity at 25°C	mS/m	N/A	110–175 135	135–170 150	180–245 215
Hardness as CaCO ₃	mg/L	0–200	199–263 215	377–411 400.5	480–542 502
Iron unfiltered	mg/L	0–0.3	<0.003	<0.003	<0.003–0.004 <0.003
pH	NO UNIT	6.5–8.5	7.21–7.34 7.22	6.94–7.14 7.05	7.08–7.26 7.15
Sodium	mg/L	0–180	190–225 205	160–175 172.5	260–300 275
Sulfate	mg/L	0–250	53–70 56	67–74 69.5	104–125 110
TFSS	mg/L	0–500	905–1060 952.5	1040–1100 1080	1460–1720 1500
Turbidity	NTU	0–5	<0.1–0.9 <0.1	<0.1–0.1 <0.1	<0.1–0.6 <0.1

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

Health related

Health-related chemicals

Raw water from Marble Bar is analysed for chemicals that are harmful to human health, including categories of chemicals such as inorganics, heavy metals, industrial hydrocarbons and pesticides. Health-related parameters that impact on water quality are summarised in the following table.

Health-related detections for Marble Bar

Parameter	Units	ADWG health guideline value*	Marble Bar raw water SP	
			Range	Median
Arsenic	mg/L	0–0.007	<0.002–0.003	<0.002
Barium	mg/L	0–0.7	0.03–0.045	0.0325
Boron	mg/L	0–4	0.36–0.5	0.43
Fluoride	mg/L	0–1.5	0.45–0.8	0.6
Molybdenum	mg/L	0–0.05	<0.0005–0.0035	0.00225
Nitrate as N	mg/L	0–11.29	1.1–1.7	1.6
Selenium	mg/L	0–0.01	<0.003–0.005	<0.003
Uranium	mg/L	0–0.02	0.006–0.009	0.007

* 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 & ARMCANZ 2004a).

Microbiological contaminants

Microbiological testing of raw water samples from the Marble Bar (Coongan wellfield) raw water point 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.

A detection of *Escherichia coli* in raw water abstracted from any bore may indicate contamination of faecal material through ingress in the bore, or recharge through to the aquifer (depending on aquifer type). During the review period of July 2004 to June 2009, positive *E. coli* counts were recorded in 12.5 per cent of samples. The bores are located adjacent to the river bed and are likely to be hydrogeologically connected.

Appendix C 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			
Crown land leases – for mainly residential purposes					
Locations 70, 72, 73, 74 and 143	<ul style="list-style-type: none"> - Pathogens from septic tanks and domestic animals - Nutrients from fertilisers, septic tanks and domestic animals - Hydrocarbon/chemical contamination from fuel and chemical spills 	Medium	<ul style="list-style-type: none"> - There are a small number of residences in the Coongan wellfield's recharge area 	<ul style="list-style-type: none"> - Water quality monitoring - Lease conditions 	<ul style="list-style-type: none"> - Appropriate lease conditions for renewed lease (see Section 3.1.1) - Best practice management for land-use activities and dwelling wastewater systems (refer to WQPN series – see References) - Education and awareness raising - Regular liaison between Department of Water/Water Corporation staff and leaseholders

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Roads and tracks					
Official roads and tracks	- Hydrocarbon contamination from fuel and chemical spills	Low	- There are a number of roads and tracks within the water reserve - Occasional off-road vehicle use is reported to occur,	- Water quality monitoring	- Best practice management (refer to WQPN series – see References) - Incident management procedures - Signage, for awareness raising and with emergency contact phone number
Off-road driving	- Hydrocarbon contamination from fuel and chemical spills	Low – medium	mostly for recreational purposes. It is understood that the current level of activity is low	- Water quality monitoring	- Planning controls
Crown land – for recreation purposes					
Rifle range	- Heavy metal (lead) contamination from spent shots - Pathogen and nutrient contamination from human waste	Medium	- Terms and conditions of lease, and whether in time the range could be relocated	- Water quality monitoring	- Best practice management (including regular removal of spent shots from the site) - Signage for education and awareness raising

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Marble Bar Pool (part of the Coongan River)	<ul style="list-style-type: none"> - Hydrocarbon contamination from fuel spills and leaks - Pathogens and nutrients from swimming or dead fauna entering the water 	Low	<ul style="list-style-type: none"> - There is only a small amount of water in the river on a permanent basis - The significance of the site for local Aboriginal people - High numbers of tourists visit the site 	<ul style="list-style-type: none"> - Water quality monitoring - Liaison with Yamatji Marlpa Barna Baba Maaja Aboriginal Corporation / Department of Indigenous Affairs, as required 	<ul style="list-style-type: none"> - Signage, for awareness raising and with emergency contact phone number - Planning controls
Bore operation and maintenance					
Diesel storage and transfer	<ul style="list-style-type: none"> - Hydrocarbon contamination caused by spills and leaks 	Medium	<ul style="list-style-type: none"> - Fuel storage is located close to the bores - Some bunding is present - Low volume of diesel stored 	<ul style="list-style-type: none"> - Water quality monitoring 	<ul style="list-style-type: none"> - Assessment of fuel storage area to determine potential for leakage - Best management practices (refer to WQPN series – see References) - Consider extending the Marble Bar town power supply to Garden Road, so that the wellfield can be operated on mains power

Land use/activity	Potential water quality risks		Consideration for management	Current preventative measures	Recommended protection strategies
	Hazard	Management priority			
Uncapped bores	- Pathogens from animal carcasses and faeces	Medium	- Uncapped bores provide a pathway for contaminants to move directly into the water source	- Water quality monitoring	- Cap, and where appropriate, fence off uncapped bores

Appendix D Photographs



Figure D1 Water storage tank Marble Bar



Figure D2 Coongan River



Figure D3 Marble Bar Pool



Figure D4 Production bore 1/99 and associated storage and maintenance shed in the Coongan wellfield

List of shortened forms

ADWG	<i>Australian drinking water guidelines</i>
AHD	Australian height datum
ANZECC	Australian and New Zealand Environment Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
CA	catchment area
CFU	colony forming units
HAZMAT	hazardous materials
ha	hectares
kL	kilolitre
km	kilometre
km²	square kilometre
LEMC	local emergency management committee
m	metres
mg/L	milligram per litre
mL	millilitre
mm	millimetre
MPN	most probable number
NHMRC	National Health and Medical Research Council
NRMMC	Natural Resource Management Ministerial Council
PDWSA	public drinking water source area
TCU	true colour units
TDS	total dissolved solids
TFSS	total filterable solids by summation
WHPZ	wellhead protection zone
WESTPLAN–HAZMAT	Western Australian plan for hazardous materials

Glossary

Abstraction	The pumping of groundwater from an aquifer, or the removal of water from a waterway or water body.
Adsorb	Adsorb means to accumulate on the surface of something. For example, microorganisms can adsorb onto soil particles.
Aesthetic guideline value	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 & NRMMC 2004a).
Allocation	The quantity of water that a licensee is permitted to abstract is their allocation, usually specified in kilolitres per annum (kL/a).
Aquifer	An aquifer is a geological formation or group of formations able to receive, store and transmit significant quantities of water.
Australian drinking water guidelines	The <i>National water quality management strategy: Australian drinking water guidelines 6, 2004</i> (NHMRC & NRMMC 2004a) (ADWG) outlines acceptable criteria for the quality of drinking water in Australia (see this plan's Bibliography).
Australian height datum	Australian height datum is the height of land in metres above mean sea level. For example, the AHD is +0.026 m at Fremantle.
Bore	A bore is a narrow, lined hole drilled into the ground to monitor or draw groundwater (also called a well).
Catchment	The physical area of land which intercepts rainfall and contributes the collected water to surface water (streams, rivers, wetlands) or groundwater.
Colony forming units	Colony forming units are a measure of pathogen contamination in water.
Fractured rock	An aquifer where groundwater is present in the fractures, joints, solution cavities, bedding planes and zones of weathering igneous, metamorphic and deformed sedimentary rocks. Fractured rock aquifers are highly susceptible to contamination from land-use activities when aquifers crop-out or sub-crop close to the land surface.
Health guideline value	The concentration or measure of a water quality characteristic that, based on current knowledge, does not result in any significant risk to the health of the consumer over a lifetime of consumption (NHMRC & NRMMC 2004a).

Hydrocarbons	A class of compounds containing only hydrogen and carbon, such as methane, ethylene, acetylene and benzene. Fossil fuels such as oil, petroleum and natural gas all contain hydrocarbons.
Hydrogeology	The study of groundwater, especially relating to the distribution of aquifers, groundwater flow and groundwater quality.
mg/L	A milligram per litre (0.001 grams per litre) is a measurement of a total dissolved solid in a solution.
Millisievert	A millisievert is a measure of annual radiological dose, with a natural dose equivalent to 2 mSv/yr.
Millisiemens per metre	Millisiemens per metre is a measure of electrical conductivity of a solution or soil and water mix that provides a measurement of salinity.
Most probable number	Most probable number is a measure of microbiological contamination.
Nephelometric turbidity units	Nephelometric turbidity units are a measure of turbidity in water.
Nutrient load	The amount of nutrient reaching the waterway over a given timeframe (usually per year) from its catchment area.
Nutrients	Minerals, particularly inorganic compounds of nitrogen (nitrate and ammonia) and phosphorous (phosphate) dissolved in water which provide nutrition (food) for plant growth.
Pathogen	A disease-producing organism that can cause sickness and sometimes death through the consumption of water, 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 seven indicates an acidic solution and above seven indicates an alkaline solution.
Point source pollution	Pollution originating from a specific localised source, e.g. sewage or effluent discharge; industrial waste discharge.

Pollution	Water pollution occurs when waste products or other substances (effluent, litter, refuse, sewage or contaminated runoff) change the physical, chemical or biological properties of the water, adversely affecting water quality, living species and beneficial uses.
Public drinking water source area	Includes all underground water pollution control areas, catchment areas and water reserves constituted under the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> and the <i>Country Areas Water Supply Act 1947 (WA)</i> .
Public sector circular number 88	A state government circular produced by the Department of Health providing guidance on appropriate herbicide use within water catchment areas.
Recharge	Recharge is the action of water infiltrating through the soil/ground 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.
Scheme supply	Water diverted from a source or sources by a water authority or private company and supplied via a distribution network to customers for urban and industrial use or for irrigation.
Stormwater	Rainwater that has run off the ground surface, roads, paved areas etc., and is usually carried away by drains.
Total dissolved solids	Total dissolved solids consist of inorganic salts and small amounts of organic matter that are dissolved in water. Clay particles, colloidal iron and manganese oxides, and silica fine enough to pass through a 0.45 micrometer filter membrane can also contribute to total dissolved solids. Total dissolved solids comprise sodium, potassium, calcium, magnesium, chloride, sulfate, bicarbonate, carbonate, silica, organic matter, fluoride, iron, manganese, nitrate (and nitrite) and phosphate (NHMRC & NRMCC 2004a).

Total filterable solids by summation	Total filterable solids by summation is a water quality test which is a total of the following ions: Na (sodium), K (potassium), Ca (calcium), Mg (magnesium), Cl equivalent (chloride), alkalinity equivalent, SO ₄ equivalent (sulfate) or S (sulfur) in grams, Fe (iron), Mn (manganese), and SiO ₂ (silicon oxide). It is used as a more accurate measure than total dissolved solids (TDS). The higher the value, the more solids that are present and generally the saltier the taste.
Treatment	Application of techniques such as settlement, filtration and chlorination to render water suitable for specific purposes, including drinking and discharge to the environment.
True colour units	True colour units are a measure of degree of colour in water.
Turbidity	The 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	Water quality is the collective term for the physical, aesthetic, chemical and biological properties of water.
Water reserve	A water reserve is an area proclaimed under the <i>Country Areas Water Supply Act 1947 (WA)</i> or the <i>Metropolitan Water Supply Sewerage and Drainage Act 1909 (WA)</i> for the purposes of protecting a drinking water supply.
Watertable	The upper saturated level of the unconfined groundwater is referred to as the watertable.
Wellfield	A wellfield is a group of bores located in the same area used to monitor or withdraw groundwater.
Wellhead	The top of a well (or bore) used to draw groundwater is referred to as a wellhead.
Wellhead protection zone	A wellhead protection zone (WHPZ) is usually declared around wellheads in public drinking water source areas to protect the groundwater from immediate contamination threats in the nearby area.

References

Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) & Australian and New Zealand Environment and Conservation Council (ANZECC) 1996, *Draft rural land uses and water quality – A community resource document*, ARMCANZ & ANZECC, Canberra.

Department of Health 2007, *Use of herbicides in water catchment areas*, Circular no: PSC 88, February 2007, Department of Health, Perth.

Department of Water various dates, Water quality protection note – *various titles*, Department of Water, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for water quality protection notes:

- WQPN no. 10: *Contaminant spills – emergency response*
- WQPN no. 25: *Land use compatibility in public drinking water source areas*
- WQPN no. 36: *Protecting public drinking water source areas*
- WQPN no. 44: *Roads near sensitive water resources*
- WQPN no. 60: *Tanks for mobile fuel storage in public drinking water source areas*
- WQPN no. 65: *Toxic and hazardous substances – storage and use*
- WQPN no. 70: *Wastewater treatment – onsite domestic systems*
- WQPN no. 76: *Land use planning in public drinking water source areas*
- WQPN no. 96: *Pest animal management in public drinking water source areas*

Department of Water & Department of Health 2008, *Risks from pathogenic micro-organisms in public drinking water source areas*, Department of Water, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for our advisory brochures relevant to drinking water.

Department of Water 2008, *Pilbara regional water plan – Strategic directions – Draft for public comment, November 2008*, Department of Water, Perth, available <<http://www.water.wa.gov.au>> Water regions> Pilbara> Pilbara regional plan>.

Geldreich, EE 1996, 'Pathogenic agents in freshwater resources', *Hydrological Processes*, vol. 10, pp. 315-333.

Government of Western Australia 1914, *Rights in Water and Irrigation Act*, Reprinted under the *Reprints Act (WA) 1984* as at 1 February 2008, available <www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_844_homepage.html>.

- Government of Western Australia 1947, *Country Areas Water Supply Act (WA)*, reprinted under the *Reprints Act 1984* as at 14 April 2008, available <www.slp.wa.gov.au/legislation/statutes.nsf/main_mrtitle_208_homepage.html>.
- Government of Western Australia 2007, *State water plan 2007*, Department of the Premier and Cabinet, Perth, available <www.water.wa.gov.au> Publications > Find a publication > A-Z browse.
- Hrudey, SE & Hrudey, EJ 2004, *Safe drinking water – Lessons from recent outbreaks in affluent nations*, IWA Publishing, London.
- Krogh, M, Davison, A, Miller, R, O'Connor, N, Ferguson, C, McClaughlin, V & Deere, D 2008, *Effects of recreational activities on source protection areas – Literature review*, Water Services Association of Australia, Melbourne.
- National Health and Medical Research Council (NHMRC) & Natural Resource Management Ministerial Council (NRMMC) 2004a, National Water Quality Management Strategy: *Australian drinking water guidelines*, Australian Government, Canberra, available <www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.
- NHMRC & NRMMC 2004b, *Water made clear – A consumer guide to accompany the Australian drinking water guidelines 2004*, Australian Government, Canberra, available <www.nhmrc.gov.au/publications/synopses/eh19syn.htm>.
- National Minimum Bore Specifications Committee 2003, *Minimum construction requirements for water bores in Australia*, 2nd edn, Land and Water Biodiversity Committee, Queensland, available <www.water.wa.gov.au> Publications > Find a publication > A-Z browse.
- State Emergency Management Committee 2005, Policy statement no. 7: *Western Australian emergency management arrangements*, Government of Western Australia, Perth.
- Water and Rivers Commission 1996, *Hydrogeology report HR 26: Explanatory notes on the Marble Bar 1:250 000 hydrogeological sheet Western Australia*, by DP Commander, Water and Rivers Commission, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for our policies.
- Water and Rivers Commission 2000, Water and Rivers Commission report WRP 31: *Marble Bar Water Reserve water source protection plan*, Water and Rivers Commission, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for our source protection plans and assessments.
- Water and Rivers Commission 2003, Statewide policy no. 13: *Policy and guidelines for recreation within public drinking water source areas on Crown land*, Water

and Rivers Commission, Perth, available <<http://drinkingwater.water.wa.gov.au>> and scroll down to the link for our policies.

Water Corporation 2005, *Marble Bar water source review 2004*, Water Corporation, Perth.

Water Corporation 2006, *SG097 Source protection operations manual*, Water Corporation, Perth.

Water Corporation 2009, *Marble Bar water resource management operation strategy*, prepared as a condition of the Marble Bar groundwater scheme water allocation licence and approved by the Department of Water January 2010.

Western Australian Planning Commission 1997, *State planning strategy*, Government of Western Australia, Perth, available <<http://www.planning.wa.gov.au/Plans+and+policies/Publications/52.aspx>>.

Western Australian Planning Commission 2003, Statement of planning policy no.2.7: *Public drinking water source policy*, Government Gazette Western Australia, 10 June 2003, pp. 2077-82, Government of Western Australia, Perth, available <<http://www.planning.wa.gov.au/Plans+and+policies/Publications/149.aspx>>

Western Australian Planning Commission 2006, State planning policy no.2.9: *Water resources*, Government Gazette Western Australia, 19 December 2006, pp. 5707-22 Government of Western Australia, Perth, available <<http://www.planning.wa.gov.au/Plans+and+policies/Publications/1281.aspx>>

World Health Organization 2004, *Guidelines for drinking-water quality – Volume 1 – Recommendations*, 3rd edn, World Health Organization, Geneva, available <www.who.int/water_sanitation_health/dwq/gdwq3rev/en/index.html>.

The background of the page is a solid olive green color. It features several large, overlapping, curved bands in lighter shades of green and yellow, creating a sense of movement and depth. These bands are positioned in the upper and middle sections of the page, framing the text area.

Department of Water

168 St Georges Terrace, Perth, Western Australia
PO Box K822 Perth Western Australia 6842
Phone: 08 6364 7600
Fax: 08 6364 7601
www.water.wa.gov.au